

ABOS Self-Assessment Examination Library of Questions

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Adult Reconstruction

1. Answer: D

C-reactive protein and erythrocyte sedimentation rate are used as first-line screening tests for periprosthetic joint infections. However, false negatives are most likely present in what scenario:

- A) In patients with diabetes
- B) In patients with HIV
- C) Patients with autoimmune disease on disease modifying agents
- D) When infection is caused by *Cutibacterium acnes*
- E) During the early postoperative period

Discussion: ESR and CRP below the threshold do not exclude the diagnosis of PJI. These diagnostic markers may be normal when PJI is caused by slow-growing organisms, since the low-grade infection may not necessarily elicit a physiological inflammatory response. Additionally, the administration of therapeutic antibiotics before laboratory workup may result in false negative results in ESR and CRP. False positives may occur as well; in the early postoperative period, these markers may be elevated.

Reference: Team Orthobullets (D) MD

2. Answer: C

After further consultation with the above patient she asks you what the consequence of component retention and polyethylene liner exchange is to her long term success of infection resolution?

- A) Minimal long term consequence. You expect that open debridement, polyethylene liner exchange, and IV antibiotics will be 90% successful.
- B) No consequence, if she fails the open debridement, polyethylene liner exchange, and iv antibiotics she can then proceed with a two stage revision with a 90% chance of success
- C) Moderate consequence, if she fails the open debridement, polyethylene liner exchange, and iv antibiotics she can then proceed with a two stage revision with a 70% chance of success
- D) Significant consequence, if she fails the open debridement, polyethylene liner exchange, and iv antibiotics she can then proceed with a two stage revision with a 50% chance of success

Discussion: The patient in question #62 has a staph aureus infection for an indeterminate amount of time two years after total knee replacement. The most appropriate treatment option is two stage revision. Although open debridement with liner exchange and IV antibiotics may be appropriate in some infections, such as *S epidermidis* and acute hematogenous infections, it has been less successful in treating *S aureus* infection (less than 10%). Therefore, two stage revision is most appropriate in this patient with a staph aureus infection for an indeterminate amount of time.

Additionally, it has been shown that results of two stage revision after a failed debridement with liner exchange are worse (30 % failure rate) than with immediate two stage revision (10% failure rate).

Reference: Orthopaedic Knowledge Update 4: Hip and knee reconstruction, page 207/8. Glassman, Lachiewicz, Tanzer.

3. Answer: B 2020

When planning a THA for a patient with DDH and a significant leg length discrepancy how much length can be added to the shortened limb safely?

- A) 2 cm
- B) 4 cm
- C) 6 cm
- D) 8 cm

Discussion: When performing THA in patients with significant DDH and concomitant shortening of the limb, the incidence of sciatic nerve palsy is increased with lengthening greater than 4cm

Reference: Orthopaedic Knowledge Update 4: Hip and knee reconstruction, page 233. Glassman, Lachiewicz, Tanzer.

4. Answer: C 2020

Patella Clunk Syndrome is most frequently associated with:

- A) First generation cruciate retaining knee designs
- B) Entrapment of hyperplastic tissue along the anterior femoral flange
- C) Occurs with active knee extension from 60 degrees to 30 degrees of extension
- D) Occurs with active knee flexion from 30 degrees to 60 degrees

Discussion: Patella clunk syndrome is associated with first generation PS knee designs with entrapment of hyperplastic scar tissue about the superior aspect of the patella in the intercondylar notch during active knee extension.

Reference: References: Orthopaedic Knowledge Update 4: Hip and knee reconstruction, page 152. Glassman, Lachiewicz, Tanzer.

5. Answer: D 2020

The number of total knee replacements in the US:

- A) Has stayed the same from 1993-2010
- B) Has decreased slightly from 1993-2010
- C) Is expected to increase by 25% through 2020
- D) Is expected to increase by over 100% by 2020
- E) Will not change through 2020

Discussion: The demand for primary TKAs is expected to grow by 110% by 2020. The number of TKAs in the US tripled from 1993-2010.

Reference: Kurtz, S. M., Ong, K. L., Lau, E., & Bozic, K. J. (2014). Impact of the Economic Downturn on Total Joint Replacement Demand in the United States. *The Journal of Bone & Joint Surgery*, 96(8), 624-630.

6. Answer: A 2020

Analysis of TKA patients in a Medicare sample comparing various hospital length of stays found:

- A) That the outpatient group had less overall costs than the groups with longer length of stays
- B) Shorter hospital stays may be associated with less favorable outcomes
- C) Not all care centers may be able to provide the appropriate support with outpatient discharges
- D) Proper screen and surgical timing may affect outcomes for outpatient procedures

Discussion: Costs at 2 years were reduced by over \$8,000 for the outpatient group and nearly \$2000 less compared to the 1-2 day group, and \$1100 compared to the 5+ day group. Shorter hospital stays require appropriate services and education to improve outcomes with outpatient discharges.

Reference: 1.Lovald, S. T., Ong, K. L., Malkani, A. L., Lau, E. C., Schmier, J. K., Kurtz, S. M., & Manley, M. T. (2013). Complications, mortality, and costs for outpatient and short-stay total knee arthroplasty patients in comparison to standard-stay patients. *The Journal of arthroplasty*, 29(3), 510-515.

7. Answer: B 2020

The demographics of primary and revision THA in Medicare patients between 1991-2008:

- A) The mean length of stay for primary THA increased from 3.7 to 9.1 days
- B) The mean length of stay for primary THA decreased from 9.1 to 3.7 days
- C) Decreased hospital stay led to fewer readmissions
- D) Decreased hospital stay led to fewer discharges to rehabilitation centers

Discussion: From 2001-2008, the mean length of stay for primary THA decreased from 9.1 to 3.7 days. The decreased stay corresponded with an increase in the number of patients discharged to rehab centers and to an increase in patient readmissions.

Reference: 1.Cram, P., Lu, X., Kaboli, P. J., Vaughan-Sarrazin, M. S., Cai, X., Wolf, B. R., & Li, Y. (2011). Clinical characteristics and outcomes of Medicare patients undergoing total hip arthroplasty, 1991-2008. *Jama*, 305(15), 1560-1567.

8. Answer: A 2020

Proposed benefits of multimodal pain management include:

- A) Reducing individual doses of analgesics
- B) Fewer analgesic gaps
- C) Minimize side effects of any one medication

Discussion: Multimodal pain management uses multiple analgesics to achieve a synergistic or additive effect. Consequently, it reduces dosing of any individual analgesic, thereby minimizing side effect. Dosing of additional medications also allows fewer analgesic caps with possibly improved functional outcomes and patientsatisfaction

Reference: Kehlel, et al. *Anesth Analg*. 1993. White, *Curr Opin Investig Drugs* 2008. Skinner *Am J Orthop* 2004

9. Answer: D

A patient presents with a painful total hip arthroplasty, as shown below. An infection work-up demonstrates an ESR of 20 and a C-reactive protein of 0.8 mg/L. Metal ions demonstrate a serum cobalt level of 21 ppb and a serum chromium level of 6 ppb. What is the source of the patient's pain?

- A) Metal-on-Metal Articulation
- B) Polyethylene-induced Osteolysis
- C) Calcar Fracture
- D) Modular Junction Corrosion
- E) Stress Shielding

Discussion: Modular junction corrosion has a differential elevation in the serum cobalt ions when compared to the serum chromium ions.



References: Cooper, H. J., et al. (2012). "Corrosion at the head-neck taper as a cause for adverse local tissue reactions after total hip arthroplasty." *J Bone Joint Surg Am* **94**(18): 1655-1661. Huber, M., et al. (2009). "Presence of corrosion products and hypersensitivity-associated reactions in periprosthetic tissue after aseptic loosening of total hip replacements with metal bearingsurfaces." *Acta Biomater* **5**(1): 172-180. Korovessis, P., et al. (2006). "Metallosis after contemporary metal-on-metal total hip arthroplasty. Five to nine-yearfollow-up." *J Bone Joint Surg Am* **88**(6): 1183-1191. Park, Y. S., et al. (2005). "Early osteolysis following second-generation metal-on-metal hip replacement." *J Bone Joint Surg Am* **87**(7): 1515-1521.

10. Answer: E

A patient presents with a painful metal-on-metal total hip arthroplasty as shown below. Exam findings are all normal except for pain localized to the groin with resisted hip flexion. All infectious workup was normal and metal ion levels were within normal limits. CT scan demonstrated a retroverted component. What would be the best diagnostic modality to delineate the reason for failure?

- A) MRI without contrast
- B) Ultrasound
- C) Lumbar spine roentgenograms
- D) MRI with contrast
- E) Iliopsoas injection



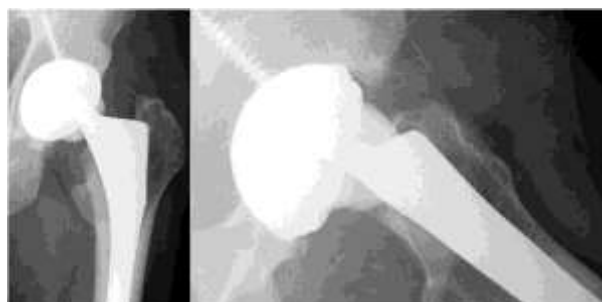
Discussion: Important exam findings include pain with resisted hip flexion which indicates the diagnosis of iliopsoas impingement, especially in the setting of a retroverted acetabular cup or high-profile cup and articulation. Iliopsoas impingement can be confirmed with an interventional radiology-guided iliopsoas injection.

Reference: Fabi DW, Levine BR, Paprosky W, Sporer S, DellaValle CV, Klein G, Levine H, Hartzband M. Metal-on-Metal Total Hip Revisions: A Review of Causes, Clinical Outcomes and a High Incidence of Early Failure. *Orthopaedics* 2012.

11. Answer: B

What is the incidence of the finding below in current generation ceramic bearings?

- A) .5%
- B) .004%
- C) .05%
- D) .4%
- E) .02%



Discussion: A distinct issue with COC bearings is the incidence of liner and/or femoral head fracture. Earlier generation COC bearings and ceramic heads alone had a high incidence of fracture with bearing produced before 1990 demonstrating a rate of 13.4% as states preciously. Newer generation Ceramic heads and liners have fortunately improved upon this complication and now have an extremely low incidence of fracture with a reported incidence of 0.004%. Diagnosis of head and liner fracture is relatively straightforward as this is often noticeable on plain roentgenograms.

Reference:

Willmann G. Ceramic femoral head retrieval data. *Clin Orthop Relat Res.* 2000 Oct; (379):22-8.

12. Answer: A

Unique to ceramic bearings is the incidence of squeaking. Current causes of this phenomenon are not entirely known. However, proposed explanations include:

- A) Edge-loading and stripe wear
- B) Corrosion and edge-loading
- C) Stripe-wear and corrosion
- D) Anteverted femoral component and corrosion
- E) Stripe wear and elevated anteverted femoral component

Discussion: Unique to COC THA is the incidence of clinically audible “squeaking”. This phenomenon has a reported incidence range of 0.7% to 20.9%. Causes of this occurrence is currently unknown however, proposed etiologies include edge-loading, stripe-wear, component malposition and altered fluid mechanics of the bearing surface.

References: *Chevillotte C, Trousdale RT, Chen Q, Guyen O, An KN. The 2009 Frank Stinchfield Award: "Hip squeaking": a biomechanical study of ceramic-on-ceramic bearing surfaces. Clin Orthop Relat Res. 2010 Feb;468(2):345-50. doi:10.1007/s11999-009-0911-x. Epub 2009 Jun 19.*

Restrepo C, Parvizi J, Kurtz SM, Sharkey PF, Hozack WJ, Rothman RH. The noisy ceramic hip: is component malpositioning the cause? J Arthroplasty. 2008 Aug;23(5):643-9. doi: 10.1016/j.arth.2008.04.001.

Sexton SA, Yeung E, Jackson MP, Rajaratnam S, Martell JM, Walter WL, Zicat BA, Walter WK. The role of patient factors and implant position in squeaking of ceramic-on-ceramic total hip replacements. J Bone Joint Surg Br. 2011 Apr;93(4):439-42. doi: 10.1302/0301-620X.93B4.25707

13. Answer: D

A 70 year-old female with a history of multiple dislocations in her left hip was revised to a dual-mobility construct. Following her surgery, she initially did very well but then went on to dislocate her hip again while getting out of a car. She went to an outside emergency department where she was treated via a closed reduction and discharged home. She later presented to the office with a new onset of painless crepitus with ambulation in her hip as well as a golf ball sized mobile mass in her buttock. New Xrays from your office visit as well as the advanced imaging you order are shown below. What is the diagnosis?

- A) Liner fracture
- B) Ceramic femoral head fracture
- C) A complete dislocation of the femoral head from the acetabular component
- D) An intraprostatic disassociation

Discussion: The left femoral head is eccentrically located within the acetabulum. The MRI demonstrates the dual mobility liner in the soft tissue. When the hip was relocated, the articulating polyethylene liner became disassociated from the femoral head. This is a rare but described complication of this device. It is important to recognize that the eccentrically located femoral head within the cup calls for further work-up with advanced imaging.



References: Banka, T. R., Ast, M. P., & Parks, M. L. (2014). Early intraprosthetic dislocation in a revision dual-mobility hip prosthesis. *Orthopedics*, 37(4), e395–7. doi:10.3928/01477447-20140401-63Langlois, J., Hage, El, S., & Hamadouche, M. (2014). Intraprosthetic dislocation: a potentially serious complication of dual mobility acetabular cups. *Skeletal Radiology*, 43(7), 1013–1016. doi:10.1007/s00256-014-1824-7Philippot, R., Boyer, B., & Farizon, F. (2013). Intraprosthetic dislocation: a specific complication of the dual-mobility system. *Clinical Orthopaedics and Related Research*, 471(3), 965–970. doi:10.1007/s11999-012-2639-2 (Banka, Ast, & Parks, 2014; Langlois, Hage, & Hamadouche, 2014)

14. Answer: C

A 68 year-old female comes in following a revision total hip arthroplasty for a history of multiple dislocations. She was revised to a modular dual mobility cup. The patient initially did well, however 1 month after her revision she felt a pop in her left hip and presented to the ED where an X-ray was taken. The emergency room physician tried to relocate the hip multiple times under conscious sedation but was not successful. What is the most accurate diagnosis and what is the next best step in treating the patient?

- A) Hip dislocation - Attempt closed reduction under general anesthesia in the operating room
- B) Femoral head and articulating liner dissociation – Take the patient to the operating room and re-engagement of the polyethylene liner to the femoral head followed by reduction of the joint
- C) Acetabular liner and cup disassociation- Take the patient to the operating room and attempt to reengage the acetabular liner and cup followed by hip joint reduction
- D) Intraprosthetic disassociation – Take the patient back to the OR for a planned both component revision



Discussion: Though choice D may inevitably happen, this constructed likely failed due to lack of properly engaging the CoCr liner within the cup. As a both component revision poses significant risk to the patient, it is worthwhile taking the patient back to the OR to inspect the locking mechanism in the cup, assuring that the proper size liner was used, and reimpacting the liner. If the hip is found to be stable, it is reasonable to use the current components.

Reference: Philippot, R., Boyer, B., & Farizon, F. (2013). Intraprosthetic dislocation: a specific complication of the dual-mobility system. *Clinical Orthopaedics and Related Research*, 471(3), 965–970. doi:10.1007/s11999-012-2639-2

15. Answer: A

When used in the setting of recurrent instability, what is the failure rate from instability from registry data that supports the use of dual mobility devices?

- A) 1-5% re-dislocation rate
- B) 5-10% re-dislocation rate
- C) 15-25% re-dislocation rate
- D) 25-50% re-dislocation rate
- E) >50% re-dislocation rate

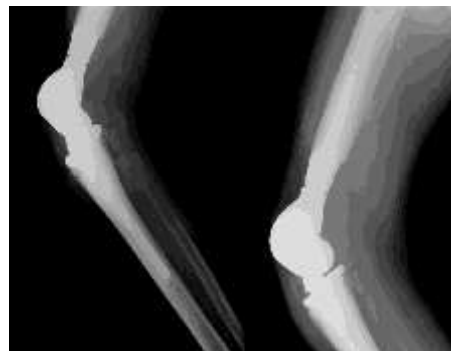
Discussion: From the Swedish registry, Hailer et.al. looked at the failure rate of 228 patients when they were revised for instability. They found an overall failure rate after revision to be 8%. However, their re-dislocation rate was only 2% (4 patients).

Reference:

Hailer, N. P., Weiss, R. J., Stark, A., & Kärrholm, J. (2012). Dual-mobility cups for revision due to instability are associated with a low rate of re-revisions due to dislocation: 228 patients from the Swedish Hip Arthroplasty Register. *Acta Orthopaedica*, 83(6), 566–571. doi:10.3109/17453674.2012.742395

16. Answer: A

A 77-year-old male is in your office to discuss definitive treatment for his left knee. He had staged bilateral TKAs nine years ago. Five years ago he developed an infection in his right knee that was treated with a two-stage resection protocol. After reimplantation, he developed another chronic periprosthetic infection which was treated with a right above knee amputation. Two years ago he developed an infection in his left TKA. A debridement with modular bearing exchange failed to cure the infection. He underwent a two-stage resection-reimplantation protocol 1 year ago. At reimplantation, a medial gastrocnemius flap was placed over the anterior knee and all cultures were negative. He presents now to your office with an open wound with an exposed prosthesis. A photo of the knee and radiographs are shown below in Figures 1a-1c. He has a knee contracture of 85° and his extensor mechanism is completely deficient. His foot is warm with a +1 dorsalis pedis pulse and normal sensation to the foot. Fluid cultures from the knee are growing staph epidermidis. He now takes a total of 20mg of Hydrocodone per day for his knee pain. What would be the best treatment option?



Above knee amputation

- Arthrotomy, debridement, modular bearing exchange and placement of a latissimus dorsi free flap to the anterior knee. IV antibiotics for six weeks.
- Resection of TKA implants, debridement, IV antibiotics for six weeks. Definitive treatment with permanent resection arthroplasty.
- Two-stage resection protocol. Definitive reconstruction with a knee fusion.
- Two-stage resection protocol. Definitive reconstruction with another endoprosthetic rotating hinge TKA.

Reference: Garvin KL, Konigsberg BS. Infection Following Total Knee Arthroplasty: Prevention and Management. JBJS. 2011; 93: 1167-75.

17. Answer: C

Of all the clinical scenarios listed below, which one provides an absolute diagnosis of a periprosthetic joint infection?

- A painful TKA with a serum CRP of 1.8 (0 to 0.8 normal range) and an ESR of 24 (0 to 20 normal range)
- A swollen TKA with a mild effusion with growth of Staph Epi on Broth Culture medium
- A draining sinus located at the posterior corner of the knee which upon probing communicates to the knee prosthesis
- A stiff, painful TKA with a positive Technetium bone scan that shows activity around the femoral and tibial components on all 3 phases of the scan
- A painful TKA with an aspiration WBC of 2400 WBC/dl with 60% Neutrophils, a serum CRP of 1.0 (0 to 0.8 normal range), and an ESR of 18 (0 to 20 normal range)

Reference: Parvisi J, Adeli B, Zmistowski B, Restrepo C, Greenwald AS. Management of Periprosthetic Joint Infection: The Current Knowledge. J Bone Joint Surg Am. 2012; 94: e104(1-9).

18. Answer: B

Infection associated with joint arthroplasty is a significant, debilitating condition. What is the main pathomechanical source of deep periprosthetic infection?

- Nasopharyngeal contamination of the wound from the surgeon
- Airborne contamination of the prosthesis via bacteria shed from operating room personnel
- Hematogenous seeding of the wound from bacteria derived from the lung
- Hematogenous seeding of the wound from bacteria derived from the bladder or gut
- Bacterial contamination of the prosthesis from an open draining wound

Reference: McPherson, E.J., Peters, C.L., Musculoskeletal Infection, In: Flynn JM, ed. Orthopaedic Knowledge Update 10. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2011: 239-58.

19. Answer: E

Bacteria that have transformed into a biofilm state become significantly more resistant to antibiotics compared to their planktonized state. How much more resistant can they become?

- A) Up to 15x more resistant
- B) Up to 50x more resistant
- C) Up to 100x more resistant
- D) Up to 1,000x more resistant
- E) Up to 15,000x more resistant

Reference: Howlin RP, Brayford MJ, Webb JS, Cooper JJ, Aiken SS, Stoodley P. Antibiotic-Loaded Synthetic Calcium Sulfate Beads for Prevention of Bacterial Colonization and Biofilm Formation in Periprosthetic Infections. *Antimicrobial Agents and Chemotherapy*. 2015; 59(1): 111-20.

20. Answer: B

Of the treatment regimens listed below, which modality is least likely to reduce the risk of intraoperative colonization of a total joint wound?

- A) Vertical laminar airflow system with surrounding plexi-glass shields to the level of the surgeon's shoulder
- B) Personal hooded body exhaust system with inflow above head and exhaust coming out of the bottom of the surgical gown
- C) Antibiotic-loaded cement, not exceeding 1 gram per 40 gram bag of PMMA powder
- D) Intraoperative ultraviolet light with all personnel appropriately protected with UV-protective gear
- E) Perioperative intravenous antibiotics started 1 hour before surgery and continued for 24 hours after surgery

Reference: McPherson, E.J., Peters, C.L., Musculoskeletal Infection, In: Flynn JM, ed. Orthopaedic Knowledge Update 10. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2011: 239-58.

21. Answer: A 2020

A 56-year-old man undergoes a primary TKA. He has no medical problems other than hypertension. The patient is anticoagulated perioperatively with enoxaparin sodium. The surgeon did not use a post-operative drain. The patient has had persistent sero-bloody drainage from the inferior aspect of the knee incision, despite compressive wraps. It is now post-op day 5. What is the appropriate next treatment step?

- A) Open exploration, lavage, and change anticoagulation regimen
- B) Open exploration, lavage, and continue anticoagulation regimen
- C) Open exploration, lavage, and discontinue anticoagulation regimen
- D) Discontinue anticoagulation regimen, continue with compressive wraps, start IV antibiotics, and once drainage has stopped, restart anticoagulation with a different regimen
- E) Discontinue anticoagulation regimen, continue with compressive wraps, and once drainage has stopped, restart anticoagulation with a different regimen

Reference: Patel VP, Walsh M, Sehgal B, Preston C, DeWal H, Di Cesare PE. Factors associated with prolonged wound drainage after primary total hip and knee arthroplasty. *J Bone Joint Surg Am*. 2007; 89(1): 33-8.

22. Answer: E 2020

The responsibility of minimizing infection risk for a patient undergoing a total joint arthroplasty procedure primarily rests with:

- A) JACHO
- B) The hospital administration
- C) The infection control team within the hospital
- D) The OR director
- E) The surgeon

Reference: McPherson, E.J., Peters, C.L., Musculoskeletal Infection, In: Flynn JM, ed. Orthopaedic Knowledge Update 10. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2011: 239-58.

23. Answer: B

You are performing a total shoulder replacement. With an understanding of the intra-operative pathomechanics of bacterial contamination, which habit (intentional or unintentional) listed below would most likely increase the chance of bacterial contamination of the operative wound?

- A) Placement of an ioban dressing over the operative extremity
- B) The continual use of a yankaur suction tip placed into the depths of the surgical wound
- C) Preventing the opening and closing of the OR door into the main hallway once the total joint procedure has started
- D) Pre-positioning of all anticipated implant parts within the operative theatre before the surgical procedure commences
- E) The use of body exhaust system by the OR team

Reference: Givissis P, Karataglis D, Antonarakos P, Symeonidis PD, Christodoulou A. Suction during orthopaedic surgery. How safe is the suction tip? Acta Orthop Belg. 2008; 74: 531-33.

24. Answer: A

What main determinate separates acute periprosthetic infection from a chronic periprosthetic infection?

- A) The elaboration of a peribacterial biofilm that envelops the prosthesis, devitalized bone, and soft tissue
- B) Gram stain (i.e., gram stain positive vs. gram stain negative organism)
- C) A bone scan that is positive on all 3 phases
- D) Wound drainage in a post-operative total joint wound
- E) The absolute value of the quantitative C-reactive protein

Reference: McPherson EJ. Adult Reconstruction. In: Miller MD, Thompson SR, Hart JA, eds. Review of Orthopaedics. 6th ed. Philadelphia, PA: Elsevier Saunders; 2012: 353-427.

25. Answer: D

Of the below listed options, which would be the best treatment for an established chronic PJI of the hip?

- A) A 3-month course of IV antibiotics via a PICC line
- B) Arthrotomy, radical debridement surgery, modular bearing exchange, and placement of dissolvable antibiotic-loaded calcium sulphate beads
- C) Implant removal, radical periarticular debridement, placement of dissolvable antibiotic-loaded calcium sulphate beads, and IV antibiotics for 6 weeks
- D) Implant removal, radical periarticular debridement, lavage, and placement of a high-dose antibiotic-loaded cement spacer and dissolvable antibiotic-loaded calcium sulphate beads
- E) Surgical ablation of the limb, IV antibiotics for 6 weeks, and application of a wound vac to operative site for 7-10 days

Reference: McPherson EJ. Adult Reconstruction. In: Miller MD, Thompson SR, Hart JA, eds. Review of Orthopaedics. 6th ed. Philadelphia, PA: Elsevier Saunders; 2012: 353-427.

26. Answer: E 2020

Based upon the International Consensus Group on Periprosthetic Joint Infection, which statement below is not a recommended technique in the OR?

- A) Reduce traffic flow in the OR to an absolute minimum
- B) Cover all surgical equipment trays with sterile towels (not large drapes) until the procedure commences
- C) Change suction tips every 90 minutes during the procedure
- D) Change gloves every 90 minutes during the procedure
- E) The use of cloth head caps

Reference: Jefferson University Hospitals. Consensus document from the International Consensus Group on Periprosthetic Joint Infection. Available at: <http://hospitals.jefferson.edu/departments-and-services/orthopedic-surgery/periprosthetic-joint-infection/>. Accessibility verified February 10, 2015.

27. Answer: E

The advantages of metal-on-metal hip prostheses when compared to metal-on-polyethylene include all of the following EXCEPT:

- A) Reduced total wear
- B) METAL ON METAL bearings self-polish
- C) Large heads increase range of motion
- D) MOM bearing's wear rate is 2% that of METAL ON POLYETHYLENE
- E) Large heads increase impingement and dislocation rates

Reference: OKU-10 Chapter 7 - Pages 76-77

28. Answer: B

Compared to METAL ON POLYETHYLENE bearing surfaces, METAL ON METAL bearings exhibit a steady state wear rate per year of:

- A) 1-2 microns
- B) 3-7 microns
- C) 8-10 microns
- D) 0.25 – 1 micron
- E) 10-12 microns

Reference: OKU-10 Chapter 7 - Pages 76-77

29. Answer: A

METAL ON METAL bearings exhibit a run in wear rate in the first one million cycles of about:

- A) 25 microns
- B) 10 angstroms
- C) 12 - 17 microns
- D) 50 microns
- E) 25 angstroms

Reference: OKU-10 Chapter 7 - Pages 76-77

30. Answer: D

The histology characteristics of an ALVAL lesion are all of the following except:

- A) Vasculitis
- B) Lymphocytic response
- C) Like a type IV delayed hypersensitivity reaction
- D) A macrophage response
- E) Perivascular infiltrate

Reference: OKU-10 Chapter 7 - Page 77

31. Answer: C

What is not an identifiable characteristic of a "Pseudotumor?"

- A) Joint effusion
- B) Local soft tissue reaction
- C) Requiring loosening of components
- D) METAL ON METAL bearing surfaces
- E) Independent of failure or loosening of components

Discussion: Pseudo tumors are thought to occur with greater frequency when there is higher wear concentrations of metal ions. Component malposition and edge loading are felt to increase wear particles and the possibility of pseudo tumors. ALVAL pseudo tumor from metal-on-metal wear.

Reference: OKU-10 Chapter 7 - Page 7

32. Answer: C

How much greater is the systemic distribution of metal ions in the body in patients with METAL ON METAL bearing articulations:

- A) 10-15 fold
- B) 1 to 3 fold
- C) 5 to 10 fold
- D) 4 fold
- E) Greater than 15 fold

Reference: OKU-10 Chapter 7- Page 77

33. Answer: C

Has there been any proof the increased systemic metal ions from METAL ON METAL implants increases the risk of malignancy?

- A) Some proof
- B) Yes, in both sexes
- C) No
- D) Yes, for young females
- E) No for females but yes for males

Discussion: Current studies have not proven a direct relationship between metal ion levels and primary malignancies

Reference: OKU-10 Chapter 7- Page 77

34. Answer: D

A patient underwent a metal on metal total hip arthroplasty. A few years later, the patient began experiencing pain and an antalgic limp. The patient ultimately was revised and intraoperative images are shown below. What is a major risk factor associated with metal-on-metal total hip arthroplasty that may have contributed to the findings below:

- A) Male gender
- B) Anteverted acetabular cup position
- C) Third body wear
- D) Vertical acetabular cup position
- E) Age

Discussion: Causes of these local soft tissue ramifications have been thought to be attributed to component malposition (particularly vertical and retroverted), female gender and femoral head size.

**References:**

1. Grammatopoulos G, Pandit H, Glyn-Jones S, McLardy-Smith P, Gundle R, Whitwell D, Gill HS, Murray DW. Optimal acetabular orientation for hip resurfacing. *J Bone Joint Surg Br.* 2010 Aug;92(8):1072-8.
2. Onda K, Nagoya S, Kaya M, Yamashita T. Cup-neck impingement due to the malposition of the implant as a possible mechanism for metallosis in metal-on-metal total hip arthroplasty. *Orthopedics.* 2008 Apr;31(4):396.

35. Answer: C

Work-up of a painful metal-on-metal total hip arthroplasty demonstrated a large effusion on MRI. ESR and CRP were within normal limits. Metal ion levels were found to be highly elevated. Preoperative cell count demonstrated 917 WBCs and 51% PMNs and cultures were negative. Intra-op pathologic specimens demonstrated all areas <5 WBCs/HPF. Imaging demonstrated well fixed components with a vertically oriented acetabular cup and appropriately oriented femoral component. What is the likely best course of treatment?

- A) Total hip arthroplasty explant and placement of antibiotic spacer
- B) Femoral head and liner exchange to a ceramic on polyethylene bearing with retention of acetabular and femoral components
- C) Acetabular cup and femoral component revision
- D) Femoral component revision and conversion to a ceramic on polyethylene bearing with retention of acetabular cup
- E) Acetabular cup revision and conversion to a ceramic on polyethylene bearing with retention of femoral component



Discussion: Infection needs to be investigated, as a reason for MOM THA failure. However, one needs to be aware that distinction between septic failure and MOM-related failures can, at times, be difficult to differentiate. MOM reactions can mimic infection with elevated inflammatory markers (ESR and CRP), elevated synovial cell counts (need a manual count ordered) and effusions that grossly resemble purulent material. With a stable ingrown cup that is malpositioned and with associated elevated metal ion levels, acetabular cup revision should be considered particularly with a vertical component as this can predict an increase in the risk of polyethylene liner edge-loading and ultimately early failure either via liner fracture or early liner wear from edge-loading.

Reference: Hsu AR, Kim JD, Fabi D, Levine BR. Adverse reactions in metal-on-metal total hip arthroplasty: two cases presenting as pseudoseptic acetabular component loosening. *Am J Orthop (Belle Mead NJ).* 2011 Oct;40(10):509-513.

36. Answer: E

Which of the following is considered an "off-label" use for the only modular dual mobility device currently approved by the FDA?

- A) Using an "on-growth" cup that accepts the CoCr liner
- B) Using an "in-growth" cup that accepts the CoCr liner
- C) Using ceramic head from the same manufacturer
- D) Using a CoCr head from the same manufacturer
- E) Using the modular dual mobility bearing with a stem from a different manufacturer.

Discussion: It is considered to be an off-label use of the Stryker Dual Mobility System to use a head from a different manufacture. The reason being is that in the smaller bearing, the 22mm bearing, the head size is actually 22.2mm. Therefore, using this device when a different companies stem is retained, is not recommended. The Trident cup is an HA coated on-growth cup and the Tritanium cup is a porous in-growth cup that both accept the CoCr liner that. You can use either ceramic or CoCr bearings as long as they are from Stryker.

References: stryker.com

37. Answer: B

A patient underwent a total hip arthroplasty. A few years later, the patient began experiencing pain and an antalgic limp. The patient ultimately was revised. An intra-operative image is shown below. What process led to the failure of the total hip arthroplasty?

- A) Osteolysis
- B) Corrosion
- C) Infection
- D) Malposition
- E) Implant Fracture



Discussion: Corrosion at the trunnion of modular total hip implants can lead to an adverse local soft tissue reaction like that seen in metal-on-metal articulations. The liberated chromium ions interact with organic phosphate ions forming a chromium (III) phosphate precipitate on the interface surface.

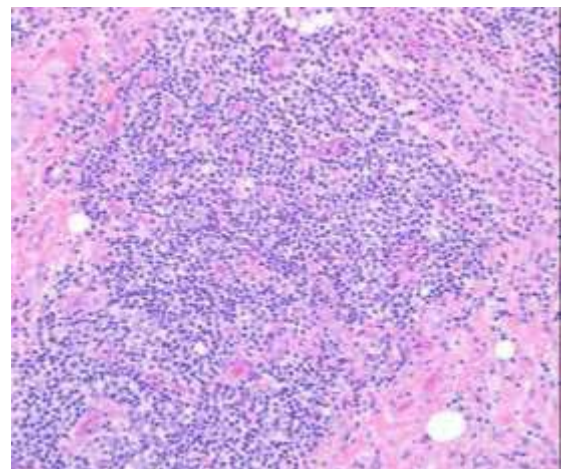
References:

Cooper, H. J., et al. (2012). "Corrosion at the head-neck taper as a cause for adverse local tissue reactions after total hip arthroplasty." *J Bone Joint Surg Am* **94**(18): 1655-1661. Kop, A. M. and E. Swarts (2009). "Corrosion of a hip stem with a modular neck taper junction: a retrieval study of 16 cases." *J Arthroplasty* **24**(7): 1019-1023.

38. Answer: D

A painful dual modular total hip arthroplasty was worked-up and found to have an ESR and C-reactive protein within normal limits, elevated serum metal ion levels, and the intra-operative pathologic specimen that demonstrates:

- A) Infection
- B) Osteolysis
- C) Fracture
- D) Aseptic Lymphocyte-dominated Vasculitis-Associated Lesion
- E) Non-Hodgkins Lymphoma



Discussion: Corrosion at modular junctions can lead to aseptic lymphocyte-dominated vasculitis-associated lesion like that seen in metal-on-metal articulations.

References: Cooper, H. J., et al. (2012). "Corrosion at the head-neck taper as a cause for adverse local tissue reactions after total hip arthroplasty." *J Bone Joint Surg Am* **94**(18): 1655-1661. De Smet, K. A. (2005). "Belgium experience with metal-on-metal surface arthroplasty." *Orthop Clin North Am* **36**(2):203-213.

39. Answer: E

What serum metal ion level indicates a failing total hip arthroplasty?

- A) 1 ppb
- B) 3 ppb
- C) 5 ppb
- D) 7 ppb
- E) There is no consensus serum metal ion level for a failing total hip arthroplasty

Discussion:

Serum ion concentrations of both cobalt and chromium are used for screening and diagnosis, though research has indicated mixed results regarding formal cutoff levels. Additionally, serum metal ion levels are poor predictors of soft tissue damage and the need for revision surgery.

References:

Griffin, J. W., et al. (2012). "Management of failed metal-on-metal total hip arthroplasty." *World Journal of Orthopedics* **3**(6): 70-74. Kwon, Y. M., et al. (2014). "Risk stratification algorithm for management of patients with dual modular taper total hip arthroplasty: consensus statement of the American Association of Hip and Knee Surgeons, the American Academy of Orthopaedic Surgeons and the Hip Society." *J Arthroplasty* **29**(11): 2060-2064.

40. Answer: A

Off-axis loading of the femoral head on the stem trunnion results in _____

- A) Double the amount of micromotion with a given amount of force applied to the femoral head
- B) Cold welding of the head to the trunnion
- C) Increased head-neck dissociation
- D) Notching of the stem trunnion leading to trunnion breakage
- E) Increases the load required to initiate micromotion at the head-neck interface

Discussion:

Off-axis loading of the femoral head on the stem trunnion causes the femoral components to tip with respect to the trunnion and double the amount of micromotion with a given force applied to the femoral head.

References:

Shareef, N. and D. Levine (1996). "Effect of manufacturing tolerances on the micromotion at the Morse taper interface in modular hip implants using the finite element technique." *Biomaterials* **17**(6): 623-630.

41. Answer: D 2020

Polyethylene wear is decreased by all of the following except:

- A) Medializing the hip center of rotation
- B) Increased off-set of the femoral stem
- C) Intentional cross-linking of the polyethylene
- D) Thicker polyethylene components
- E) Ceramic femoral heads

Discussion: Several studies have shown that the "Charnley principle" of reducing the joint reaction force have a

favorable effect on polyethylene wear. Contrary to popular belief, in a wear simulator study of modular polyethylene components (supporting metal back), the wear of 3mm thick components was less than that of 6mm thick components.

References: Schmalzried TP. et al: Wear is a function of use, not time. Clin. Orthop. 381:36-46, 2000. Shen FW, Lu Z, McKellop HA. Wear versus thickness and other features of 5-Mrad crosslinked UHMWPE acetabular liners. Clin Orthop Relat Res. 2011 Feb;469(2):395-404.

42. Answer: E

In a study of >1,000 total hips implanted by 11 surgeons, the single factor that most influenced polyethylene wear was:

- A) The type of polyethylene
- B) The femoral head material
- C) The size of the bearing
- D) Cementless fixation of both components
- E) The implanting surgeon

Discussion: The surgeon not only determines the position of the components, the biomechanics of the reconstruction, and the quality of fixation, he also plays a role in patient selection and post-operative activity.

Reference: Schmalzried TP, Dorey FJ, McClung CD, Scott, DL, Zahiri CA, Sanford WM, Kem L, Humphrey, W: Factors contributing to the variability of short-term radiographic wear rates in total hip replacement. Orthop. Trans. 22:81-82, and 737-738, 1998.

43. Answer: E 2020

In a survey study of surgeon-recommendations for activity following total joint replacement, the majority (>50%) of surgeons agree that patients can to all of the following except:

- A) Walking
- B) Cycling up inclines
- C) Doubles tennis
- D) Golf
- E) Skiing groomed slopes

Discussion: Surgeon recommendations for activity following total joint replacement are highly variable. In a survey of the membership of the AAHKS, only 44% recommended unlimited skiing of groomed slopes.

Reference: Swanson EA, Schmalzried TP, Dorey FJ. Activity recommendations after total hip and knee arthroplasty: A survey of the American Association for Hip and Knee Surgeons. Arthroplasty. J Arthroplasty 2009 Sep;24 (6 Suppl):120-6.

44. Answer: B 2020

Following joint replacement, the average patient takes about how many gait cycles per year?

- A) 1 million
- B) 2 million
- C) 4 million
- D) 5 million
- E) Unknown

Discussion: Early pedometer studies indicated an average of about 1 million gait cycles per year. Studies with a microprocessor worn on the ankle (greater accuracy) have shown that patients average about 2 million gait cycles per year, although the range is broad.

Reference: Silva M et al.: Average patient walking activity approaches 2 million cycles per year: Pedometers under-record walking activity. J. Arthroplasty 17:693-697, 2002.

45. Answer: C 2020

All of the following are true except:

- A) Walking speed decreases with aging
- B) Steps per day decreases with aging
- C) The highest wear rates are in the first five years post arthroplasty
- D) Polyethylene wear rate decreases with patient aging
- E) Ten years post arthroplasty with crosslinked poly, osteolysis is not an issue.

Discussion: The highest wear rates are in the first five years post-arthroplasty for most patients. As patients age, both walking speed and steps per day decrease. Consequently, polyethylene wear decreases with patient aging, and osteolysis is rare with 10 years follow-up.

Reference: Battenberg AK, Hopkins JS, Kupiec AD, Schmalzried TP. The 2012 Frank Stinchfield Award: Decreasing Patient Activity With Aging: Implications for Crosslinked Polyethylene Wear. *Clin Orthop Relat Res.* 2013 Feb;471(2):386-92.

46. Answer: D

What is the most likely cause of massive osteolysis seen in this 47 year old patient?

- A) Use of ceramic liner
- B) Use of large femoral head
- C) Backside wear of the acetabular component
- D) Infection
- E) Component malpositioning

Discussion: This patient has extensive osteolysis which is most likely due to the use of a large femoral head resulting in high volumetric wear. The patient has a cemented all polyethylene acetabular liner and a monolithic femoral component which despite loosening of the acetabular component appear to be well positioned. There is no ceramic liner or any possibility of backside wear as this patient has a one piece polyethylene component.

References: Lachiewicz PF, Heckman DS, Soileau ES, Mangla J, Martell JM. Femoral head size and wear of highly cross-linked polyethylene at 5 to 8 years. *Clin Orthop Relat Res.* 2009 Dec;467(12):3290-6.

McKellop HA. Bearing surfaces in total hip replacements: state of the art and future developments. *Instr Course Lect.* 2001;50:165-79.

47. Answer: E

A 67 year old woman is presenting with severe hip pain 2 years following total hip arthroplasty. She has active underlying inflammatory bowel disease and her ESR and CRP is always elevated. Aspiration of the hip was performed revealing neutrophil count of 6000 per ul and neutrophil differential of 82%. What is the most likely cause of her symptoms:

- A) Fracture of ceramic liner
- B) Loosening of acetabular component
- C) Bone on bone impingement
- D) Periprosthetic fracture
- E) Chronic periprosthetic infection

Discussion: The femoral stem is subsided and is loose. The cause of stem loosening is likely to be infection in this patient as the neutrophil count and differential are both very high. In recent years multiple studies, using receiver operating characteristics (ROC) analysis have determined the threshold for neutrophil count and differential for chronic and acute periprosthetic joint infections. The threshold for neutrophil count and differential for chronic hip infection is 3200 cells/ul (when the serology is abnormal) and neutrophil differential of 80%.

References: Schinsky MF, Della Valle CJ, Sporer SM, Paprosky WG. Perioperative testing for joint infection in patients undergoing revision total hip arthroplasty. *J Bone Joint Surg Am.* 2008 Sep;90(9):1869-75. Erratum in: *J Bone Joint Surg Am.* 2010 Mar;92(3):707. Ghanem E, **Parvizi J**, Burnett S, Sharkey PF, Keshavarzi N, Aggarwal A, Barrack RA. Cell count and differential of aspirated fluid in the diagnosis of infected total knee arthroplasty. *J Bone and Joint Surg,* 90(8): 1637-43, 2008. Bedair H, Ting N, Jacovides C, Saxena A, Moric M, **Parvizi J**, Della Valle CJ. The Mark Coventry Award: Diagnosis of Early Postoperative TKA Infection Using Synovial Fluid Analysis. *Clin Orthop Relat Res* May 2010 (E-Pub).

48. Answer: D 2020

Which of the following is not a predictor of discharge to an extended care facility following primary, elective total knee arthroplasty?

- A) Older age (>80 years old)
- B) Female gender
- C) Higher ASA score
- D) Primary vs. Revision TKA
- E) Medicare Insurance status

Discussion: Looking at nearly 8,000 patient discharges, Bozic et al performed a stepwise linear regression analysis of patients treated at 3 high volume total joint centers and found that 29% of patients were discharged to an ECF. Medicare insurance, older age, female gender, higher ASA score were all associated with a higher risk of discharge to an ECF. Other studies have identified older age, poor pre-operative mobility, the use of gait aids, and the lack of a caregiver as predictors of rehabilitation risk.

Reference: Predictors of Discharge to an Inpatient Extended Care Facility After Total Hip or Knee Arthroplasty. K Bozic, AWagie, J Naessens, D Berry, H Rubash. *J Arthroplasty* 21,6: 151, 2006
Predicting Risk of Extended Inpatient Rehabilitation After Hip or Knee Arthroplasty. LB Oldmeadow, H McBurney, V Robertson. *J Arthroplasty* 18,6: 775, 2003

49. Answer: D 2020

Of the options given below, which is most common cause for readmission following primary total knee arthroplasty?

- A) Disorders of the urinary tract
- B) Complications associated with venous thromboembolism
- C) Length of stay
- D) Cardiac events
- E) Pneumonia

Discussion: Several papers have looked at causes for readmission following primary total joint arthroplasty. Vorhies et al found that cardiac events (including congestive heart failure, myocardial infarction and dysrhythmias) made up nearly 50% of all readmissions. Pneumonia was approximately 2.6%, urinary tract disorders (2.1%) and VTE issues were less than 2%. Along with Vorhies et al, Bini et al in another recent paper showed no correlation with a shorter LOS and readmissions looking at large patient population.

Reference: Readmission and Length of Stay After Total Hip Arthroplasty in a National Medicare Sample. JS Vorhies, Y Wang, J Herndon, WJ Maloney, JI Huddleston. *J Arthroplasty*, 26:6, 119 2011. Does Discharge Disposition after primary total joint arthroplasty affect readmission rates? Bini SA, Fithian DC, Paxton LW. *J Arthroplasty* 2010; 25:1

50. Answer: D 2020

Of the options below, which is the closest to the current average length of stay (LOS) following primary total joint replacement in the United States?

- A) 1 day
- B) 2 days
- C) 3 days
- D) 4 days
- E) 5 days

Discussion: 3.7 to 4.0 days is the average LOS in the United States based on recent literature. Length of stay of one day or less has been reported in some centers.

Reference: The Influence of Procedure Volumes and Standardization of Care on Quality and Efficiency in Total Joint Replacement Surgery. Bozic KJ, Maselli J, Pekow PS, Lindenauer PK, Vail TP, Auerbach AD. JBJS Am 2010 Nov 17;92(16):2643-52

51. Answer: D 2020

Of the options below, which average length of stay (LOS) following primary total joint replacement in the United States is associated with the highest rate of complications and readmissions?

- A) 2 days
- B) 3 days
- C) 4 days
- D) 5 days

Discussion: Higher volume centers tend to have shorter LOS fewer complications, while lower volume centers tend to have higher LOS and higher complications.

Reference: The Influence of Procedure Volumes and Standardization of Care on Quality and Efficiency in Total Joint Replacement Surgery. Bozic KJ, Maselli J, Pekow PS, Lindenauer PK, Vail TP, Auerbach AD. JBJS Am 2010 Nov 17;92(16):2643-52

52. Answer: B 2020

Of the options below, which is the closest to the current average readmission rate following primary total joint replacement in the United States?

- A) 1-3%
- B) 3-5%
- C) 5-7%
- D) 7-9%
- E) >10%

Discussion: The current reported readmission rates for all comers is approximately 4% in multiple papers. The rate can be much higher or lower in various cohorts and multiple factors can affect readmission, however, the average rate remains approximately 4%.

Reference: The Influence of Procedure Volumes and Standardization of Care on Quality and Efficiency in Total Joint Replacement Surgery. Bozic KJ, Maselli J, Pekow PS, Lindenauer PK, Vail TP, Auerbach AD. JBJS Am 2010 Nov 17;92(16):2643-52

53. Answer: E

A 69-year-old patient presents to the emergency room with wound healing problems three weeks following total knee arthroplasty. Blood tests are done with C-reactive protein= 12.6 mg/L and Erythrocyte sedimentation rate=56 mm/hr. Figure 1 shows the appearance of the wound. What is the next step in management?

- A) Administration of oral antibiotic and recheck of wound in two weeks
- B) Admission for observation and intravenous antibiotic administration
- C) Irrigation and debridement
- D) One or two stage exchange
- E) Aspiration of the joint

Discussion: According to the Guidelines issued by the American Academy of Orthopedic Surgeons (AAOS) for diagnosis of periprosthetic joint infection, patients with abnormal serology should undergo aspiration of the joint. The aspirate needs to be sent for cell count, neutrophil percentage, and culture. Recent studies have determined the appropriate threshold for cell count and neutrophil percentage both in the acute setting (as is the case here) and later time points for patients with suspected chronic periprosthetic joint infection.

References: Della Valle C, Parvizi J, Bauer TW, Dicesare PE, Evans RP, Segreti J, Spnaghel M, Watters WC, Keith M, Turkleson CM, Wies JL, Hitchcock K. American Academy of Orthopaedic Surgeons Clinical Guideline on: The Diagnosis of periprosthetic joint infections. *J Bone Joint Surg* 20:93(14): 1355-7, 2011

Bedair H, Ting N, Jacovides C, Saxena A, Moric M, Parvizi J, Della Valle CJ. The Mark Coventry Award: Diagnosis of Early Postoperative TKA Infection Using Synovial Fluid Analysis. *ClinOrthopRelat Res* 469(1): 34-40, 2011.

Ghanem E, Parvizi J, Burnett S, Sharkey PF, Keshavarzi N, Aggarwal A, Barrack RA. Cell count and differential of aspirated fluid in the diagnosis of infected total knee arthroplasty. *J Bone and Joint Surg*, 90(8): 1637-43, 2008

54. Answer: B

DASH, VAS pain and VAS patient satisfaction scores observed with an early mobilization protocol following ligament reconstruction with tendon interposition (LRTI) surgery are:

- A) Better than scores observed with an immobilization protocol.
- B) The same as scores observed with an immobilization protocol.
- C) Worse than scores observed with an immobilization protocol.
- D) Impossible to study given the varied nature of postoperative rehabilitation protocols following LRTI surgery.

Discussion: According to the prospective, randomized study performed by Hutchinson et al (reference below), DASH, VAS pain and VAS patient satisfaction scores seen with an early mobilization protocol were not significantly different from outcomes with an immobilization protocol following LRTI surgery. This study looked at a minimum of 1-year follow-up in 169 thumbs in 157 patients, divided randomly into two postoperative rehabilitation protocols, early mobilization and immobilization. In addition to DASH, VAS pain, VAS patient satisfaction and 9-hole peg test scores, the authors also looked at wrist and thumb ROM and strength at various post-op intervals.

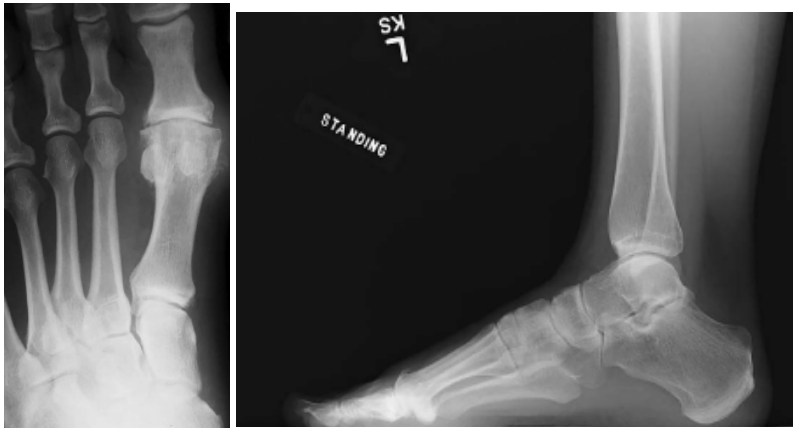
References: Team Orthobullets (D) MD

Foot & Ankle

55. Answer: C 2022

Anteroposterior and lateral radiographs are shown of a 65-year-old woman who has daily pain at the hallux metatarsophalangeal joint during standing and walking. She has pain with joint range of motion, over her prominent medial eminence, and with midrange motion of the hallux metatarsophalangeal joint. No significant plantar pain is noted. After failing nonsurgical treatment, what is the best option for long-term surgical treatment of her symptoms?

- A) Cheilectomy
- B) Cheilectomy with proximal phalanx osteotomy
- C) Metatarsophalangeal arthrodesis
- D) Distal chevron bunionectomy with cheilectomy
- E) Implant arthroplasty for hallux of the metatarsophalangeal joint



References: O'Malley MJ, Basran HS, Gu Y, Sayres S, Deland JT. Treatment of advanced stages of hallux rigidus with cheilectomy and phalangeal osteotomy. *J Bone Joint Surg Am.* 2013 Apr 3;95(7):606-10. doi: 10.2106/JBJS.K.00904. PubMed PMID: 23553295. McNeil DS, Baumhauer JF, Glazebrook MA. Evidence-based analysis of the efficacy for operative treatment of hallux rigidus. *Foot Ankle Int.* 2013 Jan;34(1):15-32. doi: 10.1177/1071100712460220. Review. PubMed PMID: 23386758.

56. Answer: A 2022

With regard to ankle replacement and ankle fusion, ankle arthroplasty:

- A) Has similar pain relief to ankle fusion
- B) Is more durable than ankle fusion
- C) Is less likely to require reoperation than ankle fusion
- D) results in less sagittal plane motion than ankle fusion
- E) can be used to correct greater deformities than ankle fusion

Discussion: Ankle replacement and fusion were found to have similar pain relief in a prospective, controlled study comparing the two treatments.

References: Saltzman CL, Mann RA, Ahrens JE, Amendola A, Anderson RB, Berlet GC, Brodsky JW, Chou LB, Clanton TO, Deland JT, Deorio JK, Horton GA, Lee TH, Mann JA, Nunley JA, **Thordarson DB**, Walling AK, Wapner KL, Coughlin MJ. Prospective controlled trial of STAR total ankle replacement versus ankle fusion: initial results. *Foot and Ankle Int.* 2009;(30)7:579-596.

57. Answer: C 2022

On physical examination a patient is noted to have subluxation of their peroneal tendons with dorsiflexion and eversion. What is the underlying pathology, and what are surgical treatment options?

- A) Superior peroneal retinaculum, retinaculum repair with possible groove deepening
- B) Inferior peroneal retinaculum, peroneal tendon tear repair
- C) Superior peroneal retinaculum, brostrom lateral ligament reconstruction
- D) Inferior peroneal retinaculum, syndesmosis repair
- E) Superior peroneal retinaculum, peroneus longus to brevis tenodesis

References: Cerrato, Rebecca A., and Mark S. Myerson. "Peroneal tendon tears, surgical management and its complications." *Foot and ankle clinics* 14.2 (2009): 299-312.

58. Answer: D 2022

A 22 year old college soccer player sustains an injury to her left ankle. She undergoes 3 months of rest, immobilization and physical therapy, with continued lateral ankle pain that is worsened with active resisted eversion. What is the insertion site of the most likely injured structure?

- A) First metatarsal base
- B) Navicular
- C) Fifth metatarsal base
- D) Cuboid
- E) Medial cuneiform

Reference: Cerrato, Rebecca A., and Mark S. Myerson. "Peroneal tendon tears, surgical management and its complications." *Foot and ankle clinics* 14.2 (2009): 299-312.

59. Answer: D 2022

In patients with Torg type I and II fractures, which have the longest time to union and higher nonunion rates following operative intervention?

- A) Acute complete fractures
- B) Incomplete fracture with plantar gap less than 1 mm
- C) Acute on chronic complete fractures
- D) Incomplete fracture with fracture gap >1 mm

Discussion: In studies by Lee et al in 2011 and 2013, they reported that Torg classification type was prognostic in time to union but this could be expanded upon to include complete or incomplete fractures and a plantar gap >1 mm seen on the oblique foot radiograph.^{1,2} In the 2011 study, Torg type II fractures managed operatively healed at an average of 104 days. Of the patients with Torg type II fractures, those with a plantar gap <1 mm healed at an average of 72 days with 1 nonunion (5%) compared with 129 days and 8 nonunions (33.3%) in the group with a plantar gap more than 1 mm. In the 2013 study, Lee et al reported that incomplete fractures took significantly longer to heal than complete fractures and again a plantar gap >1 mm was prognostic of a longer healing time.

References: 1. Lee, KT; Park, YU; Jegal, H, et al.: Prognostic classification of fifth metatarsal stress fracture using plantar gap. *Foot Ankle Int.* 34: 691-696, 2013. <http://dx.doi.org/10.1177/1071100713475349> 2. Lee, KT; Park, YU; Young, KW; Kim, JS; Kim, JB: The plantar gap: another prognostic factor for fifth metatarsal stress fracture. *Am J Sports Med.* 39: 2206-2211, 2011. <http://dx.doi.org/10.1177/0363546511414856>

60. Answer: E 2022

In the only randomized control study evaluation early operative intervention versus cast immobilization for acute Jones fractures, what differences were found between the groups?

- A) Earlier return to sport in operatively treated patients
- B) Later time to healing in casted patients
- C) Equal nonunion rates in both groups
- D) Lower treatment failures in the operatively treated group
- E) A, B, D
- F) All of the above

Discussion: In 2005, Mologne et al performed a prospective, randomized control trial to compare early intramedullary fixation versus casting in acute Jones fractures. Patients were included if the fracture had sharp margins (Torg1), prodromal pain less than 14 days, and an acute injury. Eighteen patients were randomized to cast treatment and 19 patients were randomized to screw fixation. Operative fixation was performed with a single sold, 4.5 mm intramedullary screw and kept NWB for 2 weeks postop followed by a hard soled shoe until clinical resolution of the symptoms. Patients randomized the cast group were treated in a non-weight-bearing short leg cast for 8 weeks, followed by a walking cast or hard-sole shoe until clinical union. Return to sport was determined by clinical union which was defined as a nontender fracture site, the absence of pain with ambulation, and radiographic evidence of fracture healing. All patients were followed up in the clinic at monthly intervals for 6 months and then at 1 year and 2 years after the initial injury. For the surgery group, the median times to union and return to sports were 7.5 and 8.0 weeks, respectively. For the cast group, the median times were 14.5 and 15.0 weeks, respectively. There was 1 failure (5%) of the operatively treated group versus 8 (44%) in the casted group.

References: Mologne, TS; Lundeen, JM; Clapper, MF; O'Brien TJ: Early screw fixation versus casting in the treatment of acute Jones fractures. AM J Sports Med. 33: 970-975, 2005. <http://dx.doi.org/10.1177/0363546504272262>

61. Answer: E

A 62-year-old tennis player ruptured his Achilles tendon 12 months ago. He initially chose non-operative treatment, but continued to have weakness and difficulty ambulating. During surgery extensive debridement there is a 6cm gap between viable tissue ends. Which of the following surgical techniques most likely will provide the best clinical outcome?

- A) Primary repair with the foot in maximal plantar flexion followed by a gradual stretching program
- B) Reconstruction with hamstring autograft
- C) Achilles repair augmented with transfer of the posterior tibial tendon
- D) Achilles repair augmented with transfer of the extensor digitorum longus
- E) Achilles repair augmented with transfer of the flexor hallucis longus

Discussion: The gap is not likely to be repairable primarily. The Flexor HallucisLongus tendon transfer is adjacent to the Achilles, works in phase and has acceptable strength.

References: Team Orthobullets (D) MD

62. Answer: E

What is the biggest advantage of surgical repair of an acute Achilles tendon rupture with early range of motion compared to non-operative treatment with immobilization in a short-leg cast for 6 weeks?

- A) Lower rate of infection
- B) Lower rate of nerve injury
- C) Better skin cosmesis
- D) Lower rate of DVT/ VTE
- E) Lower rate of re-rupture

Discussion: Open operative treatment of acute Achilles tendon ruptures significantly reduces the risk of re-rupture compared with nonoperative treatment done without function rehabilitation. However surgical treatment has the drawback of a increased surgical complications such as wound infection.

References: Team Orthobullets (D) MD

63. Answer: D 2020

In a recent study looking at the treatment of low energy Lisfranc injuries in an active military population, the authors found:

- A) Better outcome in both short and long term with arthrodesis
- B) Worse outcomes in both short and long term with arthrodesis
- C) A faster return to duty but worse short term outcome with Open Reduction Internal Fixation (ORIF)
- D) Better outcome in the short term but no difference in the long term with arthrodesis
- E) No difference in the short term between ORIF and Arthrodesis

Discussion: In this study the authors found faster return to duty, better short-term outcomes but similar long-term outcome with arthrodesis of low energy Lisfranc injuries. Patients who underwent an ORIF had a longer return to duty, worse short-term outcomes, but equivalent long-term outcomes as compared to arthrodesis.

Reference: Team Orthobullets (D) MD

64. Answer: B

Which of the following ligaments does NOT contribute to the stability of the syndesmosis?

- A. Anterior inferior tibiofibular ligament
- B. Anterior talofibular ligament
- C. Posterior inferior tibiofibular ligament
- D. Interosseous ligament
- E. Deltoid ligament

Discussion: The syndesmosis is stabilized laterally by the anterior inferior tibiofibular ligament (AIFTL), posterior inferior tibiofibular ligament (PITFL), Interosseous ligament (IOL), interosseous memberane, and inferior transverse ligament (TL). The syndesmosis is stabilized medially by the Deltoid ligament complex. The anterior talofibular ligament (ATFL) prevents anterior subluxation of the tibiotalar joint and does not impact the syndesmosis.

Reference: Team Orthobullets (D) MD

65. Answer: E 2017/2020

An 18-year-old football player reports acute pain and swelling after a direct injury to his plantar flexed foot. Examination reveals midfoot swelling and tenderness. Nonstanding radiographs are normal. What is the next most appropriate step in management?

- A) Gradual return to play
- B) Physical therapy program
- C) Custom orthosis
- D) Non-weight-bearing cast
- E) Weight-bearing AP radiograph

Discussion: Differentiating between a midfoot sprain and Lisfranc diastasis is critical in the management of the athlete with an acute injury to the midfoot. Greater than 2 mm of displacement between the first and second metatarsals on a weight-bearing radiograph is an indication for anatomic reduction with internal fixation of the tarsometatarsal joints. If no subluxation is noted, treatment should consist of a non-weight-bearing cast for 6 weeks, followed by a gradual return to activity.

66. Answer: C 2017/2020

A 25-year-old male falls from a ladder and presents with a homolateral Lisfranc injury. Which of the following is true when comparing primary arthrodesis with open reduction and internal fixation for the first, second and third tarsometatarsal joints in this injury?

- A) Higher rates of implant removal with primary arthrodesis
- B) Lower rates of post-traumatic arthritis with open reduction and internal fixation
- C) Improved return to activity with primary arthrodesis
- D) Higher rates of malreduction with open reduction and internal fixation
- E) Worse functional outcomes with primary arthrodesis

Discussion: The patient presents with a Lisfranc injury with primarily ligamentous disruption of the tarsometatarsal joint articulations. Recent randomized controlled studies have found improved functional outcomes, increased return to activity and decreased rates of secondary surgery with primary arthrodesis of the medial three tarsometatarsal joints in these injuries.

Lisfranc injuries may lead to arthritis and collapse of the longitudinal arch if not addressed operatively. Regardless of the treatment method chosen, anatomic reduction and stable fixation is necessary to optimize outcome. Careful assessment of the intercuneiform and naviculocuneiform joints should be performed to avoid continued instability.

References: Treatment of primarily ligamentous Lisfranc joint injuries: primary arthrodesis compared with open reduction and internal fixation. A prospective, randomized study.

Ly TV, Coetzee JC

Open reduction internal fixation versus primary arthrodesis for Lisfranc injuries: a prospective randomized study.

Henning JA, Jones CB, Sietsema DL, Bohay DR, Anderson JG

Foot Ankle Int. 2009 Oct;30(10):913-22

67. Answer: C 2017/2020

Which ligament connects the medial cuneiform to the base of the second metatarsal?

- A) Spring ligament
- B) Chopart ligament
- C) Lisfranc ligament
- D) Intermetatarsal ligament
- E) Calcaneofibular ligament

Discussion: The Lisfranc ligament arises from the lateral surface of the medial cuneiform and inserts onto the medial aspect of the second metatarsal base near the plantar surface. It is the largest and strongest interosseous ligament in the tarsometatarsal joint complex. The spring ligament (plantar calcaneonavicular ligament) is a broad, thick band of fibers, which connects the anterior margin of the calcaneus to the navicular. It supports the head of the talus and helps maintain the medial longitudinal arch of the foot.

Reference: Anatomy of the Lisfranc joint complex. de Palma L, Santucci A, Sabetta SP, Rapali S. Foot Ankle Int. 1997 Jun;18(6):356-64

68. Answer: C 2017/2020

A 54-year-old woman sustains a twisting injury to her foot. A radiograph is provided in Figure A. Which of the following is the most appropriate treatment?

- A) Closed reduction and pinning
- B) Closed reduction and casting
- C) Open reduction and internal fixation
- D) CAM walker and weight bearing as tolerated
- E) Weight bearing as tolerated

Discussion: This is a Lisfranc injury. No consensus exists about optimal treatment of these injuries, but evidence is clear that a satisfactory result is directly related to the accuracy of the reduction and its successful maintenance through healing. Some recent studies support primary fusion over ORIF as optimal treatment for purely ligamentous injuries; however, this is not an answer choice. Many authors recommend open reduction and screw fixation for treatment of all TMT fractures and dislocations. Alterations in the anatomy of the Lisfranc joints secondary to trauma can result in foot collapse and altered weight bearing which are difficult to salvage later.

**69. Answer: E - 2017/2020**

A 30-year-old equestrian caught her foot in a stirrup 1 week ago and now complains of midfoot pain with difficulty bearing weight. Radiographs are shown in figure A.

What treatment is most appropriate?

- A) Non-weight bearing in an aircast
- B) Weight bearing as tolerated in a walking cast
- C) Modified-Brostrom procedure
- D) Delayed corrective osteotomy and arthrodesis of the medial column
- E) Arthrodesis of the medial tarsometatarsal joints

Discussion: The patient has a Lisfranc injury. These are typically high energy injuries involving the Lisfranc ligament which connects the base of the 2nd metatarsal to the medial cuneiform. Dorsal dislocation is most common form. Anatomic reduction is necessary and can only reliably be achieved through open reduction and internal fixation. The ligament or a bony avulsion can become incarcerated in the joint preventing anatomic reduction. Following surgery patients should be treated with protected weight-bearing for 3-5 months and therapy emphasizing passive midfoot ROM. Midfoot post traumatic arthritis and pain are the long term outcomes of a non-anatomically reduced joint. Regardless when considering fusion or ORIF, operative reduction must be done.



References: Outcome after open reduction and internal fixation of Lisfranc joint injuries. Kuo RS, Tejwani NC, Digiovanni CW, Holt SK, Benirschke SK, Hansen ST, Sangeorzan BJ. J Bone Joint Surg Am. 2000 Nov;82-A(11):1609-18. Treatment of primarily ligamentous Lisfranc joint injuries: primary arthrodesis compared with open reduction and internal fixation. A prospective, randomized study. Ly TV, Coetzee JC. J Bone Joint Surg Am. 2006 Mar;88(3):514-20.

70. Answer: C 2017/2020

Joint made worse by activity and closed shoes. She has failed shoe wear modifications. What is the most appropriate operative treatment?

- A) Lapidus bunionectomy
- B) Proximal first metatarsal osteotomy
- C) Distal first metatarsal osteotomy
- D) Double osteotomy of the first metatarsal

Discussion: Patients with mild increase in the intermetatarsal angle do well with distal chevron osteotomies with less surgical impact than the others.

Reference: Coughlin MJ, Mann RA. Hallux valgus. In Coughlin MJ, Mann RA, Saltzman CL, eds. Surgery of the Foot and Ankle 8th edition ed. Philadelphia, PA: Mosby-Elsevier; 2007:230-23

**71. Answer: B 2017/2020**

56 year old female that has complained about progressive first MTP pain and deformity and has failed non-operative treatment. What is the most appropriate operative treatment?

- A) Lapidus bunionectomy
- B) Proximal first metatarsal osteotomy
- C) Distal first metatarsal osteotomy
- D) Double osteotomy of the first metatarsal

Discussion: Patient has a large increase in intermetatarsal angle that will not be correctable without a more proximal osteotomy. Lapidus would be acceptable but there was no mention of instability or pain in the first TMT joint.

Reference: Coughlin MJ, Mann RA. Hallux valgus. In Coughlin MJ, Mann RA, Saltzman CL, eds. Surgery of the Foot and Ankle 8th edition ed. Philadelphia, PA: Mosby-Elsevier; 2007:230-236.

**72. Answer: A 2017/2020**

64 year old female with complaints of increasing pain and deformity of her foot with activity and has failed non-operative treatment. On examination she has increased pain at the first tarsal-metatarsal joint with dorsal and plantar motion. What is the most appropriate operative treatment?

- A) Lapidus bunionectomy
- B) Proximal first metatarsal osteotomy
- C) Distal first metatarsal osteotomy
- D) Double osteotomy of the first metatarsal

Discussion: Patient with a large deformity but also symptomatic first TMT arthrosis.

Reference: Coughlin MJ, Mann RA. Hallux valgus. In Coughlin MJ, Mann RA, Saltzman CL, eds. Surgery of the Foot and Ankle 8th edition ed. Philadelphia, PA: Mosby-Elsevier; 2007:230-236



73. Answer: C**2017/2020**

The majority of hallux valgus deformities in middle aged patients is related to what type of pathologic process?

- A) Rheumatologic
- B) Traumatic
- C) Degenerative
- D) Neoplastic

Discussion: Hallux valgus is a degenerative instability of the first ray in these patients with an acquired deformity. The medial collateral ligament is elongated and the pathology shows degeneration often including cystic changes.

Reference: Coughlin MJ, Mann RA. Hallux valgus. In Coughlin MJ, Mann RA, Saltzman CL, eds. *Surgery of the Foot and Ankle* 8th edition ed. Philadelphia, PA: Mosby-Elsevier; 2007:230-236

74. Answer: E

A 55-year-old man with a history of unknown trauma to his ankle 20 years ago complains of ankle pain. His ankle range of motion is limited by pain from 5 degrees dorsiflexion to 25 degrees plantar flexion with normal hindfoot motion. He has a plantigrade foot. Radiographs demonstrate end-stage ankle arthritis. If he undergoes an ankle fusion for this condition:

- A) it will normalize stresses across the adjacent hindfoot joints
- B) it will decrease the energy of walking compared to a normal ankle
- C) it will increase the stride length on the affected side after surgery
- D) it will increase the stride length on the affected side after surgery
- E) approximately 1/3 of normal sagittal plane motion of the foot will remain

References: Mazur J, Schwartz E, Simon R. - Ankle arthrodesis. Long-term follow-up with gait analysis. *J Bone Joint Surg Am.* 1979; 61(7):964-975

Thomas R, Daniels T, Parker K. - Gait analysis and functional outcomes following ankle arthrodesis for isolated ankle arthritis *J Bone Joint Am Surg* 2006; 88(3):526-535

75. Answer: C**2017**

Which of the following statements about the biomechanics of the ankle joint is NOT correct?

- A) The bony anatomy, ligaments, and joint capsule guide and restrain movement between the talus and the mortise
- B) Talus has a continuously changing axis of rotation as it moves from maximum dorsiflexion to maximum plantar flexion relative to the mortise
- C) The ankle joint has half the surface contact area of the knee joint yet is exposed to the same maximal joint forces
- D) The talus and mortise widen slightly from posterior to anterior
- E) When the talus is plantar flexed, its narrowest portion sits in the ankle mortise and allows rotatory movement between the talus and mortise

Discussion: The ankle joint has one third the contact surface area compared to the knee joint. The joint is exposed to maximal forces that are 5-7 times body weight compared to the knee joint which experiences up to 3-4 times body weight.

References: Kimizula, M., Kurosawa, H., Fukubayashi. 1980. Load bearing pattern of the ankle joint: Contact area and pressure distribution. *Archives of Orthopaedic and Trauma Surgery* 96(1), pp. 45-9.

Stauffer, R.N., Chao, E.Y.S., Brewster, R.C. 1977. Force and motion analysis of the normal, diseased, and prosthetic ankle joint. *Clinical Orthopaedics* 127, pp. 189-196. M. Kamran Shahid. A review of current total ankle replacements with reference to the stress distribution in the ankle joint. *J. Orthopaedics* 2011;8(4)e7

76. Answer: B 2017

Which of the following ligaments does NOT contribute to the stability of the syndesmosis?

- A) Anterior inferior tibiofibular ligament
- B) Anterior talofibular ligament
- C) Posterior inferior tibiofibular ligament
- D) Interosseous ligament
- E) Deltoid ligament

Discussion: The syndesmosis is stabilized laterally by the anterior inferior tibiofibular ligament (AIFTL), posterior inferior tibiofibular ligament (PITFL), Interosseous ligament (IOL), interosseous memberane, and inferior transverse ligament (TL). The syndesmosis is stabilized medially by the Deltoid ligament complex. The anterior talofibular ligament (ATFL) prevents anterior subluxation of the tibiotalar joint and does not impact the syndesmosis.

Reference: Hermans JJ, Beumer A, de Jong TA, Kleinrensink GJ. Anatomy of the distal tibiofibular syndesmosis in adults: a pictorial essay with a multimodality approach. *J Anat.* 2010 Dec;217(6):633-45. Zalavras C, Thordarson D., Ankle syndesmotic injury, *J Am Acad Orthop Surg.* 2007 Jun;15(6):330-9

77. Answer: B 2017

According to recent literature, approximately what percentage of all ankle sprains in competitive football are high ankle sprains (syndesmosis injuries)?

- A) 5%
- B) 25%
- C) 50%
- D) 75%
- E) 90%

Discussion: According to a recent review of the NCAA injury surveillance system, about 24% of all ankle sprains in college football are syndesmosis injuries (i.e., high ankle sprains). In addition, it is estimated that about 15% of players participating in the NFL combine have a history of syndesmosis injuries. Boytim (5) reported 18 of 98 (18%) acute syndesmotic injuries when looking at members of the Minnesota Vikings football team.

Reference: Hunt KJ, George E, Harris AH, Dragoo JL., Epidemiology of Syndesmosis Injuries in Intercollegiate Football: Incidence and Risk Factors From National Collegiate Athletic Association Injury Surveillance System Data from 2004-2005 to 2008-2009., *Clin J Sport Med.* 2013 Jan 21
Boytim MJ, Fischer DA, Neumann L. Syndesmotic ankle sprains. *Am. J. Sports Med.* 1991; 19:294-8.

78. Answer: E 2017

A 62-year-old tennis player ruptured his Achilles tendon 12 months ago. He initially chose non-operative treatment, but continued to have weakness and difficulty ambulating. During surgery extensive debridement there is a 6cm gap between viable tissue ends. Which of the following surgical techniques most likely will provide the best clinical outcome?

- A) Primary repair with the foot in maximal plantar flexion followed by a gradual stretching program
- B) Reconstruction with hamstring autograft
- C) Achilles repair augmented with transfer of the posterior tibial tendon
- D) Achilles repair augmented with transfer of the extensor digitorum longus
- E) Achilles repair augmented with transfer of the flexor hallucis longus

Discussion: The gap is not likely to be repairable primarily. The Flexor Hallucis Longus tendon transfer is adjacent to the Achilles, works in phase and has acceptable strength.

References: Will RE, Galey SM Outcome of single incision flexor hallucis longus transfer for chronic Achilles tendinopathy. *Foot Ankle Int.* 2009 Apr;30(4):315-7

79. Answer: C

What is the most common location of a talar dome osteochondral lesion?

- A) Antero-lateral
- B) Postero-medial
- C) Superior medial boarder
- D) Superior lateral boarder

Discussion: Traditional teaching is that the majority of osteochondral lesions of the talus occur either anterolaterally or posteromedially. Several recent studies, however, demonstrate that the majority of talar lesions occur at the superior central medial surface, followed by the superior central lateral. Medial lesions tend to be larger and deeper than lateral lesions.

References: Raikin, S; Elias, I, et al: Osteochondral Lesions of the Talus: Localization and Morphologic Data from 424 Patients Using a Novel Anatomical Grid Scheme. *Foot Ankle Int.* 28(2): 154-161, 2007
Hembree, W; Wittstein, J, et al: Magnetic Resonance Imaging Features of Osteochondral Lesions of the Talus. *Foot Ankle Int.* 33 (7): 591 – 597, 2012

80. Answer: C

Intermediate-Term (5 year) results of total ankle replacement and ankle arthrodesis demonstrate:

- A) A superior clinical outcome for total ankle patients
- B) A clinically significant increase in subtalar arthritis in ankle fusion patients
- C) Comparable clinical outcomes for both groups
- D) A higher rate of major complications with ankle fusion
- E) None of the above

Discussion: A prospective 2014 study of 388 patients in Canada demonstrated that intermediate-term clinical outcomes in total ankle replacement and ankle arthrodesis were comparable. The major complication rate for ankle arthrodesis was 7% vs. 19% for total ankle replacement. There is no data that confirms a clinically significant increase in subtalar arthritis following ankle fusion.

Reference: Daniels, T., et al., Intermediate-Term Results of Total Ankle Replacement and Ankle Arthrodesis, *JBJS*, 2014; 96:135-142

81. Answer: C

Comparison of gait after total ankle replacement and ankle arthrodesis demonstrates that:

- A) Patients with a total ankle function as well as normal control subjects.
- B) Patients with a total ankle have better gait function than patients with an ankle arthrodesis.
- C) There is no consistent superior gait function in either group of patients.
- D) Total ankle patients have a greater gain in both ankle dorsiflexion and plantar flexion than patents with an ankle arthrodesis.
- E) Total ankle patients have better coronal plane motion than patients with an ankle arthrodesis.

Discussion: A recent well done prospective gait lab study compared gait after total ankle arthroplasty and ankle arthrodesis. There was no consistently superior gait function with TAA compared with AF. Patients had increased total sagittal motion following a TA, although the AF had a greater plantar flexion arc. AF patients had increased coronal motion compared to the TA group.

Reference: Flavin, R., et al., Comparison of Gait AfterTotal Ankle Arthroplasty and Ankle Arthrodesis, *Foot and Ankle International*, 2013; 34: 1340 – 1347

82. Answer: D 2020

The American Academy of Orthopaedic Surgeons has released Evidence-Based Medicine Guidelines for the treatment of which foot and ankle problem(s):

- A) Ankle Arthritis and Achilles Tendon Rupture
- B) Ankle Arthritis
- C) Achilles Tendon Rupture and Acquired Adult Flatfoot Deformity
- D) Achilles Tendon Rupture
- E) Acquired Adult Flatfoot Deformity and Ankle Arthritis

Discussion: The AAOS has released one EBM Guideline for the foot (Achilles Tendon Rupture in Feb 2010).

Reference: <http://www.aaos.org/research/guidelines/guide.asp>
<http://www.aaos.org/news/aaosnow/mar10/research1.asp>

83. Answer: B

According to JBJS's Instruction for Authors a prospective randomized control trial of a therapeutic treatment with a minimum of 2 year follow-up, adequate power, and 75% follow-up would be considered:

- A) Level I Evidence
- B) Level II Evidence
- C) Level III Evidence
- D) Level IV Evidence
- E) Level V Evidence

Discussion: This would be considered a Level II study based on only a 75% follow-up. Greater than 80% follow-up is needed to be considered a "High quality" randomized control trial.

Level I: "High-quality randomized controlled trial with statistically significant difference or no statistically significant difference but narrow confidence intervals."

Level II: Lesser-quality randomized controlled trial (e.g., <80% follow-up, no blinding, or improper randomization)

Reference: <http://jbjs.org/public/instructionsauthors.aspx>

84. Answer: C

Which is NOT presently an AAOS "Recommendation Grade?"

- A) Strong
- B) Moderate
- C) Weak
- D) Inconclusive
- E) Consensus

Discussion: The AAOS recently changed their designated Treatment Recommendation Grade from "Weak" to "Limited." This was done so as not to imply that the treatment in question is "weak", but rather that there is evidence to support the treatment in question (ex. multiple Level IV studies with consistent findings) albeit evidence that is not robust enough to support a high grade of recommendation. The language associated with a "Limited" Treatment Recommendation Grade is: "Treatment X is an OPTION."

Reference: <http://www.aaos.org/research/guidelines/guide.asp>

85. Answer: C

A 55-year-old man complains of pain in the right ankle. It has been getting worse for more than 10 years. He has 10 degrees dorsiflexion and 40 degrees plantar flexion with pain throughout the range of motion. The patient has failed conservative treatment and wishes to undergo a total ankle arthroplasty instead of an arthrodesis. With regard to total ankle arthroplasty vs fusion, the arthroplasty results in:

- A) A lower rate of reoperation
- B) A higher rate of adjacent joint arthritic changes
- C) A more normal gait pattern
- D) Ability to correct large coronal plane deformities (greater than 15 degrees)
- E) An increase in hindfoot motion

References: Coester L., Saltzman C., et. al - Long Term Results following ankle arthrodesis for post traumatic arthritis - J Bone Joint Surg, 2001; 83:219-228
SooHoo N., Zingmond D, Ko, C. - Comparison of Re-Operation rates following ankle arthrodesis and ankle fusion - JBJS AM, 2007; 89:2143-2149
Piriou P, Culpan MP, Mullins M, et al.- Ankle replacement versus Ankle Arthrodesis: A Comparative Gait Analysis Study - Foot and Ankle International 2008; 29(1):3-9.
Mazur J, Schwartz E, Simon R. - Ankle arthrodesis. Long-term follow-up with gait analysis. J Bone Joint Surg Am. 1979; 61(7):964-975
Thomas R, Daniels T, Parker K. - Gait analysis and functional outcomes following ankle arthrodesis for isolated ankle arthritis - J Bone Joint Am Surg 2006 88(3):526-535
Guyer A, Richardson G. - Current Concepts Review: Total Ankle Arthroplasty Foot and Ankle International 2008. 29(2): 256-264

86. Answer: D

In this same patient, relative indications for performing a total ankle replacement over an ankle arthrodesis include:

- A) Avascular necrosis of the talus
- B) History of infection
- C) Greater than 15 degrees varus
- D) Pre-existing ipsilateral hindfoot fusion
- E) Significantly increased range of motion postoperatively compared to preoperatively

References: Coester L., Saltzman C., et. Al - Long Term Results following ankle arthrodesis for post traumatic arthritis - J Bone Joint Surg, 2001; 83:219-228. Mazur J, Schwartz E, Simon R. - Ankle arthrodesis. Long-term follow-up with gait analysis. J Bone Joint Surg Am. 1979; 61(7):964-975. Thomas R, Daniels T, Parker K. - Gait analysis in function outcomes following ankle arthrodesis for isolated ankle arthritis - J Bone Joint Am Surg 2006; 88(3):526-535. Guyer A, Richardson G. - Current Concepts Review: Total Ankle Arthroplasty Foot and Ankle Int; February 2008; vol. 29, 2: pp. 256-264.

87. Answer: E

A 21 year-old collegiate football player suffers an external rotation of his ankle. He has difficulty walking afterward. He has no fractures. Which of the following ankle ligaments is most likely to be the initial structure injured?

- A) Calcaneofibular ligament
- B) Anterior talofibular ligament
- C) Deep deltoid ligament
- D) Superficial deltoid ligament
- E) Anterior inferior tibiofibular ligament

Discussion: High ankle sprains are external rotation injuries of the ankle and syndesmosis. They often occur in skiers, hockey players, and running and cutting athletes, particularly in collision sports. The anterior inferior tibiofibular ligament is the initial ligament injured. External rotation of the foot on the leg causes the talus to press against the lateral malleolus. This rotational movement first affects the anterior inferior tibiofibular ligament of the syndesmosis. If external rotation continues, the interosseous membrane and then the posterior tibiofibular ligament will be injured. Clanton's study supports that the anterior inferior tibiofibular ligament is the most commonly injured ligament in ankle sprains where the mechanism of injury is external rotation. This occurs regardless of the position of the foot at the time of injury. Pure dorsiflexion causes the interosseus ligaments to tighten and abduction on a neutral ankle can cause interosseus injury when preceded by deltoid injury or medial malleolus fracture.

References: Clanton TO, Paul P. Syndesmosis injuries in athletes. *Foot Ankle Clin.* 2002 Sep;7(3):529-49. Hopkinson WJ, St Pierre P, Ryan JB, Wheeler JH. Syndesmosis sprains of the ankle. *Foot Ankle.* 1990 Jun; 10(6):325-30.

88. Answer: D

Which of the following is true for "item response theory" (i.e., computer adaptive testing) in test administration?

- A) All questions in the instrument question bank are administered to all patients and a summative score is calculated
- B) A small portion of the questions in the overall instrument are administered, selected at random
- C) Item response theory typically includes more questions than classical test theory.
- D) Each question is selected from the question bank based on the patient's response to the previous question
- E) Computer adaptive tests are typically scored on a scale of 100 possible points

References: Assessment. 2011 Sep;18(3):291-307. The value of item response theory in clinical assessment: a review. Thomas ML

89. Answer: C

In selecting an instrument for patient-reported outcome measurement (PROM), which of the following is NOT an important feature of the instrument?

- A) Inclusion of a validated PROM instrument
- B) Measurement of the domain(s) of interest to the patient population and disorder
- C) Include objective findings like degrees of motion and radiographs
- D) Allow meaningful comparison to other series and studies of similar populations
- E) Be responsive to detect a change in the condition with time or intervention

References: Validation of PROMIS[®] Physical Function computerized adaptive tests for orthopaedic foot and ankle outcome research.

Hung M, Baumhauer JF, Latt LD, Saltzman CL, SooHoo NF, Hunt KJ; National Orthopaedic Foot & Ankle Outcomes Research Network. *Clin Orthop Relat Res.* 2013 Nov;471(11):3466-74

90. Answer: D

Which clinical test for syndesmosis injury has the fewest false-positive results and smallest inter-observer variance?

- A) Squeeze test
- B) Fibular translation
- C) Cotton test
- D) External rotation stress test
- E) Anterior drawer test

Discussion: The external rotation stress test helps to diagnose high ankle sprains and syndesmotic injuries. The athlete's knee is flexed 90 degrees and the ankle is in neutral. Stabilizing the tibia and fibula with one hand, the examiner externally rotates the ankle with the other. Pain over the syndesmosis indicates a positive test. Beumer et al tested the squeeze, fibula translation, Cotton, and external rotation tests. None of the syndesmotic tests was uniformly positive in chronic syndesmotic injury. The external rotation test had the fewest false-positive results, the fibula translation test the most. The external rotation test had the smallest inter-observer variance.

References: Beumer A, Swierstra BA, Mulder PG: Clinical diagnosis of syndesmotic ankle instability: Evaluation of stress tests behind the curtains. *ActaOrthopScand* 2002;73:667-669. PMID:12553515
Boytim MJ, Fischer DA, Neumann L: Syndesmotic ankle sprains. *Am J Sports Med* 1991;19:294-298. PMID:1907807

91. Answer: B

All of the following statements about syndesmotic ankle injuries are true EXCEPT:

- A) They are usually caused by external rotation or eversion of the ankle
- B) The injuries result in tearing of the anterior talofibular ligament
- C) Purely ligamentous injuries (high ankle sprains) are common in contact sports, and rarely require surgery
- D) Syndesmotic injuries are more common on artificial surfaces
- E) High ankle sprains result in 2-3x more time to return to play compared to inversion ankle injuries

Discussion: The anterior talofibular ligament is injured during an inversion ankle sprain. The syndesmotic ligaments include: the anterior-inferior tibiofibular ligament; the interosseous ligament; the inferior transverse ligament; and the posterior-inferior tibiofibular ligament.

Reference: Zalavras C, Thordarson D. Ankle syndesmotic injury. *The Journal of the American Academy of Orthopaedic Surgeons*. Jun 2007;15(6):330-339.

92. Answer: B

An active 35-year-old woman suffers an acute Achilles tendon rupture. Which of the following statements applies to patients undergoing NONOPERATIVE treatment compared to operative treatment?

- A) They have a higher risk of skin problems
- B) They have a higher risk for rerupture
- C) They are less likely to return to sport
- D) They have lower patient satisfaction scores
- E) Their ultimate strength is decreased

Discussion: A higher rerupture rate has been reported in Achilles tendon ruptures treated non-operatively compared to operatively. Skin problems are less common in patients treated non-operatively. Return to sports; patient satisfaction; and ultimate strength has been reported as equivalent when compared to operative treatment.

References: Weber M, Niemann M, Lanz R, Müller T. Nonoperative treatment of acute rupture of the achilles tendon: results of a new protocol and comparison with operative treatment. *Am J Sports Med*. 2003 Sep-Oct;31(5):685-91.

Willits K, Amendola A, Bryant D, Mohtadi NG, Giffin JR, Fowler P, Kean CO, Kirkley A. Operative versus nonoperative treatment of acute Achilles tendon ruptures: a multicenter randomized trial using accelerated functional rehabilitation. *J Bone Joint Surg Am*. 2010 Dec 1;92(17):2767-75.

93. Answer: E

What is the biggest advantage of surgical repair of an acute Achilles tendon rupture with early range of motion compared to non-operative treatment with immobilization in a short-leg cast for 6 weeks?

- A) Lower rate of infection
- B) Lower rate of nerve injury
- C) Better skin cosmesis
- D) Lower rate of DVT/ VTE
- E) Lower rate of re-rupture

References: Bhandari M, Guyatt GH, Siddiqui F, et al: Treatment of acute Achilles tendon ruptures: A systematic overview and metaanalysis. ClinOrthopRelat Res 2002;400:190-200

Khan RJ, Fick D, Keogh A, et al. Treatment of acute Achilles tendon ruptures: A meta-analysis of randomized, controlled trials. J Bone Joint Surg Am 2005;87:2202-2210

Willits K, Amendola A, Bryant D, Mohtadi NG, Giffin JR, Fowler P, Kean CO, Kirkley A. Operative versus nonoperative treatment of acute Achilles tendon ruptures: a multicenter randomized trial using accelerated functional rehabilitation. J Bone Joint Surg Am. 2010 Dec 1;92(17):2767-75.

Patel A, Ogawa B, Charlton T, Thordarson D Incidence of deep vein thrombosis and pulmonary embolism after Achilles tendon rupture. ClinOrthopRelat Res. 2012 Jan;470(1):270-4.

94. Answer: E

Which factor increases the chance of wound complications after Achilles tendon repair?

- A) Increased body mass index
- B) Immediate surgery
- C) Male gender
- D) Age over 40 years old
- E) Tobacco use

References: Bruggeman NB, Turner NS, Dahm DL, Voll AE, Hoskin TL, Jacofsky DJ, Haidukewych GJ. Wound complications after open Achilles tendon repair: an analysis of risk factors. ClinOrthopRelat Res. 2004 Oct;(427):63-6.

95. Answer: B

What type of talar osteochondral lesion is associated with the poorest functional outcome following primary debridement and drilling?

- A) Lesions > 0.7cm sq.
- B) Uncontained lesions
- C) Medial lesions
- D) Lateral lesions

Discussion: Debridement and drilling is the primary treatment of choice for almost all osteochondral lesions of the talus that have failed conservative care. Uncontained lesions along the shoulder of the talus, lesions > 1.5cm sq, and large cystic lesions have the poorest functional outcome.

Reference: Cuttica, D; Smith, Bret, et al: Osteochondral Lesions of the Talus: Predictors of Clinical Outcome. Foot Ankle Int. 33 (11): 1045 – 1051, 2011

96. Answer: D

There are several classification systems of talar osteochondral lesions. Which one is based on plain radiographs?

- A) Mintz
- B) Anderson
- C) Ferkel
- D) Berndt and Harty

Discussion: In 1959 Berndt and Harty proposed a classification system for osteochondral lesions based on plain x-ray films. This system continues to be useful for acute injuries. It is inappropriate to use the Berndt and Harty classification for chronic osteochondral lesions, 50% of which may not be visualized on plain films. Other systems, based on MRI (Mintz), arthroscopy (Anderson), or CT (Ferkel), are more appropriate.

Reference: Berndt, A; Harty, M: Tarsochondral Fractures of the Talus. J Bone Joint Surg , 41-A (6), 988 – 1019, 1959

97. Answer: C

A 55-year-old man complains of pain in the right ankle. It has been getting worse for more than 10 years. He has 10 degrees dorsiflexion and 40 degrees plantar flexion with pain throughout the range of motion. The patient has failed conservative treatment and wishes to undergo a total ankle arthroplasty instead of an arthrodesis. With regard to total ankle arthroplasty vs fusion, the arthroplasty results in:

- A) a lower rate of reoperation
- B) a higher rate of adjacent joint arthritic changes
- C) a more normal gait pattern
- D) ability to correct large coronal plane deformities (greater than 15 degrees)
- E) an increase in hindfoot motion

References: Coester L., Saltzman C., et. al - Long Term Results following ankle arthrodesis for post traumatic arthritis - J Bone Joint Surg, 2001; 83:219-228

SooHoo N., Zingmond D, Ko, C. - Comparison of Re-Operation rates following ankle arthrodesis and ankle fusion - JBJS AM, 2007; 89:2143-2149

Piriou P, Culpan MP, Mullins M, et al.- Ankle replacement versus Ankle Arthrodesis: A Comparative Gait Analysis Study - Foot and Ankle International 2008; 29(1):3-9.

Mazur J, Schwartz E, Simon R. - Ankle arthrodesis. Long-term follow-up with gait analysis. J Bone Joint Surg Am. 1979; 61(7):964-975

Thomas R, Daniels T, Parker K. - Gait analysis and functional outcomes following ankle arthrodesis for isolated ankle arthritis - J Bone Joint Am Surg 2006 88(3):526-535

Guyer A, Richardson G. - Current Concepts Review: Total Ankle Arthroplasty Foot and Ankle International 2008. 29(2): 256-264

98. Answer: D

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Reference: Berndt, A; Harty, M: Tarsochondral Fractures of the Talus. J Bone Joint Surg , 41-A (6), 988 – 1019, 1959

99. Answer: A

A 40-year-old man fell off of a ladder at work sustaining the injury shown in Figures A and B. On examination, his skin is intact, but the pulses in his foot are absent. Following closed reduction and splinting, what would be the next best step?

- A) Re-evaluate pulses
- B) Vascular surgery consultation
- C) CT angiogram
- D) Formal angiogram
- E) Surgical exploration and stabilization

Discussion: This patient sustained a posterior ankle fracture/dislocation. After closed reduction and splinting, the next best step should be to re-evaluate pulses.

With any dislocation, an immediate closed reduction should be performed. Though the initial vascular examination was abnormal in this case, the dislocation is contributing to this finding. This unique ankle fracture is known as the hyperplantarflexion variant. It is composed of a posterior tibial lip fracture with posterolateral and posteromedial fracture fragments separated by a vertical fracture line.

Gardner et al. review the hyperplantarflexion variant and found that the fracture of the posteromedial tibial rim was the main feature of this injury which is sustained by a hyperflexion mechanism. They also reported that posterior malleolus fractures are present in a majority of these injuries as well. On MRI they determined that the deltoid and posterior tibiofibular ligaments were intact in all cases. They conclude, when treating these fractures with ORIF of the posteromedial and posterior fragments with antiglide fixation, excellent results were obtained.

Hinds et al. name the unique double cortical density at the inferomedial tibial metaphysis the "spur sign." They found the spur sign to be present in 79% of variant ankle fracture cases. They found the positive predictive value and negative predictive value to be 100% and 99%, respectively when this sign is present.

Figures A and B demonstrate the hyperplantarflexion variant ankle fracture. Illustration A demonstrates the spur sign, as indicated by the red arrow.

Reference: The hyperplantarflexion ankle fracture variant. Gardner, F 2007
Ankle fracture spur sign is pathognomonic for a variant ankle fracture. Hinds, FAI 2015

**100. Answer: D**

Which test for acute syndesmotic injury of the ankle has the fewest false-positive results and smallest inter-observer variance when used intraoperatively?

- A) Squeeze test
- B) Fibular translation
- C) Cotton test
- D) External rotation stress test
- E) Anterior drawer

Discussion: The aforementioned tests help in diagnosing syndesmotic injuries. For an external rotation stress test, the knee is flexed 90 degrees and the ankle is in neutral. Stabilizing the tibia and fibula with one hand, the examiner externally rotates the ankle with the other. Widening of the syndesmosis indicates a positive test. This test method has been recently shown to have the fewest false-positive results and most accurate diagnostic abilities.

The lateral stress test, or Cotton test, has previously been shown to have the least false positive results in an acute syndesmotom injury. In the Cotton test, the fibula is attempted to be pulled laterally, and widening of the syndesmosis would therefore indicate syndesmosis injury.

Beumer et al. tested the squeeze, fibula translation, Cotton, and external rotation tests. None of the syndesmotom tests was uniformly positive in chronic syndesmotom injury. The fibular translation test had the most false-positive results.

Stoffel et al. performed a cadaveric study that found that the Cotton test produced a significantly greater increase in the tibiofibular clear space than did the external rotation test for Weber C injuries and Weber C plus deltoid ligament injuries. A greater increase in the tibiofibular clear space was noted during the lateral stress test when both the deltoid and the anterior inferior tibiofibular ligament had been sectioned.

Matuszewski et al. presented a prospective series of 28 patients undergoing ankle fracture fixation and compared intraoperative testing methods of the syndesmosis. They reported that compared with the Cotton test, stress external rotation demonstrated a 35% increase in medial clear space widening.

The video is an example of the Cotton test for evaluation of syndesmotom instability. See video here: <https://youtu.be/dYeyXk4BhRw>

Reference: Clinical diagnosis of syndesmotom ankle instability: evaluation of stress tests behind the curtains. Beumer, ACTA 2002

Syndesmotom Ankle Sprains. Boytim, AJSM 1991

Comparison of two intraoperative assessment methods for injuries to the ankle syndesmosis. A cadaveric study. Stoffel, JBJS 2009

Prospective intraoperative syndesmotom evaluation during ankle fracture fixation: stress external rotation versus lateral fibular stress. Matuszewski, JOT 2015

101. Answer: E

Which factor increases the chance of wound complications after Achilles tendon repair? Review Topic

- A) Increased body mass index
- B) Immediate surgery
- C) Male gender
- D) Age over 40 years old
- E) Tobacco use

Discussion: Risk factors for wound complications related to open Achilles repair includes tobacco use ($p < 0.0001$), steroid use ($p = 0.0005$), and female sex ($p = 0.0400$). For patients with one or more of the following risk factors: diabetes, tobacco use, or steroid use; there was significantly more rates of wound complications than those without risk factors present ($p < 0.0001$). Surgeons doing open Achilles tendon repairs should be cognizant of the specific risk factors identified in the study, as it may impact decision making with regard to operative versus nonoperative treatment.

Reference: Team Orthobullets (D) MD

102. Answer: D

A 30-year-old female sustains a lateral malleolar ankle fracture while playing a recreational soccer game. After reducing the fibula with a plate and screw construct, the syndesmosis is tested under fluoroscopy, with the results seen in Figure A. What test is being performed and what is the best next step based on these results?

- A) External rotation stress test, syndesmotic screw placement at least 2cm proximal to the above joint
- B) Cotton test, syndesmotic tightrope
- C) Cotton test, syndesmotic screw placement at least 2cm proximal to the above joint
- D) Cotton Test, no further fixation required
- E) External rotation stress test, deltoid ligament reconstruction using allograft



Discussion: The figure is demonstrating the Cotton or Hook test. No widening of the syndesmosis is demonstrated thus no further fixation is required.

The integrity of the syndesmosis is of utmost importance for achieving accurate anatomic reduction after an ankle fracture. Unsatisfactory results are highly correlated with a non- or mal-reduced syndesmosis. Several radiographic features and exam maneuvers have been described to assess the syndesmotic integrity both pre- and intra-operatively. The Cotton/hook test is a common maneuver where a bone hook is placed around the fibula and a distracting force is applied under fluoroscopy. If a loss of the tibia and fibula anatomic relationship is demonstrated, internal fixation of this joint must be performed.

Pakarinen et al. examined supination-external rotation type ankle fractures intra-operatively and compared both the hook test and external rotation stress test. They found high inter-observer reliability and high specificity for both tests, however sensitivity was low for both. This highlights the need to perform both tests intra-operatively, while also considering comparison of the contralateral side in diagnosing these injuries.

Lafferty et al. reviewed the role of stress radiographs in assessing syndesmotic integrity with concomitant ankle fractures. Several radiographic measurements such as increased medial clear space and tibiofibular clear space, and decreased tibiofibular overlap during external rotation stress test may be used to diagnose syndesmotic disruption. However, tibiofibular clear space is least affected by orientation of the x-ray beam within 5 degrees of external rotation to 25 degrees of internal rotation, thus this is a more reliable indicator of injury.

Van den Bekerom reviewed intra-operative tests of syndesmotic integrity. He showed the Cotton test to be more reliable than intra-operative external rotation stress test in creating displacement. However, he recommended that the distracting force on the fibula be done in the sagittal plane with 100N and viewed on a lateral radiograph, rather than in the coronal plane on an AP mortise view, as there is greater displacement seen.

Figure A shows the Cotton/hook test with a bone hook applying a distracting force to the fibula. A medial clear space widening is created.

Illustration A depicts the Cotton/hook test. Illustration B depicts the external rotation stress test.

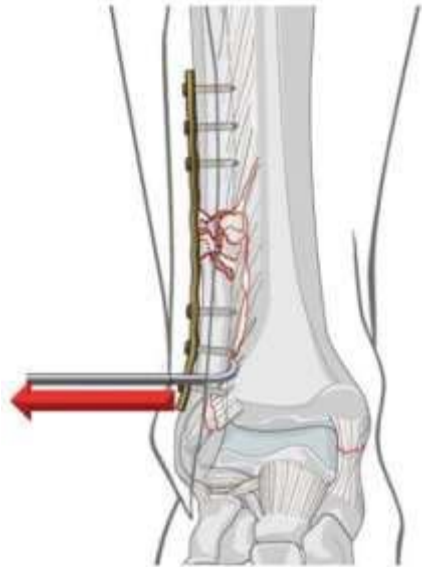


Figure A



Figure B

Reference: Stress radiographs in orthopaedic surgery. Lafferty, JAAOS 2009 Diagnosing syndesmotic instability in ankle fractures. van, WJO 2011

103. Answer: E

A 22-year-old male Division I collegiate football player felt a popping sensation along the heel during push off in practice and was unable to play thereafter. He is weak to push off with his injured leg. He presents to your clinic for further evaluation and treatment. He has an echymosis along the Achilles tendon and swelling. He has weakness to ankle plantarflexion, increased passive dorsiflexion with gentle manipulation at the ankle, a palpable gap at the Achilles tendon, and a positive Thompson's test. Other parts of his exam are normal. What is further tests are needed prior to consideration of surgical treatment to confirm diagnosis?

- A) MRI of the ankle
- B) Ultrasound of the Achilles tendon
- C) X-ray of the ankle
- D) CT scan of the ankle
- E) No further imaging needed to confirm diagnosis

Discussion: The physical examination should include two or more of the following tests to establish the diagnosis of acute Achilles tendon rupture: 1. Clinical Thompson test (Simmonds squeeze test) 2. Decreased ankle plantar flexion strength 3. Presence of a palpable gap (defect, loss of contour) 4. Increased passive ankle dorsiflexion with gentle manipulation. This patient has all 4 findings consistent with an Achilles tendon rupture without injuries to other parts of his ankle or foot. As a result, further imaging such as MRI or ultrasound is generally not needed to establish a diagnosis prior to treatment.

Reference: Team Orthobullets (D) MD

104. Answer: D 2020

In a high energy, purely ligamentous Lisfranc injury involving all five rays of the foot, what is the preferred surgical treatment?

- A) Open reduction internal fixation with screws
- B) Open reduction internal fixation with dorsal plates
- C) Arthrodesis of all five rays
- D) Arthrodesis of medial three rays
- E) Temporary K wire fixation

Discussion: In a high energy, purely ligamentous Lisfranc injury involving all five rays of the foot, the preferred surgical solution is an arthrodesis of the first three rays. We have level 1 data to support that treatment. ORIF with either screws or plates is not ideal in this situation and is not supported by the literature. Also, a full arthrodesis of the foot is less than ideal as we strive to not fuse the 4th and 5th rays. Lastly, K-wire fixation may be appropriate for a temporary fixation but should never be used for definitive fixation given its propensity to failure.

Reference: Team Orthobullets (D) MD

105. Answer: B

An active 35-year-old woman suffers an acute Achilles tendon rupture. Which of the following statements applies to patients undergoing NONOPERATIVE treatment compared to operative treatment?

- A) They have a higher risk of skin problems
- B) They have a higher risk for rerupture
- C) They are less likely to return to sport
- D) They have lower patient satisfaction scores
- E) Their ultimate strength is decreased

Discussion: A higher rerupture rate has been reported in Achilles tendon ruptures treated non-operatively compared to operatively. Skin problems are less common in patients treated non-operatively. Return to sports; patient satisfaction; and ultimate strength has been reported as equivalent when compared to operative treatment.

Reference: Team Orthobullets (D) MD

106. Answers: B

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Reference: Team Orthobullets (D) MD

107. Answer: C 2020

In relation to the patient in question above, what surgical treatment is most likely to result in long-term pain relief and functional improvement?

- A) Hemiarthroplasty
- B) 2Hemiarthroplasty with meniscal interposition
- C) Total shoulder arthroplasty (TSA)
- D) Reverse TSA

Discussion: TSA is the gold standard for surgical treatment of glenohumeral osteoarthritis. Multiple comparative studies between hemiarthroplasty and total shoulder arthroplasty demonstrate advantages of TSA regarding pain relief and most functional parameters. Shoulder hemiarthroplasty with meniscal interposition has been described for young patients with glenohumeral arthritis, but outcomes at intermediate-term follow-up have been inferior to those of TSA. Reverse TSA is contraindicated in patients with an intact rotator cuff.

Reference: Team Orthobullets (D) MD

108. Answer: D

The American Academy of Orthopaedic Surgeons has released Evidence-Based Medicine Guidelines for the treatment of which foot and ankle problem(s):

- A) Ankle Arthritis and Achilles Tendon Rupture
- B) Ankle Arthritis
- C) Achilles Tendon Rupture and Acquired Adult Flatfoot Deformity
- D) Achilles Tendon Rupture
- E) Acquired Adult Flatfoot Deformity and Ankle Arthritis

Discussion: The AAOS has released one EBM Guideline for the foot (Achilles Tendon Rupture in Feb 2010). **Reference:** Team Orthobullets (D) MD

109. Answer: B

During open reduction internal fixation of an ankle fracture you obtain an intra-operative image after fixation of the fibula. Based on this image, seen in Figure A, what is the next best step in the procedure?

- A) Ankle arthrotomy to examine congruency of the tibial plafond
- B) Open reduction and internal fixation of the syndesmosis
- C) Wound irrigation and closure
- D) Revision fixation of the fibular mal-reduction
- E) Application of external fixator

Discussion: This image indicates disruption of the syndesmosis requiring open reduction and fixation. When performing operative fixation of an ankle fracture, one must consider the possibility of syndesmotic disruption and instability. This can be assessed intra-operatively by performing a stress test after completing fixation (several techniques for stress testing are described). If the syndesmosis is disrupted, the stress test will reveal widening of the syndesmotic space, or the medial clear space. When this occurs, open reduction and fixation of the syndesmosis (with trans-syndesmotic screws or suture button) is warranted. If no widening occurs, then no added fixation is needed.

Van den Bekerom reviews syndesmotic injuries and instability in the setting of ankle fractures. The article notes that the hook, or "cotton" test is the most reliable method of assessing syndesmotic instability.



Figure A is a fluoroscopic image showing fibular fixation in place with widening of the medial clear space and syndesmotic space consistent with a positive stress test of the syndesmosis. Illustration A is a fluoroscopic radiograph of a similar ankle showing reduction and fixation of syndesmotic instability with trans-syndesmotic screws. **Reference:** Diagnosing syndesmotic instability in ankle fractures. van, WJO 2011

110. Answer: D

A 22-year-old male presents 4 weeks following open reduction and internal fixation of his unstable ankle fracture. He has had three days of increasing pain, swelling and the new onset of purulent drainage from the mid-portion of the lateral incision. Laboratory values, including white blood cell count, sedimentation rate, and C-reactive protein are elevated. Current radiographs are seen in Figures A and

B. On examination the wound probes deep and likely involves the lateral plate. What is the best step in management at this time?

- A) Suppression with broad spectrum oral antibiotics until fracture healing
- B) Suppression with broad spectrum intravenous antibiotics until fracture healing
- C) Surgical debridement, removal of internal fixation, culture specific antibiotics, casting until fracture healing
- D) Surgical debridement, maintenance of internal fixation, culture specific antibiotics until fracture healing
- E) Wound culture in the office and suppression with culture specific antibiotics until fracture healing

Discussion: The patient is presenting with an acute deep infection following open reduction and internal fixation of an unstable ankle fracture. Recent studies have shown that a protocol of early aggressive surgical debridement, maintenance of internal fixation and culture specific antibiotics can be effective at achieving fracture healing.

Management of early postoperative infection following open reduction and internal fixation can be challenging. Effective treatment typically involves a combination of surgical debridement and culture specific antibiotics. Removing internal fixation prior to fracture healing can lead to additional insult to the soft tissue and ongoing inflammation secondary to fracture instability. Recently published protocols have shown effective treatment with maintenance of implants and culture specific antibiotics following early, aggressive surgical debridement.

Berkes et al. performed a multi-center retrospective study of 121 patients with acute postoperative infection (defined as less than 6 weeks from surgery) following internal fracture fixation. The authors demonstrated a 71% rate of success (defined by maintenance of implants until fracture healing) with a protocol of debridement and suppression with culture specific antibiotics. Risk factors for failure of this technique include open fractures and the use of an intramedullary nail for fracture fixation.

Figures A and B show an ankle status post open reduction and internal fixation of a lateral malleolus fracture. There are no signs of loosening of fixation or cortical erosions concerning for osteomyelitis.

Figure C and D are weight bearing X-rays that demonstrate the same fracture, now healed, after debridement and culture specific antibiotics. Illustrations C and D demonstrate the same fracture after elective removal of implants at 10 months following the index procedure. Intraoperative cultures at the time of hardware removal were negative for recurrent infection.

Reference: Maintenance of hardware after early postoperative infection following fracture internal fixation. Berkes, JBJS 2010



Figure A



Figure B



Figure C



Figure D

111. Answer: C

What type of PRP has the most evidence to support its use for chronic tendinopathy?

- A) Leukocyte Poor Platelet Rich Plasma (LP-PRP)
- B) Platelet Poor Plasma (PPP)
- C) Leukocyte Rich Platelet Rich Plasma (LR-PRP)
- D) Platelet Rich Fibrin Matrix (PRFM)
- E) Autologous Conditioned Plasma (ACP)

Discussion: Leukocyte rich PRP has by far the most evidence supporting its use for chronic tendinopathy. Multiple large prospective randomized trials have some efficacy.

References: Team Orthobullets (D) MD

Hand, Wrist and Elbow

112. Answer: C 2020

What indication has the best evidence for the use of platelet-rich plasma?

- A) Rotator Cuff Tear
- B) Degenerative Disc Disease
- C) Lateral Epicondylar Tendinopathy (Tennis Elbow)
- D) Achilles Tendinopathy
- E) Acute Hamstring Tear

Discussion: Treatment of lateral epicondylar tendinopathy (tennis elbow) with platelet rich plasma has the most evidence supporting its use. Multiple prospective randomized trials has shown efficacy and recent review articles concur that there is abundant high-quality evidence to recommend the use of PRP for this condition.

Reference: Team Orthobullets (D) MD

113. Answer: D 2017

The best radiographic projection of the wrist that can be used intra-operatively to detect dorsal cortical screw penetration when applying a volar locking distal radius plate is:

- A) AP view, in full supination
- B) lateral view
- C) Lateral view with 22° radial tilt
- D) Dorsal tangential view
- E) Supinated oblique

Discussion: The dorsal tangential view allows visualization of the dorsal cortex of the distal radius and sigmoid notch and is sensitive in the detection of dorsal cortical screw penetration.

Reference: Joseph SJ, Harvey JN, The Dorsal Horizon View: Detecting Dorsal Screw Protrusion at the Distal Radius, JHS (Am) 2011

114. Answer: B 2017

Spanning internal fixation (“bridge plating”) of distal radius fractures may be indicated in highly comminuted fractures, poly-trauma injury and severe associated soft tissue injury. When choosing which metacarpal to apply the spanning plate, important factors include:

- A) Application of the spanning plate to the 2nd metacarpal is preferred as it reduces the risk of injury to the superficial radial nerve
- B) Application of the spanning plate to the 3rd metacarpal may increase the risk of digital extensor tendon entrapment and rupture.
- C) If there is a volar lunate facet fracture, the plate should be applied palmarly to the 3rd metacarpal to ensure a solid buttress of the critical fragment.
- D) The 2nd metacarpal is preferred as the plate can be applied laterally, avoiding all extensor tendons
- E) Application of the plate to the 4th metacarpal is preferred for Galeazzi type fractures.

Discussion: Although application of the spanning plate to the third metacarpal results in a linear plate and easy passage of the plate. However, the plate must pass through the 4th dorsal extensor compartment with risk of extensor tendon entrapment or rupture. Application of the plate to the 2nd metacarpal passes the plate through the 2nd extensor compartment with little risk to the digital extensor tendons but may contact the SRN.

Reference: Lewis SL, Mostofi A, Stevonovic M, Ghiassi A, Risk of Tendon Entrapment Under a Dorsal Bridge Plate in a Distal Radius Fracture Model, JHS 2015.

115. Answer: C 2017

When applying a locking screw in the distal row of a distal radius volar locking plate:

- A) Bi-cortical screw fixation is essential for a secure construct that can tolerate early rehabilitation.
- B) The length of the screw must be carefully measured to ensure lag effect on the fracture
- C) Inserting a locking screw of 75% measured length produces construct stiffness equal to bi-cortical fixation
- D) The screw should be just long enough to capture the volar cortex
- E) The screw should be 50% of measured length to avoid flexor tendon injury

Discussion: This study allows us to select a screw that is less than the measured length. This practice prevents extensor tendon injury from dorsal screw penetration without compromising the stiffness of the volar locking plate construct.

Reference: Wall LB, Brodt MD, Silva MJ, Boyer MI, Calfee RP. The Effects of Screw Length on Stability of Simulated Osteoporotic Distal Radius Fractures Fixed With Volar Locking Plates. JHS 2012

116. Answer: B 2017

In performing ORIF of the distal radius, positioning the volar locking plate distal to the watershed line:

- A) Maximizes tensioning of the distal oblique band of the interosseous membrane
- B) Increases the risk of flexor tendon attrition and rupture
- C) Optimizes distal screw placement
- D) Facilitates a minimally invasive approach
- E) Requires simultaneous carpal tunnel decompression

Discussion: The watershed line on the volar lip of the distal radius represents a source of ligament attachment and an abrupt change in the gentle slope of the volar distal radius from proximal to distal. Positioning of volar locking plates distal to this line results in volar displacement of the construct and increasing the risk of flexor tendon rupture, with flexor pollicis longus tendon ruptures most frequently reported.

References: Soong M, Earp BE, Bishop G, Leung A, Blazar P, Volar Locking Plate Prominence and Flexor Tendon Rupture, JBJS 2011. Tanaka Y, Aoki M, Izumi T, Fujiyama M, Yamashita T, Imai T, Effect of Distal Radius Volar Plate Position on Contact Pressure Between the Flexor Pollicis Longus Tendon and The Distal Plate Edge. JHS 2011

117. Answer: D 2017

Which of the following is considered one of the most important prognostic factors after nerve injury for potential recovery of function?

- A) Smoking
- B) Patient Co-Morbidities
- C) Socioeconomic Status
- D) Age of Patient
- E) Body Mass Index

Discussion: Multiple factors affect recovery after nerve injury and repair, many of these are not under the control of the surgeon. Multiple studies and meta-analyses have shown the most important of these to consistently include: age of the patient, location of the injury (proximal or distal), the particular nerve injured, and delay before repair.

References: Ruijs AC, Jaquet JB, Kalmijn S, Giele H, Hovius SE. Median and ulnar nerve injuries: a meta-analysis of predictors of motor and sensory recovery after modern microsurgical nerve repair. Plast Reconstr Surg. 2005 Aug; 116(2):484-94.

118. Answer: D 2017

In differentiating stages of nerve injury, which of the following does not exhibit Wallerian Degeneration?

- A) Sunderland Stage IV
- B) Neurotmesis
- C) Sunderland Stage III
- D) Neurapraxia
- E) Axonotmesis

Discussion: Wallerian degeneration is the process by which the distal part of an axon breaks down after it is separated from the cell body by transection of the nerve. Seddon in 1942 classified nerve injuries as neurapraxia, axonotmesis or neurotmesis. In neurapraxia there is no anatomic disturbance of the nerve but nerve conduction is blocked. In axonotmesis the axon is disrupted but at least the epineurium remains intact. In neurotmesis the entire nerve including axons and epineurium is interrupted. Wallerian degeneration does not occur in neurapraxia as the axon remains in continuity in this injury. However it does occur in axonotmesis and neurotmesis. In 1951 Sunderland expanded the classification, subdividing axonotmesis based on continuity of the endoneurium and perineurium. Sunderland Stage I corresponds to neuropraxia. Higher stages all involve axonotmesis and therefore Wallerian degeneration would occur.

References: Birch, R. Nerve Repair. pp 175-180. in Green Operative Hand Surgery 5th Edition. Ed Green DP, Hotchkiss RN, Pederson WC, Wolfe SW. Elsevier, Philadelphia PA 2005.

119. Answer: C 2017

For nerve injuries with a gap, which of the following types of repair options is considered the “gold standard.”

- A) Decellularized Allograft
- B) Rat Sciatic Nerve
- C) Sural Nerve Autograft
- D) Primary Repair with Tension
- E) Conduit Assisted Repair

Discussion: Nerve repair under tension results in ischemia at the repair site, increased apoptosis of Schwann cells and poor axonal growth. While tension-free primary nerve repair is always favored, for injuries that result in a nerve gap, autogenous nerve grafting is the “gold standard” for repair. The graft provides Schwann cells and neurotrophic factors to promote axonal regeneration. Autogenous nerve is nonimmunogenic, while allograft nerve such as rat sciatic nerve is not. Nerve conduits have advantages over autograft in that there is no donor site morbidity and unlimited lengths could be available, however they have been shown to have poorer outcomes except for short gaps (< 2 cm). Decellularized nerve allografts provide a more substantial scaffold than simple conduits without immunogenicity of fresh allograft. Early results show promise for improved outcomes above conduit but there is not enough experience with these to date for them to supplant autograft as the gold standard.

References: Ray WZ, Mackinnon SE. Management of nerve gaps: Autografts, allografts, nerve transfers, and end-to-side neurorrhaphy. *Exp Neurol.* 2010 May; 223(1) 77-85. Safa B, Buncke G. Autograft substitutes: conduits and processed nerve allografts. *Hand Clinics.* 2016 May; 32(2)127-140.

120. Answer: E (2017)

Other than surgery or wearing a brace, validated options would also include:

- A) Prolo therapy
- B) Early physical therapy
- C) Anti-inflammatory medications
- D) Bed Rest
- E) Education and activity modification

Discussion: In two recent randomized reports, Bailey and colleagues at the University of British Columbia reported that patients with neurologically intact, mechanically stable thoracolumbar burst fractures, at one year, reported similar outcomes whether they wore a brace, or simply modified their activities until the pain resolved.

References: Bailey, et al J Neurosurg Spine 2009 Sep; 11(3): 295-303
Bailey, et al Spine J 2014 Nov 1; 14(11): 2557-64

121. Answer: B 2017/2020

The longitudinal axis of forearm rotation passes through the center of the radial head proximally. Distally, the axis passes through:

- A) The articulation of the ulnar head and sigmoid notch
- B) The foveal sulcus of the ulna
- C) The tip of the ulnar styloid
- D) The medial cortex of the ulnar styloid
- E) The lunate fossa of the distal radius

Discussion: The preferred response is B. The longitudinal axis of pronosupination of the forearm is well described. Proximally, the axis passes through the center of the radial head. Distally, the axis passes through the foveal sulcus at the lateral base of the ulnar styloid. This area represents the point of attachment of the dorsal and volar radioulnar ligaments.

Reference: Kleinman WB. Stability of the distal radioulnar joint: Biomechanics, pathophysiology, physical diagnosis, and restoration of function what we have learned in 25 years. J Hand Surg. 2007; 32A:1086- 1106.

Af Ekenstam F, Hagert CG. Anatomical studies on the geometry and stability of the distal radio ulnar joint. Scand J Plast Reconstr Surg. 1985; 19:17–25.

Huang JI, Hanel DP. Anatomy and biomechanics of the distal radioulnar joint. Hand Clinics. 2012; 28(2):157-163.

122. Answer: B 2017

At 30 degrees of dorsal angulation in an extra articular distal radius malunion, arthritic change likely occurs at the:

- A) Scapholunate (S-L)
- B) Midcarpal
- C) Scaphotrapezialtrapezoid(STT)
- D) Distal radioulnar
- E) Radiocarpal (R-C)

Discussion: The preferred response is B. Malunited fractures of the distal radius with dorsal angulation greater than 30o have been associated with mid carpal instability and subsequent mid carpal arthritis. Radiocarpal arthritis is associated with Scaphoid nonunion and scapho-lunate dissociation. Arthritis at either the STT or S-L joints is not associated with distal radius malunions.

References: Mitchell, S, Azari K. KC, Murray, PM. (Eds). Management of Burns Chung. Hand Surgery Update V.

American Society for Surgery of the Hand. 2012; 379-389. Wolfe SW, Hotchkiss RN, Pederson WC, Kozin SH

(Eds). Green's Operative Hand Surgery. 6th Ed. Philadelphia, PA: Elsevier. 2011; 2089-2120. Taleisnik J, Watson

HK. Mid carpal instability caused by malunited fractures of the distal radius. J Hand Surg. 1984;9A (3): 350-357.

123. Answer: B 2017

Following open reduction and internal fixation of a displaced distal radius fracture using a palmar approach and fixed angle plate, repair of the pronator quadratus has been shown to:

- A) Improve grip strength
- B) Provide no significant benefit
- C) Improve range of motion
- D) Decrease the incidence of tendon rupture
- E) Improve DASH scores

Discussion: The pronator quadratus (PQ) must be divided and the muscle belly reflected to provide exposure for the palmar approach to internal fixation of fractures of the distal radius. Some authors have suggested that repair of the PQ is useful in preventing flexor tendon irritation, flexor tendon rupture, and to enhance pronation strength and stability of the distal radio-ulnar joint.^{1, 2} In addition, a recent survey³ of ASSH members showed that 86% of 753 respondents reported routinely attempting repair. Recent studies, however, have demonstrated no significant benefit from PQ repair with respect to grip strength, range of motion, DASH scores, or incidence of tendon rupture.^{4, 5}

References: Orbay JL. The treatment of unstable distal radius fractures with volar fixation. *J Hand Surg.* 2000;5(2):103–112. Rhee PC, Dennison DG, Kakar S. Avoiding and treating perioperative complications of distal radius fractures. *HandClin.* 2012;28(2):185–198. Swigart CR, Badon MA, Bruegel VL, Dodds SD. Assessment of pronator quadratus repair integrity following volar plate fixation for distal radius fractures: a prospective clinical cohort study. *J Hand Surg Am.* 2012;37(9):1868–1873. Tosti R, Ilyas AM. Prospective Evaluation of Pronator Quadratus Repair Following Volar Plate Fixation of Distal Radius Fractures. *J Hand Surg.* 2013; 38A:1678-1684. Hershman SH, Immerman I, Bechtel C, Lekic N, Paksima N, Egol KA. The effects of pronator quadratus repair on outcomes after volar plating of distal radius fractures. *J Orthop Trauma.* 2013;27(3):130–133=

124. Answer: D 2017

It has been observed that Vitamin C may reduce the incidence of Complex Regional Pain Syndrome after distal radius fractures. The recommended daily dose and duration of treatment is

- A) 200 mg daily for 30 days
- B) 200 mg daily for 50 days
- C) 500 mg daily for 30 days
- D) 500 mg daily for 50 days
- E) 1000 mg daily for 50 days

Discussion: The preferred response is D. Though its mechanism of action is not currently known, Vitamin C has demonstrated benefit in reducing CRPS in patients with distal radius fractures. The favorable response rate increased with higher doses, but leveled off at 500 mg daily, when compared with placebo. The recommended duration of treatment is 50 days.

References: Zollinger PE, Tuinebreijer WE, Breedervld RS, Kreis RW. Can vitamin C prevent complex regional pain syndrome in patients with wrist fractures? A randomized, controlled, multicenter dose response study. *J Bone Joint Surg Am.* 2007; 89: 1424-1431. Shah AS, Verma MK, Jebson PJJ. Use of oral vitamin C after fractures of the distal radius. *J Hand Surg.* 2009; 34:1736-1738. American academy of orthopedic surgeons. The treatment of distal radius fractures guidelines and evidencereport. 2009

125. Answer: A 2017

A patient, living at home independently, falls on both wrists sustaining a left nondisplaced scaphoid fracture and a right displaced distal radius fracture, with a failed closed reduction. The most appropriate treatment is:

- A) Operative fixation of both wrists
- B) Operative fixation of right wrist, casting of left wrist
- C) Operative fixation of left wrist, casting of right wrist
- D) Casting of both wrists
- E) Operative fixation of the right wrist, electrical stimulation of the left wrist

Discussion: The preferred response is A. In the face of multiple injuries to both wrists it is prudent to internally fix all of the bony pathology at once. Although the left scaphoid fracture is non displaced treating it closed when the right wrist is undergoing internal fixation will necessitate immobilizing both wrists for a period of time making the patient unable to perform self care. Fixation of the left scaphoid will allow early mobilization and use of the left wrist. Nonoperative treatment will not allow return to early independent function.

References: Tang JB, Shi D, Gu YQ, Zhang QG. Can cast immobilization successfully treat scapholunate dissociation associated with distal radius fractures? *J Hand Surg Am.* 1996; 21 (4): 583-90
 Kwon BC, Baek GH. Fluoroscopic diagnosis of scapholunate interosseous ligament injuries in distal radius fractures. *Clin Orthop Relat Res.* 2008; 466 (4): 969-976
 Rutgers M, Mudgal CS, Shin R. Combined fractures of the distal radius and scaphoid. *J Hand Surg Er.* 2008; 33E: (4): 478-483

126. Answer: C 2017

A patient sustains a fall resulting in an unstable fracture of the distal radius and a concomitant fracture of the ulnar styloid base. Following volar plating of the distal radius fracture, the DRUJ is found to be stable. In addition to the contact between the ulnar head and sigmoid notch, which structure is most responsible for the retained stability of the distal radioulnar joint?

- A) Dorsal radiocarpal ligament
- B) Extensor carpi ulnaris tendon
- C) Distal interosseous membrane
- D) Flexor carpi ulnaris tendon
- E) Pronator quadratus

Discussion: In the setting of distal radius fractures with a concomitant ulnar-sided wrist injury, the distal aspect of the interosseous membrane has been found to be very important in the stability of the distal radioulnar joint. The distal interosseous membrane inserts on the inferior rim of the sigmoid notch of the distal radius.

References: Kitamura T, Moritomo H, Arimitsu S, Berglund LJ, Zhao KD, An KN, et al. The biomechanical effect of the distal interosseous membrane on distal radioulnar joint stability: a preliminary anatomic study. *J Hand Surg Am.* 2011;36(10):1626-1630. Kihara H, Short WH, Werner FW, Fortino MD, Palmer AK. The stabilizing mechanism of the distal radioulnar joint during pronation and supination. *J Hand Surg Am.* 1995;20(6):930-936.

127. Answer: E 2017

Which flexor tendon is at greatest risk of attritional rupture following volar plate fixation of distal radius fractures?

- A) Ring FDP
- B) Long FDS
- C) Long FDP
- D) Index FDS
- E) FPL

Discussion: Within the volar compartment, two tendon ruptures have been described involving the flexor pollicis longus and flexor digitorum profundus to index. Both of these tendons run along the radial column and have the potential to interface with the volarly placed device. Despite plate designs to improve the contour radially, attritional ruptures have been reported. Plate position relative to the volar rim has been postulated as a risk factor in the development of tendon irritation. Although these delayed tendon ruptures are rare, they most commonly involve the flexor pollicis longus.

According to a recent anatomic study, the FPL at the watershed line is located at an average of 19 mm lateral to the volar-ulnar corner of the radius, approximately at the midpoint of the maximum width of the distal radius. In the axial view, this location was not the most volarly prominent segment of the watershed line, which was in fact located on the ulnar side. Rather, the gliding path of the FPL tendon was located in the trough of the watershed line, within a sulcus between the scaphoid and lunate fossas (Figure 1 from Limthongthang, et al). Orbay referred to this area as the interfossa sulcus (Orbay JL, presented at the American Association for Hand Surgery Annual Meeting, 2013).

References: Kitay A, Swanstrom M, Schreiber JJ, Carlson MG, Nguyen JT, Weiland AJ, et al. Volar Plate Position and Flexor Tendon Rupture Following Distal Radius Fracture Fixation. *J Hand Surg Am.* 2013;38(6):1091-1096.
 Griffin JW, Chhabra AB. Complications after volar plating of distal radius fractures. *J Hand Surg Am.* 2014;39(6):1183-1185.
 Soong M, Earp BE, Bishop G, Leung A, Blazar P. Volar locking plate implant prominence and flexor tendon rupture. *J Bone Joint Surg Am.* 2011;93(4):328-335.
 Limthongthang R, Bachoura A, Jacoby SM, Osterman AL. Distal radius volarlocking plate design and associated vulnerability of the flexor pollicis longus. *J Hand Surg Am.* 2014;39(5):852-860.

128. Answer: D 2017

A 36-year-old woman develops pain and swelling four weeks after operative fixation of a distal radius fracture. She is treated with multiple stellate ganglion blocks with only minimal relief of symptoms. She complains of numbness and tingling in the median nerve distribution. Nerve conduction studies show slowing of median nerve conduction at the carpal tunnel. What is the most likely diagnosis?

- A) Brachial plexus injury secondary to the stellate ganglion blocks
- B) Iatrogenic injury to the median nerve
- C) CRPS Type I
- D) CRPS Type II
- E) Acute pronator syndrome

Discussion: Pain out of proportion to the initial event and swelling are among the initial clinical signs of Complex Regional Pain Syndrome (CRPS). After ruling out compartment syndrome, the patient was treated with stellate ganglion blocks. Initially following the fracture, pain and swelling rather than sensory changes *were the patient's prevalent complaint*. Later with complaints of numbness, tingling and specifically EMG changes, the diagnosis of CRPS Type II was made, and carpal tunnel release was done with significant improvement in her symptoms. Type I CRPS is initiated by trauma and often has a cast or tight bandage and swelling. Type II CRPS is related to an identifiable peripheral nerve problem, and minimal positive response can be obtained with sympathetic blocks. Surgery with nerve decompression often *aides significantly in the patient's recovery*.

References: Patterson RW, Li Z, Smith BP, Smith TL, Koman LA. Complex regional pain syndrome of the upper extremity. *J Hand Surg Am.* 2011;36(9):1553-1562.

Ochoa JL. Truths, errors, and lies around "reflex sympathetic dystrophy" and "complex regional pain syndrome." *J Neurol.* 1999;246(10):875-879.

Vranceanu AM, Barsky A, Ring D. Psychosocial aspects of disabling musculoskeletal pain. *J Bone Joint Surg Am.* 2009;91(8):2014-2018.

4. Ring D, Barth R, Barsky A. Evidence-based medicine: disproportionate pain and disability. *J Hand Surg Am.* 2010;35(8):1345-1347.

129. Answer: C 2017/2020

Which of the following statements accurately describes primary elbow arthritis of the elbow and/or its treatment?

- A) Elbow osteoarthritis is very common, primarily affecting sedentary individuals
- B) Patients typically present with pain through the full arc of elbow motion but no loss of motion.
- C) Elbow motion may be limited by osteophyte formation and capsular contracture.
- D) Loose bodies are not typically seen in primary elbow osteoarthritis.
- E) Coronoid osteophytes may limit elbow extension while olecranon osteophytes may limit flexion

Discussion: Symptomatic primary elbow osteoarthritis affects up to 2% of the population and is four times more common in men than women. Individuals in their fourth and fifth decades engaged in heavy manual labor are most affected. Common presentations include a loss of terminal extension and/or pain leading to functional limitations in activities of daily living. Motion is limited by the formation of osteophytes at the tip of the coronoid and olecranon and the corresponding coronoid and olecranon fossa's. This leads to capsular contracture. Coronoid osteophytes limit elbow flexion while olecranon osteophytes limit elbow extension. Loose body formation is very common in elbow osteoarthritis and can lead to "catching" or "locking" of the elbow.

Reference: Galle SE, Beck J, Burchette R, Harness NG. Outcomes Elbow Arthroscopic Osteocapsular Arthroplasty, *Journal of Hand Surgery*; 2016; 41A: 184-191.

Kokkalis Z, Schmidt C, Sotereanos. Elbow Arthriits Current Concepts, *J Hand Surg* 2009;34A:761-768.

130. Answer: B 2017/2020

Which of the following statements about the treatment of elbow arthritis is false?

- A) Rest, NSAID's, activity modification and steroid injections are the most common non-operative treatment options.
- B) Viscosupplementation (Sodium hyaluronate injections) have been shown to be a better option than steroid for elbow arthritis.
- C) Open surgery, arthroscopy and mini-open (Outerbridge-Kashiwagi) can produce similar outcomes.
- D) Complete capsular release and osteophyte excision can be performed arthroscopically.
- E) Elbow arthroscopy allows complete visualization of the elbow joint.

Discussion: The arthritic elbow should always be treated with conservative measures as a first line of treatment. The most effective options are rest, NSAID's, activity modification and steroid injections. Activity modification is difficult for most active individuals and manual laborers. Viscosupplementation was evaluated in one study and was found to be ineffective for relief of pain in elbow arthritis. Long term pain relief and motion are similar between open, arthroscopic and mini-open procedures. Elbow arthroscopy allows complete visualization of the joint and the ability to complete a capsular release and osteophyte excision.

Reference: Adams JE, Wolff LH III, Merten SM, Steinmann SP. Osteoarthritis of the elbow: results of arthroscopic osteophyte resection and capsulectomy. *J Shoulder Elbow Surg.* 2008;17:126–131.

Antuna SA, Morrey BF, Adams RA, O'Driscoll SW. Ulnohumeral arthroplasty for primary degenerative arthritis of the elbow: long-term outcome and complications. *J Bone Joint Surg Am.* 2002;84: 2168-2173.

Kokkalis Z, Schmidt C, Sotereanos. Elbow Arthriits Current Concepts, *J Hand Surg* 2009;34A:761-768.

Mansat P, Morrey BF. The "column procedure" a limited surgical approach for the treatment of stiff elbows. *J Bone Joint Surg.* 1998;80A(11):1603-1615. Phillips NJ, Ali A, Stanley D. Treatment of primary degenerative arthritis of the elbow by ulnohumeral arthroplasty.A long-term follow-up. *J Bone Joint Surg Br.* 2003;85: 347-350.

131. Answer: D 2017/2020

All of the following are advantages of elbow arthroscopic osteocapsular arthroplasty except?

- A) Less risk of heterotopic ossification
- B) Less pain and early range of motion
- C) Less damage to surrounding musculature
- D) Technically demanding
- E) Improved articular inspection

Discussion: When the arthroscopic approach is compared to standard open elbow release and osteophyte excision, there is less extensive dissection and stripping of muscular origins. The open approach is more prone to heterotopic bone formation, higher levels of postop pain and potential for delay in early motion. Arthroscopy is more technically demanding but provides better visualization of the articular surfaces. For the non-arthroscopist, open surgery may be the safest approach and can provide similar outcomes to arthroscopy.

Reference: Adams JE, Wolff LH III, Merten SM, Steinmann SP. Osteoarthritis of the elbow: results of arthroscopic osteophyte resection and capsulectomy. *J Shoulder Elbow Surg.* 2008;17:126–131.
Phillips NJ, Ali A, Stanley D. Treatment of primary degenerative arthritis of the elbow by ulnohumeral arthroplasty. A long-term follow-up. *J Bone Joint Surg Br.* 2003;85: 347-350.

132. Answer: C 2017/2020

All of the following outcomes of elbow arthroscopic arthroplasty have recently been reported except?

- A) Statistically significant improvement in motion, including flexion and extension.
- B) Visual analog scale improvement of 4 to 5 points.
- C) Complete pain resolution in all patients.
- D) Minimal risk of nerve injury.
- E) Statistically significant improvement in the Mayo Elbow Performance Score.

Discussion: Galle et al, showed that pain improvement was the expectation in the majority of patients (4-5 points on a 10 point scale) but approximately 37% continued to have some degree of elbow pain at an average of 3 years after arthroscopic osteocapsular arthroplasty. Statistically significant improvement was observed in: extension (pre-operative 24 degrees to post-operative 12 degrees), flexion (pre-operative 126 degrees to post-operative 135 degrees). There were no complications or any nerve injuries although nerve injury is a known complication of elbow arthroscopy (0-14%). Mayo elbow performance scores improved from a poor level preoperatively to good postop (pre-operative 56.5 (poor) to post-operative 87.9 (good)). Adams, et al found similar improvement in pain and motion in their series from the Mayo Clinic.

Reference: Galle SE, Beck J, Burchette R, Harness NG. Outcomes Elbow Arthroscopic Osteocapsular Arthroplasty, *Journal of Hand Surgery;* 2016; 41A: 184-191. Adams JE, Wolff LH III, Merten SM, Steinmann SP. Osteoarthritis of the elbow: results of arthroscopic osteophyteresection and capsulectomy. *J Shoulder Elbow Surg.* 2008;17:126–131.

133. Answer: C 2017

This 74-year old patient (Figure) complains of ulnar sided wrist pain with loading and twisting activities. He has immobilized the wrist and has taken NSAIDs previously without significant improvement. Which is the most reliable procedure to relieve his pain?

- A) Arthroscopic wafer procedure
- B) Ulnar shortening osteotomy
- C) Distal ulnar resection
- D) Distal ulnar prosthetic arthroplasty
- E) Total wrist arthrodesis

Discussion: The patient has elements of ulnar impaction syndrome as well as distal radioulnar joint arthrosis evidenced by the inferior/proximal osteophyte off the ulnar head. Therefore, simply treating the ulnar impaction syndrome with a wafer resection or ulnar shortening osteotomy procedure would not be of benefit to this patient, as the persistent DRUJ arthrosis could continue to cause pain with forearm rotation. Distal ulnar prosthetic arthroplasty would also not be of benefit assuming the sigmoid notch is involved with degenerative changes. A total wrist arthrodesis would not address the distal radioulnar joint. The distal ulnar resection has been shown to be a reliably useful procedure in these circumstances, especially in a lower demand population. Many procedures to stabilize the distal ulnar stump using either the pronator quadratus or ECU tendons have been described.



References: Grawe B, Heincelman C, Stern P. Functional results of the darrach procedure: a long-term outcome study. *J Hand Surg Am.* 2012 Dec;37(12):2475-2480.

Zimmerman RM, Kim JM, Jupiter JB. Arthritis of the distal radioulnar joint: from Darrach to total joint arthroplasty. *J Am Acad Orthop Surg.* 2012 Oct;20(10):623-32.

134. Answer: C 2017

Which of the following is not a component of the triangular fibrocartilage complex?

- A) Articular disc
- B) ECU subsheath
- C) Dorsal radiocarpal ligament
- D) Ligamentum subcruentum
- E) Meniscal homologue

Discussion: The dorsal radiocarpal ligament is a component of the dorsal wrist capsule and stabilizes the radiocarpal joint. All of the other answers represent accepted components of the triangular fibrocartilage complex.

References: Ishii S, Palmer AK, Werner FW, Short WH, Fortino MD. An anatomic study of the ligamentous structure of the triangular fibrocartilage complex. *J Hand Surg Am.* 1998 Nov;23(6):977-85.

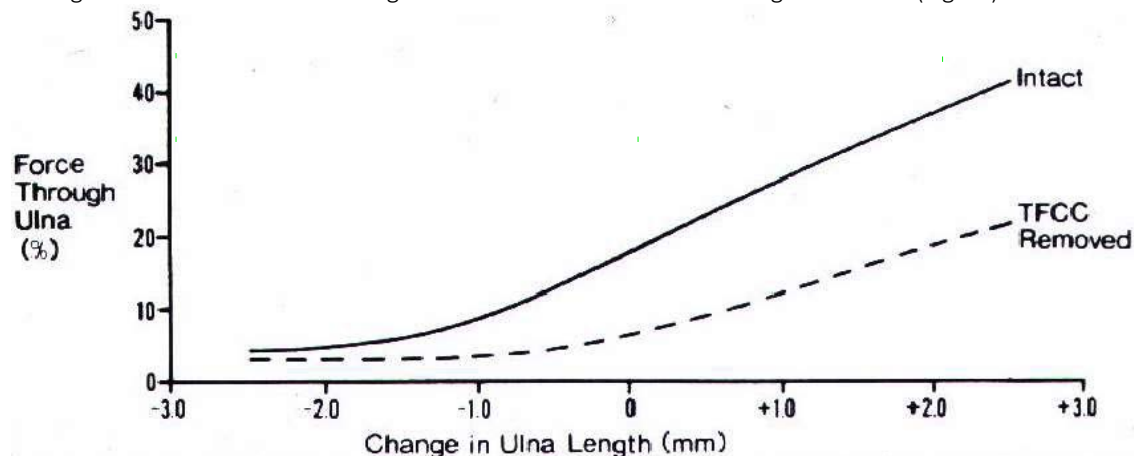
Palmer AK, Werner FW. The triangular fibrocartilage complex of the wrist--anatomy and function. *J Hand Surg Am.* 1981 Mar;6(2):153-62.

135. Answer: B 2017

The normal load transfer from the carpus to the forearm changes with ulnar variance. In an ulnar positive variant of +2 mm, the load transfer across the radius and ulna are:

- A) 80% and 20%
- B) 60% and 40%
- C) 50% and 50%
- D) 40% and 60%
- E) 20% and 80%

Discussion: With neutral ulnar variance, the radius bears 80% of the load from the carpus to the forearm, and the ulna accounts for 20%. With an ulnar positive variant of +2 mm, the load transfer through the ulna increases to 40% (60% through the radius). Similarly, with a negative ulnar variant of -2 mm leads to a load transfer of only 4% through the ulna with the remaining 96% of the load transmitted through the radius (Figure).



Reference. Werner FW, Glisson RR, Murphy DJ, Palmer AK. "Force transmission through the distal radioulnar carpal joint: effect of ulnar lengthening and shortening," *Handchir Mikrochir Plast Chir.* 1986 Sep;18(5):304-8.

136. Answer: D

The following option would be most appropriate for an 18-year old athlete with a fragmented, unsalvageable proximal pole scaphoid nonunion:

- A) Vascularized bone graft
- B) Scaphoid excision, 4-corner fusion
- C) Proximal row carpectomy
- D) Osteochondral rib autograft
- E) Silicone prosthesis

Discussion: In the rare case of an unsalvageable, fragmented proximal pole scaphoid nonunion, reconstructive options such as bone grafting procedures would not be possible as the fragmented proximal pole is not a contained defect and not salvageable. Silicone scaphoid prostheses have uniformly failed. Salvage procedures such as a scaphoid excision and 4-corner fusion or proximal row carpectomy would not be ideal in this young patient. Using the osteochondral rib autograft to reconstruct the proximal pole of the unsalvageable scaphoid has been met with some good mid- to long- term results.

References: Sandow MJ. Proximal scaphoid costo-osteochondral replacement arthroplasty.

J Hand Surg Br. 1998 Apr;23(2):201-8.

Yao J, Read B, Hentz VR. "The Fragmented Proximal Pole Scaphoid Nonunion Treated With Rib Autograft, A Case Series and Review of the Literature," *J Hand Surg [Am].* 2013 Nov;38(11):2188-92.

137. Answer: C

Following the scaphoid, this carpal bone is the most commonly fractured:

- A) Trapezium
- B) Lunate
- C) Triquetrum
- D) Capitate
- E) Pisiform

Discussion: Triquetral fractures are the second most common fractures of the carpus, second only to scaphoid fractures. Triquetral ridge fractures, typically avulsions of either the dorsal intercarpal or dorsal radiocarpal ligaments, are the most common type of triquetral fractures, accounting for up to 93% of these fractures.

References:

Höcker K, Menschik A. Chip fractures of the triquetrum. Mechanism, classification and results. *J Hand Surg Br* 1994; 19:584. Marchessault J, Conti M, Baratz ME. Carpal fractures in athletes excluding the scaphoid. *Hand Clin* 2009; 25:371.

138. Answer E

Which of the following methods of fixation for scaphoid waist hypertrophic nonunions in conjunction with the addition of bone graft would be considered LEAST effective?

- A) Headless screw fixation
- B) Plate fixation
- C) Nitinol staple fixation
- D) Intramedullary radial strut grafts
- E) External fixation

Discussion: External fixation would not provide adequate stability to the small scaphoid. All of the other techniques provide some form of internal stability which would allow for healing of nonunions of this relatively unstable and avascular bone.

References:

Dodds SD, Patterson JT, Halim A. "Volar plate fixation of recalcitrant scaphoid nonunions with volar carpal artery vascularized bone graft," *Tech Hand Up Extrem Surg.* 2014 Mar;18(1):2-7
 Bain GI, Turow A, Phadnis J. "Dorsal Plating of Unstable Scaphoid Fractures and Nonunions," *Tech Hand Up Extrem Surg.* 2015 Sep;19(3):95-100.

139. Answer: E

The procedure with the best chance of correcting this scaphoid waist nonunion in a 13 year old football player with humpback deformity is:

- A) Bone stimulation
- B) Nonvascularized bone graft from the radius
- C) Nonvascularized bone graft from the iliac crest
- D) Vascularized bone graft using the 1,2-ICSRA pedicle
- E) Vascularized bone graft using the free medial femoral condyle vascularized autograft



Discussion: This scaphoid nonunion with concern for avascular necrosis on the MRI would be best treated with a vascularized bone graft. The humpback deformity is difficult if not impossible to correct via a dorsal approach. The success of the 1,2- ICSRA graft in these situations is limited. The vascularized medial femoral condyle autograft procedure would provide robust bone graft with a large pedicle and has been shown to have high union rates in these challenging cases.

References:

Jones DB Jr, Shin AY. Medial femoral condyle vascularized bone grafts for scaphoid nonunions," *Chir Main.* 2010 Dec;29 Suppl 1:S93-103. Chang MA, Bishop AT, Moran SL, Shin AY. "The outcomes and complications of 1,2-intercompartmental supraretinacular artery pedicled vascularized bone grafting of scaphoid nonunions," *J Hand Surg Am.* 2006Mar;31(3):387-96.

140. Answer: E

A 65 year old male fell from a standing height onto the left outstretched hand. The preoperative films are shown (A, B). He underwent open reduction and internal fixation of the fracture with the immediate postop films shown (C,D). Within 4 weeks the patient returned with increasing pain and deformity of the wrist and the following radiographs (E,F). Which of the following is the most likely cause of the current situation?

- A) Use of a non-locking plate
- B) Unreduced volar tilt
- C) Failure to use a dorsal plate
- D) Failure to use a radial column plate
- E) Failure to support the volar lunate facet fracture fragments

Figure K

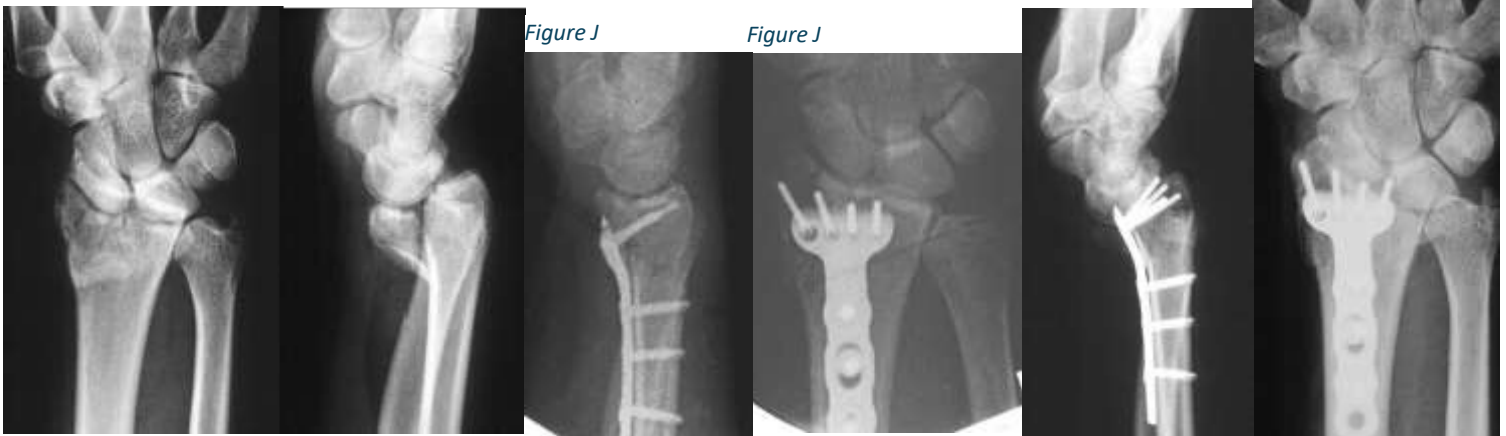
Figure J

Figure J

Figure J

Figure J

Figure J



Radiographs courtesy JBJS; Harness, 2004.

Discussion: The failure of this patient's fracture fixation is due to a lack of support for the small volar lunate facet fracture fragment. The volar lunate facet is the attachment point for the short volar radio carpal ligaments and is critical for stability of the carpus. Due to the unique anatomy of the fragment, it is difficult to stabilize with a standard volar locking plate. Failure to support the fragment can result in volar displacement and subluxation of the entire carpus. Plates placed distal to the watershed line can support the fragment but also risk irritation and rupture of the flexor tendons. Lower profile fixation with pin plates, headless screws, tension band techniques and new fragment specific extensions that attach to the volar plate offer stability with less risk for tendon irritation.

Reference: Harness, N.G., Jupiter, JB, Fernandez, DL, Orbay, DL, Raskin, KR, Loss of Fixation of the Volar Lunate Facet Fragment in Fractures of the Distal Part of the Radius, *The Journal of Bone and Joint Surgery*, September 2004; 86A: 1900-1908. Beck J, Harness NG, Spencer, H. Volar Plate Fixation Failure for Volar Shearing Distal Radius Fractures With Small Lunate Facet Fragments, *Journal of Hand Surgery*; 2014;39A: 670-678. Harness NG. Fixation options for the volar lunate facet: Thinking outside the box. *Journal of Wrist Surgery*, 2016;5:9-16.

141. Answer: B

Which tendon is at greatest risk of attritional rupture after volar plate fixation of a distal radius fracture?

- A) EPL
- B) FPL
- C) Ring FDP
- D) Middle FDP
- E) Index FDP

Discussion: The most commonly reported attritional tendon rupture after volar plate fixation of the distal radius is the FPL. The index FDP is also at risk but not as commonly reported to rupture. The EPL tendon is at risk of attritional rupture when screws are placed through the dorsal cortex with distal radius volar plate fixation but is also not as commonly involved as the FPL. Plate design and placement contribute to the risk of tendon rupture. At the watershed line, the FPL is located at the mid-point of the width of the distal radius. An anatomic study determined that this location puts the FPL at risk of rupture. Soong, et al found that placement of a volar plate distal to the watershed line increases the risk of tendon rupture. The most prominent portion of the watershed line is located at the volar ulnar corner. The FPL sulcus is located just radial to the prominence of the volar lunate facet. When attempting fixation of the volar ulnar corner of the distal radius, one must be cautious in placing implants distal to the watershed line to avoid FPL irritation.

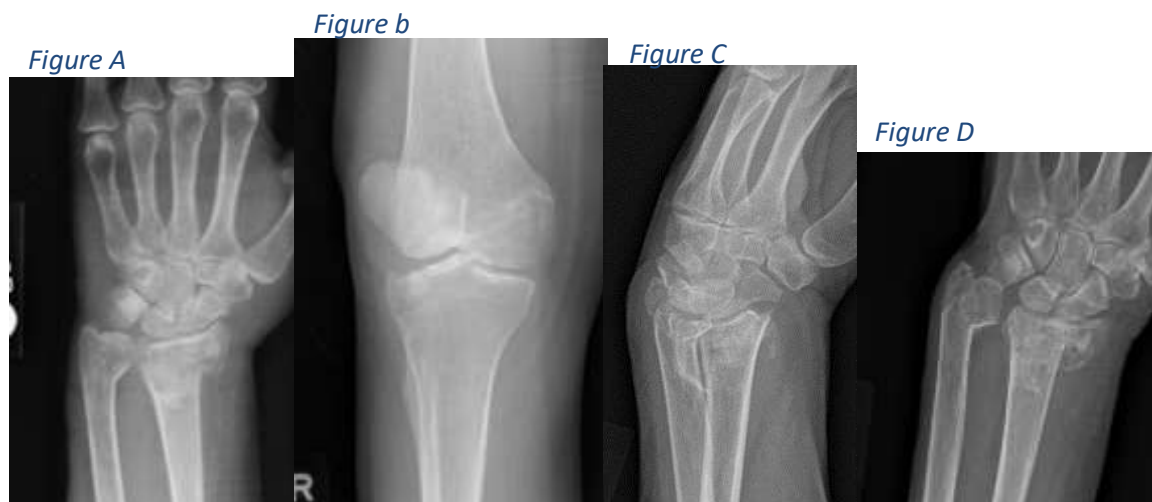
References: Soong M, Earp B, Bishop G, Leung A, Blazar P, Volar Locking Plate Implant Prominence and Flexor Tendon Rupture, *J Bone Joint Surg Am*, 2011; 93(4): 328 -335 .

Limthongthan R, Bachour S, Jacoby A, Osterman L. Distal Radius Volar Locking Plate Design and Associated Vulnerability of the Flexor Pollicis Longus. *Journal of Hand Surgery*, 2014; 39(5): 852–

142. Answer: E

A 70-year-old female fell and sustained a tibial plateau fracture and ipsilateral fracture of the distal radius (A, B). The distal radius fracture was reduced and splinted in the ER and the tibial plateau fracture was treated with ORIF. Two weeks later, the distal radius fracture displaced due to severe osteoporosis (C, D). The decision is made to treat the distal radius fracture operatively, but the patient requires full weight bearing through the forearm and wrist for ambulation with a walker. What is the best option for operative stabilization of the wrist fracture?

- A) Volar plate
- B) Dorsal plate
- C) External fixator
- D) Fragment specific fixation
- E) Dorsal spanning plate



Discussion: One of the advantages and relative indications for dorsal spanning plate fixation of distal radius fractures is in the poly trauma patient who might require forceful use of the injured upper extremity for ambulation. In this situation, a spanning plate will allow for immediate weight bearing with crutches. In addition, the spanning plate provides the advantages of an external fixator without exposed hardware.

Highly comminuted, intra articular fractures in elderly osteoporotic patients can be difficult to manage with conventional plates and screws. Bridge plating spans the osteoporotic segment and utilizes ligamentotaxis to maintain reduction.

Lauder et al, found that the use of spanning plates for distal radius fractures was safe and led to few complications. Outcomes were similar to other treatment methods. Wrist motion returned to a normal level except for wrist flexion, which remained diminished, compared to the uninjured wrist at long-term follow up in their series.

References: Lauder A, Agnew S, Bakri K, Allan C, Hanel D, Huang J; Functional outcomes following bridge plate fixation for distal radius fractures, Journal of hand surgery, 2015, (40) 8: 1554-1562.

Brogan D, Richard M, Ruch D, Kakar S, Management of severely comminuted distal radius fractures. Journal of hand surgery; 2015 (40) 9: 1905-1914.

143. Answer: C 2020

Patients with post-traumatic lack of elbow flexion (less than 100 degrees) can benefit from:

- A) Anterior band of MCL
- B) Posterior band of MCL
- C) Posterior band of MCL and Ulnar nerve transposition
- D) Anterior band of MCL and Ulnar nerve transfusion

Discussion: The posterior band of MCL gets tight in flexion. If patients have a capsular contracture and cannot flex the elbow beyond 100 degrees, they can have significant improvement in elbow flexion without instability by releasing the posterior band of the MCL

Reference: Lindenhovius AL, Jupiter JB. The posttraumatic stiff elbow: a review of the literature. Journal of Hand Surgery Dec 2007

144. Answer: E

The “column” procedure:

- A) Refers to the Medial column of the elbow joint
- B) Refers to the Lateral approach to the elbow joint
- C) Involves preservation of collateral ligaments
- D) Described by Morrey
- E) B, C, and D

Discussion: Morrey in 1998 with a series of 38 elbows with restricted elbow motion who underwent the release of the elbow contracture using this approach. There were low rates of complication and motion improved in flexion and extension in all patients. The lateral UCL must be preserved in order to avoid instability and all the releases were done via a lateral approach.

Reference: Mansat P, Morrey B. The Column Procedure: A Limited Lateral Approach for Extrinsic Contracture of the Elbow. Journal of Bone & Joint Surgery, Nov 1998.

145. Answer: D 2020

Elbow arthroplasty is considered in stiff elbow in patients

- A) Greater than 50% articular wear
- B) Young active patients
- C) Low demand patients with more advanced age
- D) A and C

Discussion: Although there are no specific guidelines for elbow replacement in elbow stiffness, most agree that it should be reserved for low demand patients with greater than 50% articular cartilage loss. Elbow arthroplasty in the setting of elbow fusion or Heterotopic bone formation remains very controversial and is not commonly performed.

Reference: Reference; Evans P, Nandi S, Maschke S, Hoyer H, Lawton J. Prevention and Treatment of Elbow Stiffness. Journal of Hand Surgery, April 2009

146. Answer: B

Botulinum Toxin A

- A) Has no role in elbow surgery
- B) Has been shown effective in ORIF of elbow fractures
- C) Should only be used for cosmetic purposes
- D) Can help reduce the incidence of HO in the elbow

Discussion: Although, the use of Botox is not a standard mode of preventing elbow stiffness, there is some evidence to show its effectiveness in preventive elbow stiffness in patients that undergo ORIF of distal humerus fractures.

Reference: Evans P, Nandi S, Maschke S, Hoyer H, Lawton J. Prevention and Treatment of Elbow Stiffness. Journal of Hand Surgery, April 2009

147. Answer: A 2020

Which statement is true regarding the use of total elbow arthroplasty (TEA) for the treatment of distal humerus fractures?

- A) In osteoporotic, low-demand patients, functional outcomes following TEA are similar or better than ORIF
- B) TEA is associated with a lower complication rate as compared to ORIF in treatment of fractures of the distal humerus
- C) Osteoporosis is a contraindication to TEA
- D) Olecranon osteotomy is the preferred approach for implantation of a TEA
- E) The most common complication following TEA for distal humerus fracture is infection

Discussion: In elderly or low-demand patients with osteoporosis and severe fracture comminution, or in patients with pre-existing inflammatory arthritis, some studies have shown that a total elbow arthroplasty (TEA) may give better functional outcomes than ORIF of distal humeral fractures. In these studies, there was not a significant difference in complication rates between TEA and ORIF; however, the TEA prosthesis does have some risk of loosening with long-term overuse, and a permanent restriction of weight bearing less than 5 pounds is recommended. In cases where TEA is being considered, the surgeon cannot use an olecranon osteotomy approach; the ulnar component of the arthroplasty uses this bone for fixation, and osteotomy would compromise this area. A triceps-sparing approach is preferable, since it provides adequate space for implant insertion while allowing for immediate postoperative mobilization with no restrictions for triceps healing.

References: Egol K.A., Tsai P., Vazques O., et al: Comparison of functional outcomes of total elbow arthroplasty vs plate fixation for distal humerus fractures in osteoporotic elbows. *Am J Orthop (Belle Mead NJ)* 40. (2): 67-71.2011

148. Answer: A

The palmar neurovascular advancement flap (Moberg) is most appropriate for reconstruction of which of the following defects?

- A) Thumb pulp
- B) Index finger pulp
- C) Thumb nail bed
- D) Thumb dorsum
- E) Index dorsal middle phalanx

Discussion: Use of the Moberg flap requires an independent dorsal blood supply for digit viability as seen in the thumb but not predictably in the fingers. The Moberg flap therefore is best used for volar pulp defects in the thumb of up to 1 cm (see Figures 1, 2, and 3). Additional advancement can be achieved by exposing and mobilizing the neurovascular structures. Flexion contractures, a frequent outcome of this mobilization, are better tolerated in the thumb than in the fingers. Index finger pulp loss can be treated with the cross-finger flap. A flap from the first dorsal metacarpal artery can be used to cover dorsal thumb defects, and defects over the index dorsal middle phalanx can be covered using skin grafts or with the extended dorsal metacarpal artery flaps. The Moberg flap does not have sufficient length to cover nailbed defects.

References: Baumeister S, Menke H, Wittemann M, Germann G. Functional outcome after the Moberg advancement flap in the thumb. *J Hand Surg* 2002;27(1):105-114.

Friedrich JB, Katolik LI, Vedder NB. Soft tissue reconstruction of the hand. *J Hand Surg* 2009;34(6):1148-1155

149. Answer: D

Which of the following has been associated with lower rates of return to play following UCL reconstruction?

- A) Ulnar neuritis
- B) Use of a muscle splitting approach
- C) Increased internal rotation of the ipsilateral shoulder
- D) Posteromedial chondromalacia
- E) Younger age at time of injury

Discussion: The authors retrospectively reviewed 29 of 161 (18%) baseball players who were treated for the combined posteromedial chondromalacia (PMC) and UCL injury. Return to play was Level 1 in 22 patients (76%), Level 2 in four patients (14%), Level 3 in two patients (7%), and Level 4 in one (3%) patient. The data suggest that baseball players with concomitant PMC, may have lower rates of return to play compared with historical controls.

References: Ulnar collateral ligament reconstruction in throwing athletes: a review of current concepts. AAOS exhibit selection. Jones KJ, Osbahr DC, Schrupf MA, Dines JS, Altchek DW. J Bone Joint Surg Am. 2012 Apr 18; 94(8):e49

Does posteromedial chondromalacia reduce rate of return to play after ulnar collateral ligament reconstruction? Osbahr DC, Dines JS, Rosenbaum AJ, Nguyen JT, Altchek DW. ClinOrthopRelat Res. 2012 Jun; 470(6):1558-64.

150. Answer: C 2020

Which of the following statements is true regarding the treatment of lateral epicondylitis?

- A) Corticosteroid injections for lateral epicondylitis are associated with improved long-term patient outcomes
- B) Plasma rich platelet (PRP) has a potent anti-inflammatory effect on local tissue
- C) Non-operative management of lateral epicondylitis will result in successful resolution of symptoms in 90% of patients
- D) Outcomes following arthroscopic treatment of lateral epicondylitis are superior to open approaches
- E) Worker's compensation status has no correlation with outcomes following treatment for lateral epicondylitis

Discussion: Medial and lateral epicondylitis are overuse injuries that respond well to non-operative management. Their etiology is degenerative and related to repetitive overuse and underlying tendinopathy. Nonsteroidal anti-inflammatory drugs and localized corticosteroid injections yield moderate symptomatic relief in short term but do not demonstrate benefit on long-term follow-up. Platelet-rich plasma injections may be advantageous in cases of chronic lateral epicondylitis. If 6 to 12 months of non-operative treatment fails, then surgical intervention can be undertaken.

Reference: Taylor SA, Hannafin JA. Evaluation and management of elbow tendinopathy. Sports Health. 2012 Sep;4(5):384-93.

151. Answer: B

What is the most common complication after total elbow arthroplasty in rheumatoid patients?

- A) Aseptic Loosening
- B) Infection
- C) Wound related
- D) Polyethylene and bushing failure
- E) Periprosthetic fracture

References: The Elbow and Its Disorders: 4th Edition by Bernard F. Morrey Pp10-439

152. Answer: B 2020

Total elbow arthroplasty has the longest survivorship in which cohort of patients?

- A) Post-traumatic
- B) Rheumatoid
- C) Osteoarthritic
- D) Congenital deformity

References: The Elbow and Its Disorders: 4th Edition by Bernard F. Morrey Pp10-439

153. Answer: C

What structure is most commonly affected after total elbow arthroplasty?

- A) Median nerve
- B) Radial nerve
- C) Ulnar nerve
- D) Biceps tendon
- E) Radial head

References: The Elbow and Its Disorders: 4th Edition by Bernard F. Morrey Pp10-439

154. Answer: A 2020

What is the most common complication after unlinked total elbow arthroplasty?

- A) Instability
- B) Stiffness
- C) Polyethylene wear
- D) Ulnar neuropathy
- E) Periprosthetic fracture

References: The Elbow and Its Disorders: 4th Edition by Bernard F. Morrey Pp10-439

155. Answer: D 2020

What is the most common long-term concern regarding total elbow arthroplasty for post-traumatic arthritis?

- A) Instability
- B) Stiffness
- C) Periprosthetic fracture
- D) Mechanical complication
- E) Ulnar neuropathy

References: The Elbow and Its Disorders: 4th Edition by Bernard F. Morrey Pp10-439

156. Answer: A

The palmar neurovascular advancement flap (Moberg) is most appropriate for reconstruction of which of the following defects?

- A) Thumb pulp
- B) Index finger pulp
- C) Thumb nail bed
- D) Thumb dorsum
- E) Index dorsal middle phalanx

Discussion: Use of the Moberg flap requires an independent dorsal blood supply for digit viability as seen in the thumb but not predictably in the fingers. The Moberg flap therefore is best used for volar pulp defects in the thumb of up to 1 cm (see Figures 1, 2, and 3). Additional advancement can be achieved by exposing and mobilizing the neurovascular structures. Flexion contractures, a frequent outcome of this mobilization, are better tolerated in the thumb than in the fingers. Index finger pulp loss can be treated with the cross-finger flap. A flap from the first dorsal metacarpal artery can be used to cover dorsal thumb defects, and defects over the index dorsal middle phalanx can be covered using skin grafts or with the extended dorsal metacarpal artery flaps. The Moberg flap does not have sufficient length to cover nailbed defects.

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Friedrich JB, Katolik LI, Vedder NB. Soft tissue reconstruction of the hand. J Hand Surg 2009;34(6):1148-1155.

157. Answer: D

A patient presents with spontaneous inability to flex his thumb IP joint and index finger DIP joint for four weeks. The figure demonstrates his clinical posture when asked to flex these digits. What is the recommended treatment at this time?

- A) Tapering steroid dose pack
- B) Release of the deep transverse carpal ligament
- C) Forearm exploration and release of the offending structures
- D) At least six months of non-operative treatment
- E) Referral to neurologist for possible demyelinating disorder

Discussion: Anterior interosseous nerve palsy, sometimes referred to as “honeymoon palsy” is secondary to nerve dysfunction in the anterior compartment of the forearm. One of the causes can be secondary to compressions of the nerve by the wife sleeping on the husbands’ outstretched forearm. The anterior interosseous nerve supplies the pronator quadratus, the flexor pollicis longus and the FDP of the index and long fingers. Weakness of the long flexor to the thumb and index finger affect pinch strength and cause difficulty in grasp. There are no sensory changes. AIN palsy is thought to be a type of neuritis and anatomic factors are rarely a cause, so surgical exploration is not indicated. Though, steroids are often prescribed for peripheral nerve problems, they are not indicated in this instance. Recovery usually occurs in less than six months and rarely are these disorders associated with a systematic demyelinating disorder. The differential diagnosis includes Parsonage Turner syndrome, flexor tendon rupture, or factitious disorder.

References: Kiloh LG, Nevin S. Isolated neuritis of the anterior interosseous nerve. *Br J Med* 1952;1:850-1
Miller-Breslow AM, Terrono A, Millerender LH. Nonoperative treatment of anterior interosseous nerve paralysis. *J Hand Surg* 1990; 15A:493-96.

158. Answer: E

Extracorporeal shock wave therapy (ESWT) for lateral elbow pain:

- A) Dramatically improves symptoms for a long period of time
- B) Dramatically improves symptoms for a short period of time
- C) Moderately improves symptoms for a long period of time
- D) Moderately improves symptoms for a short period of time
- E) Provides little or no benefit

Discussion: Shock wave therapy for lateral epicondylitis is a novel modality for lateral epicondylitis. Pettrone and McCall have shown encouraging results with this treatment modality. However, the study published by his group was not Level I or II evidence. When Level I-II evidence studies have been completed and other studies reviewed regarding shock wave therapy for lateral epicondylitis, it failed to show benefit over placebo. Therefore, its use cannot be recommended as definitive treatment for lateral epicondylitis.

References: Pettrone FA, McCall BR. Extracorporeal shock wave therapy without local anesthesia for chronic lateral epicondylitis. *J Bone Joint Surg Am.* 2005 Jun; 87(6):1297-304.

Chung B, Wiley JP. Effectiveness of extracorporeal shock wave therapy in the treatment of previously untreated lateral epicondylitis: a randomized controlled trial. *Am J Sports Med.* 2004 Oct-Nov; 32(7):1660-7.

Speed CA, Nichols D, Richards C, Humphreys H, Wies JT, Burnet S, Hazleman BL. Extracorporeal shock wave therapy for lateral epicondylitis—a double blind randomized controlled trial. *J Ortho Res.* 2002 Sep; 20(5):895-8.

Buchbinder R, Green SE, Youd JM, Assendelft WJ, BarnsleyL, Smidt N. Systematic review of the efficacy and safety of shock wave therapy for lateral elbow pain. *J Rheumatol.* 2006Jul;33(7):1351-63

159. Answer: B 2020

When considering outcomes of reverse shoulder arthroplasty in younger (less than 60 year old) patients, which of the following is true?

- A) ASES scores were significantly lower in younger patients than older patients
- B) Complication rates were higher in younger patients than older patients
- C) Humeral component loosening is more common in younger patients
- D) Notching was more common in younger patients
- E) Range of motion was lower in younger patients than older patients

Discussion: Ek et al examined 41 patients under the age of 65 following reverse shoulder arthroplasty. They found that motion and outcome scores were equivalent compared to older cohorts, but complication rates were significantly higher with a higher revision rate.

Reference: Ek ET, Neukom L, Catanzaro S, Gerber S. Reverse total shoulder arthroplasty for massive irreparable rotator cuff tears in patients younger than 65 years old: results after five to fifteen years. JSES 2013 Feb 2

160. Answer: D

A 54-year-old male presents with complaint of wrist stiffness and pain for the last several years. He vaguely remembers history of prior trauma. Examination reveals swelling over the dorso radial wrist. Radiographs are shown in Figures 1 and 2. He desires some long-term pain relief while maintaining strength and some degree of motion. The best treatment option is:

- A) Splinting
- B) Steroid injection
- C) Proximal row carpectomy
- D) Scaphoid excision partial wrist fusion
- E) Complete wrist fusion

Discussion: Scapholunate advanced collapse progresses through four stages, first involving the distal radioscaphoid joint, then the proximal radioscaphoid joint, then mid carpal joint, and finally pan-carpal arthritis including the radiolunate joint. Surgical treatments include proximal row carpectomy and partial wrist fusion after scaphoid excision. In this case, there is clear midcarpal involvement, which is a contra-indication to proximal row carpectomy because of the irregular capitate head. Splinting and steroid injections are unlikely to provide long term relief, and complete wrist arthrodesis is reserved for stage 4 pan-carpal arthritis.

References: Strauch RJ. Scapholunate advanced collapse and scaphoid nonunion advanced collapse arthritis – update on evaluation and treatment. J Hand Surg Am 2011; 36(4):729-735. Review. PubMed PMID: 21463735.

Mulford JS, Ceulemans LJ, Nam D, Axelrod TS. Proximal row carpectomy vs four corner fusion for scapholunate(Slac) or scaphoid nonunion advanced collapse (Snac)wrists: a systematic review of outcomes. J Hand Surg Eur2009; 34(2):256-63. Review. PubMed PMID: 19369301

Dacho A, Grundel J, Holle G, Germann G, Sauerbier M. Long-term results of midcarpal arthrodesis in the treatment of scaphoid nonunion advanced collapse (SNAC-Wrist) and scapholunate advanced collapse (SLAC-Wrist). Ann Plast Surg 2006; 56(2):139-44. PubMed PMID: 16432320.



161. Answer: D

Flexor carpi radialis tendinitis is most frequently related to:

- A) DeQuervains tenosynovitis
- B) Scapholunate advanced collapse
- C) Scaphoid fracture
- D) Scaphotrapezial arthrosis
- E) Carpal tunnel syndrome

Discussion: Women in their 50s are most commonly affected. The FCR tendon is nearly encircled by the trapezial ridge and the tendon occupies approximately 90% of the area of the tunnel. Fitton, et al demonstrated that in 29/30 patients, arthrosis at the scaphotrapezial joint was associated with the tendonitis.

References: Fitton, Shae, and Goldie. JBJS, Br 50:359-363, 1968.

Bishop AT, Gabel G, Carmichael SW. Flexor carpi radialis tendinitis. Part I: Operative anatomy. J Bone Joint Surg Am.1994 Jul; 76(7):1009-14.

162. Answer: D

Six months after undergoing ORIF for a distal radius fracture, a patient presents complaining about persistent wrist pain. On physical exam, there is a slight click appreciated in the wrist through midrotation of her forearm. Pronation/supination: 50/50. The DRUJ feels stable to stress exam at neutral rotation. Based on this information and the x-ray below (Figure 1), which of the following is recommended?

- A) Static progressive splinting
- B) Wrist arthroscopy and TFCC debridement
- C) Reassurance and follow-up in three months
- D) Removal of hardware
- E) DRUJ stabilization



Discussion: An untoward outcome from a distal radius fracture can occur and may arise from a number of sources. Specific to the injury, this may include residual articular malalignment at the DRUJ and/or radiocarpal level, angular malunion, TFCC tear ± DRUJ instability, intercarpal ligament tear, and capsular contracture to name a few. Complications related to open distal radius treatment with volar-locked plating can occur with malpositioned plates or screws and may also result in tendon irritation or rupture. In this case, the patient had continued pain. The x-rays demonstrate an errant screw placed into the DRUJ, causing the ascribed symptoms. Reassurance is not indicated because of a mechanical problem. Static progressive splinting can be a useful adjunct for improving contracture after distal radius fracture, but is indicated when there is a satisfactory DRUJ articulation. This would likely only lead to increased pain and lack of improvement. Wrist arthroscopy and TFCC debridement or DRUJ stabilization are other treatments performed after distal radius fracture care, but the information provided should not lead to either of these options as a logical answer.

References: Arora R, Lutz M, Hennerbichler A, Krappinger D, Espen D, Gabl M. Complications following internal fixation of unstable distal radius fracture with a palmar locking-plate. J Orthop Trauma 2007;21:316-22.

Orbay J. Volar plate fixation of distal radius fractures. Hand Clin 2005;347-354.

Berglund LM and Messer TM. Complications of volar plate fixation for managing distal radius fractures. J Am Acad OrthoSurg 2009;17:369-377.

163. Answer: B

Late complications of volar plating of distal radius fractures can be increased by:

- A) Open reduction and internal fixation of all associated ulnar styloid fractures
- B) Intraoperative use of fluoroscopy
- C) Limiting the number of diaphyseal screws
- D) Keeping the plate permanently
- E) Bicortical purchase of distal screws

Discussion: Reliance on standard PA and lateral x-rays has been shown to miss screw penetration of the dorsal cortex, where extensor tendons are vulnerable, as well as penetration of the radial articular surface. Repair of associated ulnar styloid fractures is often unnecessary in the absence of DRUJ instability. The traditional principle of screw purchase of the distal cortex does not apply to volar locking plates, as the plate and subchondral bone provide stability, and screw penetration is to be avoided. Placement of the plate at the volar lip of the radius places the plate near flexor tendons and may lead to attenuation and rupture. Volar locking plates are not intended to be removed in a routine manner.

References: Sammer D, Shah H, Shauver M, Chung K. The effect of ulnar styloid fractures on patient outcomes after volar locking plating of distal radius fractures. *J Hand Surg* 2009;34A:1595-1602.

Joseph S, Harvey J. The dorsal horizon view: detecting screw protrusion at the distal radius. *J Hand Surg* 2011;36A:1691-1693.

Tweet M, Calfee R, Stern P. Rotational fluoroscopy assists in detection of intra-articular screw penetration during volar plating of the distal radius. *J Hand Surg* 2010;35A:619-627.

Klug R, Press C, Gonzalez M. Rupture of the flexor pollicis longus tendon after volar fixed-angle plating of a distal radius fracture: A case report. *J Hand Surg* 2007;32A:984-988.

164. Answer: D

A 54-year-old male presents with complaint of wrist stiffness and pain for the last several years. He vaguely remembers history of prior trauma. Examination reveals swelling over the dorsoradial wrist. Radiographs are shown in Figures 1 and 2. He desires some long-term pain relief while maintaining strength and some degree of motion. The best treatment option is:

- A) Splinting
- B) Steroid injection
- C) Proximal row carpectomy
- D) Scaphoid excision partial wrist fusion
- E) Complete wrist fusion

Discussion: Scapholunate advanced collapse progresses through four stages, first involving the distal radioscaphoid joint, then the proximal radioscaphoid joint, then mid carpal joint, and finally pan-carpal arthritis including the radiolunate joint. Surgical treatments include proximal row carpectomy and partial wrist fusion after scaphoid excision. In this case, there is clear midcarpal involvement, which is a contra-indication to proximal row carpectomy because of the irregular capitate head. Splinting and steroid injections are unlikely to provide long term relief, and complete wrist arthrodesis is reserved for stage 4 pan-carpal arthritis.

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Mulford JS, Ceulemans LJ, Nam D, Axelrod TS. Proximal row carpectomy vs four corner fusion for scapholunate(Slac) or scaphoid nonunion advanced collapse (Snac)wrists: a systematic review of outcomes. J Hand Surg Eur2009;34(2):256-63. Review. PubMed PMID: 19369301

Dacho A, Grundel J, Holle G, Germann G, Sauerbier M. Long-term results of midcarpal arthrodesis in the treatment of scaphoid nonunion advanced collapse (SNAC-Wrist) and scapholunate advanced collapse (SLAC-Wrist). Ann Plast Surg 2006;56(2):139-44. PubMed PMID: 16432320.

165. Answer: E

In scapholunate advanced collapse (SLAC), which joint is spared arthritic changes?

- A) Scapho-trapezial-trapezoid
- B) Scaphocapitate
- C) Lunocapitate
- D) Radioscaphoid
- E) Radiolunate

Discussion: Scapholunate dissociation can lead to irreducible malalignment and cartilage degeneration in a scapholunate advanced collapse (SLAC) wrist sequence. Arthritic changes begin at the radial styloid and distal scaphoid. The entire radioscaphoid joint becomes involved next. Later, the midcarpal joint is involved. Finally a pancarpal arthritis spares only the radiolunate joint.

References: Garcia-Elias M. Carpal instability. In Wolfe SW, Hotchkiss RN, Pederson WC, Kozin SH (eds). Green's Operative Hand Surgery 6th edition. Elsevier: Philadelphia 2010;465-522.

Watson HK, Weinzweig J, Zeppieri J. The natural progression of scaphoid instability. Hand Clin 1997;13:39-49.

166. Answer: D

Which of the following is an independent risk factor for community-acquired MRSA infections of the hand?

- A) Diabetes mellitus
- B) Immunocompromised states
- C) Incarceration
- D) Intravenous drug use
- E) Participation in team sports

Discussion: In both of the provided references, community acquired MRSA (CA-MRSA) has only been linked to the use of intravenous drugs, as an independent risk factor. Some studies have suggested a link to the other options above, however, none have proven to be useful as a predictor of CA-MRSA infection of the hand.

References: Imahara SD, Friedrich JB. Community-Acquired Methicillin-Resistant Staphylococcus aureus in Surgically Treated Hand Infections. J Hand Surg 2009;35A:97-103.

Nourbakhsh A, Papafragkou S, Dever LL, Capo J, Tan V. Stratification of the Risk Factors of Community-Acquired Methicillin-Resistant Staphylococcus Aureus Hand Infection. J Hand Surg 2010;35A:1135-1141.

167. Answer: D

The agent of choice used preoperatively for decolonizing MRSA carriers to reduce nosocomial infection is:

- A) Sulfamylon
- B) Chlorhexidine
- C) Neosporin
- D) Mupirocin
- E) Keflex

Discussion: Use of mupirocin applied to the nares for 5 days preoperatively for the purposes of MRSA decolonization has been shown to effectively reduce the rate of surgical site infection, and is more effective than chlorhexidine. However, decolonization of unselected patients with mupirocin is not currently recommended, as mupirocin resistance appears to be developing.

References: Simor AE. Staphylococcus aureus decolonization as a prevention strategy. *Infect Dis Clin North Am* 2009;23(1):133-51. Anderson DJ. Staphylococcal surgical site infections. *Infect Dis Clin North Am* 2009;23(1):53-72. Kirby JP. Prevention of surgical site infection. *Surg Clin North Am* 2009;89(2):365-389.

168. Answer: D

Which of the following types of collagen is least affected by the collagenase compounds utilized in collagenase clostridium histolyticum injection for the treatment of Dupuytren's contracture?

- A) Type I
- B) Type II
- C) Type III
- D) Type IV
- E) Type V

Discussion: The compounds that comprise the collagenase clostridium histolyticum injection are derived from the bacterium *Clostridium histolyticum*. Type IV collagen is least affected by these collagenase compounds. This is felt to be significant as type IV collagen makes up the basement membranes of the digital arteries and nerves that are closely opposed to the contracted collagen cord.

References: Desai SS, Hentz VR. The Treatment of Dupuytren's Disease. *J Hand Surg* 2011;36,5:936-942. Gilpin D, Coleman S, Hall S, Houston A, Karrasch J, Jones N. Injectable Collagenase *Clostridium histolyticum*: A New Nonsurgical Treatment for Dupuytren's Disease. *J Hand Surg* 2010;35A: 2027-2038.

169. Answer: D

Which of the following genes is up regulated within Dupuytren's disease tissue as compared with the normal fascia?

- A) Frizzled-related protein
- B) Glutathione peroxidase
- C) TIMP metalloproteinase
- D) Tenascin C (TNC)
- E) Phosphatidic acid phosphatase type 2B

Discussion: Glutathione peroxidase 3, aldehyde dehydrogenase 1, A1, lysyl oxidase-like 2, Phosphatidic acid phosphatase type 2B, tenascin XB, angiotensin II receptor, type1 frizzled-related protein and TIMP metalloproteinase inhibitor 3 are down regulated in Dupuytren disease. In tissue biopsies, significant fold changes were observed for ADAM12, POSTN, and TNC in the cord and/or nodule when compared with that of normal fascia. ADAM12 and POSTN are associated with accelerated or abnormal cell growth, whereas TNC has been associated with fibrotic diseases and cell migration.

References: Rehman S, Salway F, Stanley J, Ollier WER, Day P, Bayat P. Molecular Phenotypic Descriptors of Dupuytren's Disease Defined Using Informatics Analysis of the Transcriptome. *J Hand Surg*; 33A:3592008. Shih B, D Wijeratne, Armstrong DJ, Lindau T, Day P, Bayat A. Identification of Biomarkers in Dupuytren's Disease by Comparative Analysis of Fibroblasts Versus Tissue Biopsies in Disease-Specific Phenotypes. *J Hand Surg*;34A:124:2009.

170. Answer: E

Which of the following epitendon suture techniques has the lowest tensile strength?

- A) Interlocking horizontal mattress
- B) Cross-stitch
- C) Interlocking cross stitch
- D) Silverskiold
- E) Simple Running

Discussion: The simple running suture has the lowest tensile strength of the listed techniques. It is interesting to note that the epitendon suture, usually performed with a 6-0 Prolene suture, is a balance between increasing tensile strength and increasing work of flexion. Tensile strength does not directly correlate with resistance to gap formation and therefore is a separate variable to be considered.

References: Kubota H, Aoki M, Pruitt DL, Manske PR. Mechanical Properties of Various Circumferential Tendon Suture Techniques. *J Hand Surg Br* 1996;21B:4:474-480.

Dona E, Turner AWL, Gianoutsos MP, Walsh WR. Biomechanical Properties of Four Circumferential Flexor Tendon Suture Techniques. *J Hand Surg* 2003;28A:824-831.

171. Answer: E

In a Zone II flexor digitorum superficialis laceration the intact vincula tendinum can be responsible for proximal interphalangeal joint flexion of up to what percent of normal?

- A) 10%
- B) 33%
- C) 50%
- D) 74%
- E) 93%

Discussion: The vincula have classically been associated with providing a vascular supply to the flexor tendons; however, it has recently been shown via cadaver studies that the intact vincula may provide 93% of proximal interphalangeal joint motion, normally created by the action of the flexor digitorum superficialis. 69% of normal distal interphalangeal motion was recreated in the face of a complete flexor digitorum profundus laceration. The authors recommend testing function against resistance to elucidate this phenomenon in the setting of likely flexor tendon laceration with intact function.

References: Shao F, Tonosaki A, Watanabe Y. Vincula tendinum of human hands with special reference to vascular patency. *Kaibogaku Zasshi* 1995;70(6):569-76.

Stewart DA, Smitham PJ, Gianoutsos MP, Walsh WR. Biomechanical Influence of the Vincula Tendinum on Digital Motion After Isolated Flexor Tendon Injury: A Cadaveric Study. *J Hand Surg* 2007;32A:1190-1194.

172. Answer: D

Patients with the congenital deformity depicted in Figure 1 often have:

- A) Limited elbow range of motion
- B) Carpal tunnel syndrome
- C) Subluxation of the extensor carpi ulnaris tendon
- D) Short stature
- E) Mucopolysaccharidase deficiency

Discussion: Most patients with Madelung's have adyschondrosteosis, or a combination of the deformity of the distal radius, short forearms, and short stature. Elbow range of motion is rarely affected and carpal tunnel syndrome and extensor tendon abnormalities are uncommon as well.

Reference: Green's Operative Hand Surgery section on Congenital Hand. Page 528, volume 1 in 4th Edition (Ezaki).



173. Answer: B

The period of time following fertilization during which limb bud development is most rapid and when most congenital anomalies occur is:

- A) 1-4 weeks
- B) 4-8 weeks
- C) 8-12 weeks
- D) 12-14 weeks
- E) 14-18 weeks

Discussion: The most rapid period of limb development is between 4 and 8 weeks after fertilization. The majority of congenital anomalies occur during this period of time. At 8 weeks gestation all limb structures are present and further development is characterized by maturation and differentiation of existing structures.

References: Bamshad M, Watkins WS, Dixon ME, et al: Reconstructing the history of human limb development: Lessons from birth defects. *Pediatr Res* 45:291-299, 1999.

Kozin SH. Embryology. p 1375 in Green's Operative Hand Surgery ed Green DP, Hotchkiss RN, Pederson WC, Wolfe SW Churchill Livingstone, Philadelphia PA 2005.

174. Answer: A

The arterial supply of the flap shown in Figures 1 and 2 is:

- A) First dorsal metacarpal artery
- B) Dorsal antebrachial superficialis artery
- C) Second common digital artery
- D) Deep to the aponeurosis
- E) Supplying terminal skin on the dorsum of the index finger at the level of the middle phalanx



Discussion: This patient underwent treatment with a kite flap. The first dorsal metacarpal artery provides the blood supply for this flap. It is a very predictable and constant artery that arises from the radial artery. Foucher and Braun noted only 2 of 30 dissections demonstrated that it arose from the dorsal superficial antebrachial artery. It lies primarily on the dorsal radial side of the index finger. Its terminal skin supply is the dorsal aspect of the proximal phalanx of the index finger. While some aponeurotic fibers may cross over the artery, it lies on (superficial to) the aponeurosis.

References: Foucher G, Braun JB. A new skin flap transfer from the dorsum of the index to the thumb. *Plast Reconstr Surg* 1979;63:344-9.

Shi SM, Lu YP. Island skin flap with neurovascular pedicle from the dorsum of the index finger for reconstruction of the thumb. *Microsurgery* 1994;15:145-8.

175. Answer: D

A 52 year-old male presented with a history of increasing pain in his right forearm over the previous 6 months. A radiograph is shown in Figure 1. The median nerve was explored above the elbow and an aponeurotic band (held by the probe in Figure 2) was noted crossing the nerve and brachial artery. The structure is the:

- A) Arcade of Frohse
- B) Arcade of Struthers
- C) Cubital ligament
- D) Ligament of Struthers
- E) Medial brachial fascia



Discussion: According to Grant, the supracondylar process is present in 7 of 1000 subjects. A fibrous band, the ligament of Struthers, joining the supracondylar process and medial epicondyle may cross the median nerve and brachial artery and can produce a median neuropathy. In Figure 3, the bony process has been resected and the ligament released which resolved this patient's symptoms. Some fibers of the pronator teres may arise from the band. The arcade of Frohse can entrap the radial nerve in the forearm. The arcade of Struthers can entrap the ulnar nerve in the arm.



References: Grant JCB. Atlas of anatomy. 5th ed. Williams and Wilkins, Baltimore, 1962:47.

Hotchkiss RN, Green DP. Fractures and dislocations of the elbow. Ligament of Struthers. In: Rockwood CA Jr, Green DP, Buchholz RW, eds. Rockwood and Green's Fractures in Adults. 3rd edition. Philadelphia: J B Lippincott, 1991:778-9.

Suranyi L. Median nerve compression by Struthers ligament. J Neurol Neurosurg Psychiatry 1983;46:1047

Spinner M. Injuries to the major branches of peripheral nerves in the forearm. 2nd edition. Philadelphia: W B Saunders, 1978;234.

176. Answer: C

A 65-year-old female complains of aching pain in her right thumb with activity. She denies numbness and tingling. Clinical exam reveals pain with thumb grinding test at the CMC joint and marked laxity of the ulnar collateral ligament of the MCP joint with pain. There is no pain with IP joint flexion. X-rays are shown in Figures 1 and 2. Trapezial excision and tendon interposition arthroplasty is planned. An adjunctive procedure to be performed at the same time is:



- A) Open carpal tunnel release
- B) Thumb IP joint arthrodesis
- C) Thumb MCP joint arthrodesis
- D) EPB tenotomy
- E) Volar capsulodesis of MCP joint of the thumb

Discussion: Basilar joint arthritis of the thumb is a common problem and the underlying pathology can be addressed with a tendon interposition arthroplasty, CMC arthrodesis or other type of arthroplasty. The presence of chronic MCP joint UCL laxity should also be addressed at the same time. While repair or reconstruction of the UCL can be considered to provide stability, it will not provide predictable pain relief due to the MCP arthritis. While about 20% of patients with osteoarthritis of the thumb CMC joint will have concurrent carpal tunnel syndrome, this patient did not complain of numbness. Any flexed posture of the thumb IP joint usually corrects if the MCP and CMC joints are corrected. Fusion of the IP joint is not usually needed unless painful. EPB tenotomy or transfer to the metacarpal has been proposed to help address MCP hyperextension in the absence of arthritis or pain. This will not help correct ulnar MCP laxity. Volar capsulodesis of the MCP joint would not address the UCL instability but is indicated for patients with MCP hyperextension and no significant arthritis.

References: Trumble, T.E., editor, Hand Surgery Update 3, Hand, Elbow, and Shoulder; American Society for Surgery of the Hand, Rosemont, Ill., c. 2003, p. 510.

Tomaino, M. M., Pellegrini, V.D., Burton, R. I., Arthroplasty of the basal joint of the thumb, Long-term follow-up after ligament reconstruction with tendon interposition, JBS 1995;77(3): 346-355.

177. Answer: E

A 45-year-old female presents with a painful arthritic PIP joint of the dominant index finger. She has 20 degrees of painful motion and an apex-radial angular deformity of 20 degrees and has failed conservative care. The patient prefers to have only one procedure. Which treatment will provide durable pain relief while maintaining pinch strength?

- A) Joint debridement with radial collateral ligament reconstruction
- B) Surface replacement arthroplasty
- C) Silastic implant arthroplasty
- D) Radial closing wedge osteotomy proximal phalanx
- E) PIP fusion

Discussion: This patient requires strong, pain-free pinch and grip to pursue her potting. While loss of motion in the PIP joint is a concern for the patient, her primary impairment is her pain and angular deformity involving the joint. Neither joint debridement with ligament reconstruction nor proximal phalange neck osteotomy will improve her pain or prevent progression of the joint degeneration. While surface replacement and Silastic implant arthroplasties may initially resolve pain and improve motion, both are prone to gradually deteriorating motion and eventual failure. The Silastic implant offers minimal stability to the stress of lateral pinch. Only a joint fusion offers pain free stability for pinch and grip. While this comes at the expense of motion, a successful fusion will require no future revision.

References: Sweets T, Stern PJ. Proximal Interphalangeal Joint Prosthetic Arthroplasty. *J Hand Surg* 2010;35A(7):1190-93. Branam BR, Tuttle HG, Stern PJ, et al. Resurfacing arthroplasty versus silicone arthroplasty for proximal interphalangeal joint osteoarthritis. *J Hand Surg* 2007;32A:775-88. Minamikawa Y, Imaeda T, Amadio PC, et al. Lateral stability of proximal interphalangeal joint replacement. *J Hand Surg* 1994;19A:1050-54.

178. Answer: B

Late complications of volar plating of distal radius fractures can be decreased by:

- A) Open reduction and internal fixation of all associated ulnar styloid fractures
- B) Intraoperative use of fluoroscopy
- C) Limiting the number of diaphyseal screws
- D) Keeping the plate permanently
- E) Bicortical purchase of distal screws

Discussion: Reliance on standard PA and lateral x-rays has been shown to miss screw penetration of the dorsal cortex, where extensor tendons are vulnerable, as well as penetration of the radial articular surface. Repair of associated ulnar styloid fractures is often unnecessary in the absence of DRUJ instability. The traditional principle of screw purchase of the distal cortex does not apply to volar locking plates, as the plate and subchondral bone provide stability, and screw penetration is to be avoided. Placement of the plate at the volar lip of the radius places the plate near flexor tendons and may lead to attenuation and rupture. Volar locking plates are not intended to be removed in a routine manner.

References: Sammer D, Shah H, Shauver M, Chung K. The effect of ulnar styloid fractures on patient outcomes after volar locking plating of distal radius fractures. *J Hand Surg* 2009;34A:1595-1602. Joseph S, Harvey J. The dorsal horizon view: detecting screw protrusion at the distal radius. *J Hand Surg* 2011;36A:1691-1693. Tweet M, Calfee R, Stern P. Rotational fluoroscopy assists in detection of intra-articular screw penetration during volar plating of the distal radius. *J Hand Surg* 2010;35A:619-627. Klug R, Press C, Gonzalez M. Rupture of the flexor pollicis longus tendon after volar fixed-angle plating of a distal radius fracture: A case report. *J Hand Surg* 2007;32A:984-988.

179. Answer: A

Which of the following complications is most common following UCL reconstruction?

- A) Ulnar neuropathy
- B) Medial epicondyle fracture
- C) Postoperative stiffness
- D) Hematoma
- E) Ligament re-ear

Discussion: A recent systematic review of published studies evaluating reconstruction of the UCL in overhead athletes was performed using the Ovid Medline database. Overall, 83% of patients in all studies had an excellent result. There was an overall 10% complication rate, with the most common complication being postoperative ulnar neuropathy, which occurred in 6% of patients. Transition to the muscle-splitting approach was associated with better outcomes than detachment of the flexor-pronator mass, as there was only a 70% rate of excellent results and a 20% rate of postoperative ulnar neuropathy in patients treated with detachment of the flexor-pronator mass compared with 87% excellent results and a 6% rate of postoperative ulnar neuropathy in patients treated with a muscle-splitting approach.

Reference: Vitale MA, Ahmad CS. The outcome of elbow ulnar collateral ligament reconstruction in overhead athletes: a systematic review. *Am J Sports Med.* 2008 Jun;36(6):1193-205.

180. Answer: D

A 55-year-old woman presents with a 6-month history of left hand pain, numbness, and tingling involving the thumb, index, and long fingers. Her symptoms wake her at night despite appropriate splinting. She endorses concomitant neck pain with radiation to the hand as well as forearm pain. Examination demonstrates a positive Tinel sign at the midforearm. EMG/NCS is within normal limits. Which of the following is most appropriate next step?

- A) Repeat EMG in 3 months
- B) Carpal tunnel release
- C) Wrist ultrasound
- D) Corticosteroid injection into the carpal tunnel
- E) Forearm median nerve decompression

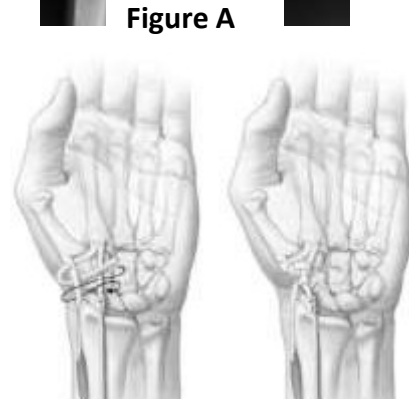
Discussion: A corticosteroid injection into the carpal tunnel can help differentiate symptoms originating from carpal tunnel compression versus more proximal median nerve compression and cervical radiculopathy in patients with equivocal clinical presentations and EMG/NCS. Corticosteroid injections into the carpal tunnel have diagnostic, therapeutic, and prognostic benefits in the management of carpal tunnel syndrome (CTS). It can delineate the degree to which carpal tunnel compression contributes to the patient's symptoms and may provide a period of relief in patients with mild and moderate CTS. More complete and longer the periods of relief correlate with more favorable prognoses following carpal tunnel release. Ponnappan et al reviewed etiologies of upper extremity pain and how to differentiate between them clinically. They discuss neurologic and musculoskeletal etiologies involving the neck, shoulder girdle, elbow, forearm, wrist, and hand. They highlight the diagnostic utility of corticosteroid injections into the carpal tunnel in equivocal cases. Kane et al reviewed double crush syndrome where a nerve can be compressed at two distinct places along its course. In carpal tunnel syndrome, concomitant cervical radiculopathy can lead to suboptimal results following carpal tunnel release. They highlight the importance of recognizing cervical radiculopathy and underlying systemic neuropathy in patients complaining of carpal tunnel symptoms.

Reference: Clinical Differentiation of Upper Extremity Pain Etiologies. Ponnappan, *JAAOS* 2015 Double Crush Syndrome. Kane, *JAAOS* 2015

181. Answer: E

A 50-year-old man presents with basal thumb pain and weakness. He is found to have Stage IV osteoarthritis (OA) of the carpometacarpal joint (CMC) of the thumb. He undergoes Weilby suspension arthroplasty using the flexor carpi radialis tendon (FCR). He returns 1 year later with recurrent pain. Radiographs are shown in Figure A. What is the next best step?

- Trapeziometacarpal arthrodesis
- Weilby suspension arthroplasty with extensor carpi radialis longus (ECRL) tendon
- Ligamentous reconstruction tendon interposition (LRTI) with FCR tendon
- Prosthetic arthroplasty
- LRTI with ECRL tendon

**Figure A****Figure B****Figure C****Figure D****Figure E**

Discussion: This patient has progressive subsidence of the thumb metacarpal after Weilby suspension arthroplasty. LRTI with ECRL is the best salvage option.

There are many surgical options for CMC OA. This includes volar ligament reconstruction and closing wedge dorsal extension osteotomy for early Stage I disease. Late disease is treated with trapeziectomy with/without metacarpal base stabilization, CMC fusion and prosthetic arthroplasty. There is no difference in results of trapeziectomy alone vs trapeziectomy with LRTI. Silastic arthroplasty is complicated by silicone synovitis. Pyrocarbon prosthetics are complicated by subluxation attributed to a shallow trapezium cup. Fusion is indicated for young (<50y) high demand patients who wish to maintain grip strength.

Jones et al. reviewed salvage options for FCR disruption during LRTI. For partial FCR injury, they recommend using the remaining tendon for a Weilby suspension arthroplasty, or the entire FCR for LRTI (if enough length is available). For complete FCR avulsion, they recommend ECRL LRTI.

Conolly reviewed 17 patients undergoing revision for CMC OA (12 silastic arthroplasty, 4 trapeziectomy, 1 arthrodesis). Revision options comprised implant removal or replacement, soft tissue arthroplasty and fusion. 53% had good results, 30% had poor results. They conclude that trapeziectomy relieves pain but late proximal migration and metacarposcaphoid arthritis occurs. Soft tissue interposition may prevent this.

Figure A shows subsidence of the thumb metacarpal 1 year after trapeziectomy and Weilby suspension arthroplasty. In CMC arthritis, the MP joint compensates with hyperextension to allow for thumb pinch and thus leads to a zigzag ("Z") deformity. When present, temporary pinning or fusion can be performed to stabilize the joint. Illustration A

shows LRTI with ECRL augmented with a suture button. Illustrations B and C show the creation of an ECRL LRTI. Illustration D shows creation of an FCR LRTI. Illustration E shows a Weilby suspensionplasty (with FCR). The Weilby suspensionplasty involves a partial FCR slip woven through the abductor pollicis longus (APL) tendon to stabilize the joint and suspend the thumb metacarpal without drill holes.

Reference: Salvage options for flexor carpi radialis tendon disruption during ligament reconstruction and tendon interposition or suspension arthroplasty of the trapeziometacarpal joint. Jones, JHS 2013

Revision procedures for complications of surgery for osteoarthritis of the carpometacarpal joint of the thumb. Conolly, JHANDS 1993

182. Answer: B

A 31-year-old man transects both flexor tendons to each of his index and middle fingers while slicing vegetables. Wide-awake tumescent local anesthesia is employed for flexor tendon repair. What is one of the primary goals of this technique?

- A. Reduce tourniquet pain
- B. Active testing of surgical repair
- C. Detect bowstringing
- D. Assess neurovascular bundle integrity
- E. Compare 2-point sensibility with adjacent digits

Discussion: The primary advantage is the ability to test the repair with full active flexion and extension by a comfortable, cooperative, unседated, tourniquet-free patient.

Other advantages of wide-awake flexor tendon repair include the ability to (1) evaluate if repairs will glide through pulleys, permitting the potential release of the entire A4 and venting of half the A2 pulley if indicated, (2) repair tendons inside tendon sheaths while demonstrating that the sheath has not been inadvertently caught, (3) confidently initiate early active motion if the patient can make a full fist during surgery (in contrast to passive or place-and-hold protocols).

Lalonde reviewed wide-awake hand surgery. He states that a tourniquet is no longer required because of epinephrine hemostasis/tumescent local anesthesia, which is safe in the digit, and its vasoconstriction is reversible with phentolamine. Sedation is unnecessary because no tourniquet is used. Current literature suggests that Wide-awake flexor tendon repair decreases tenolysis and rupture rates. One study reported that maximal vasoconstriction occurs at 26 min after injection.

Lalonde and Martin reviewed wide-awake flexor tendon repair and early mobilization for zones 1 and 2. They state that historic finger necrosis was a result of procaine, not epinephrine. The alpha blocker phentolamine is the antidote for vasoconstriction in the finger.

Illustration A shows methods to decrease pain with local anesthetic injection.

Methods of decreasing the pain of local anesthetic injection

Step 1. Buffering lidocaine and epinephrine 10:1 with 8.4% bicarbonate¹¹

Step 2. Warming the local anesthetic

Step 3. Distracting the patient or the area of injection with touch, pressure, pinching, or ice

Step 4. Using a 27-gauge needle

Step 5. Stabilizing the syringe to avoid needle wobble

Step 6. Injecting 0.5 cc perpendicularly subdermally and pausing until the patient says the needle pain is gone

Step 7. Injecting an additional 2 cc before moving the needle, and then moving antegrade very slowly with 1 cm of local anesthetic always palpable or visible ahead of the needle

Step 8. Reinserting needles within 1 cm of blanched areas

Step 9. Learning from all patients by asking them to score the number of times they felt pain during the injection

Reference: Minimally invasive anesthesia in wide awake hand surgery. Lalonde, HANDC 2014

Wide-awake flexor tendon repair and early tendon mobilization in zones 1 and 2. Lalonde, HANDC 2013
Optimal time delay between epinephrine injection and incision to minimize bleeding. McKee, PRS 2013

183. Answer: C

A 53-year-old white male presents with contractures of his ring finger and lesions over the dorsum of his hand. On examination of the lesions, they are subcutaneous, solid, and firm lesions measuring about 5 mm in diameter. They are located over the dorsum of the PIP joints of his ring and long finger. They become more mobile while the joint is in neutral and less mobile when the joint is in flexion. He also has a 5 degree flexion contracture his ring finger MCP joint. Examination of his palm reveals a palpable cord over the volar ring finger. His neurovascular examination is normal. The appearance of the dorsum of his hand is seen in Figure A. What is the next most appropriate step in treatment?



- A) Collagenase injection and resection of dorsal finger lesions
- B) Collagenase injection without resection of dorsal finger lesions
- C) Observation and follow up
- D) Surgical resection/fasciectomy and resection of dorsal finger lesions
- E) Surgical resection/fasciectomy without resection of dorsal finger lesions

Discussion: This patient has mild Dupuytren's disease with associated dorsal Dupuytren nodules, which may be observed.

Dupuytren's disease is a proliferative disorder characterized by fascial nodules and contractures of the hand. It is autosomal dominant with variable penetrance. It exhibits a 2:1 male to female ratio and is classically seen in Caucasian males of northern European descent. The main pathology of Dupuytren's disease is excessive myofibroblast proliferation and altered collagen matrix composition lead to thickened and contracted palmar fascia. Surgical intervention is often indicated in cases of $\geq 30^\circ$ of MCP contracture or any PIP contracture (usually $>15^\circ$).

Rayan et al report that dorsal Dupuytren's nodules are a subcutaneous, solid, firm, well-defined, tumor-like mass or a nodule 3 mm in diameter or larger, located over the dorsum of the PIP joint. It is seldom painful and becomes more mobile while the joint is in neutral position and less mobile during joint flexion.

Black et al report that diseased tissue is referred to as nodules or cords. The Dupuytren nodule is a palpable subcutaneous lump that may be fixed to the skin. Cords are highly organized collagen structures arranged in parallel with a relatively hypocellular matrix. Cords are predominantly composed of collagen III while normal palmar fascia is predominantly collagen I.

Figure A is a picture of a dorsal Dupuytren's nodule.

Reference: Dorsal pads versus nodules in normal population and Dupuytren's disease patients. Rayan, JHS 2010
Dupuytren disease: an evolving understanding of an age-old disease. Black, JAAOS 2011

184. Answer: C

At 6 weeks following LRTI surgery, patients treated with an immobilization protocol have wrist and thumb ROM and strength measurements that are:

- A) Better than measurements observed with an early mobilization protocol.
- B) The same as measurements observed with an early mobilization protocol.
- C) Worse than measurements observed with an early mobilization protocol.
- D) Impossible to study given the varied nature of postoperative rehabilitation protocols following LRTI surgery.

Discussion: According to the prospective, randomized study performed by Hutchinson et al (reference below), wrist and thumb ROM and strength measurements observed with an immobilization protocol were worse than measurements observed with an early mobilization protocol at 6 weeks following LRTI surgery. At 12 weeks post-op and beyond, however, there were no significant differences in wrist and thumb ROM and strength measurements between the groups. This study looked at a minimum of 1-year follow-up in 169 thumbs in 157 patients, divided randomly into two postoperative rehabilitation protocols, early mobilization and immobilization. In addition to wrist and thumb ROM and strength, the authors also looked at DASH, VAS pain, VAS patient satisfaction and 9-hole peg test scores at various post-op intervals.

Reference: Team Orthobullets (D) MD

185. Answer: B

A 65-year-old man complains of numbness and tingling in the thumb, index, and long fingers of his dominant right hand for 3 months. An EMG demonstrates prolonged median sensory latency and low amplitude compound muscle action potentials with fibrillations in the abductor pollicis brevis. What is the most appropriate treatment option and the rate of continued symptoms at 1 year after treatment?

- A) Splinting and corticosteroids; 5%
- B) Open carpal tunnel release; 20%
- C) Splinting and corticosteroids; 30%
- D) Endoscopic carpal tunnel release; 2%
- E) Open carpal tunnel release; 5%

Discussion: The most appropriate treatment of carpal tunnel syndrome (CTS) with EMG evidence of denervation is surgical release. The rate of residual symptoms at 1 year is approximately 20%. The American Association of Electrodiagnostic Medicine (AAEM) criteria delineates CTS severity by EMG. Mild CTS is purely sensory. Moderate disease demonstrates prolonged sensory and motor latencies. Severe disease progresses to involve muscle denervation. Mild and moderate CTS may be treated with carpal tunnel release following failure of nonoperative treatment; however, early operative treatment is supported for severe disease to limit further denervation. Patients experience significant improvement in symptoms; however, recovery is prolonged and persistent symptoms may be present in ~20% at 1 year. Kronlage et al. compared changes in numbness and pain following carpal tunnel release in 47 patients with moderate and 48 patients with severe CTS diagnosed on EMG. At 1 year or longer, 1 (2%) patient with moderate disease had continued symptoms compared to 9 (19%) of patients with severe CTS. They concluded that patients with severe CTS experience significant reductions in symptoms following carpal tunnel release; however, recovery may be prolonged or incomplete at 1 year postop. Ono et al. performed a systematic review of 25 studies reporting outcomes for the treatment of carpal tunnel syndrome. They noted an increasing trend towards recommending earlier surgery for CTS with or without median nerve denervation. They conclude that this differed from the 2007 AAOS guidelines, which recommended early surgery only in the setting of muscle denervation.

Reference: The benefit of carpal tunnel release in patients with electrophysiologically moderate and severe disease. Kronlage, JHS 2015. Optimal management of carpal tunnel syndrome. Ono S 2010

186. Answer: C

What clinical finding is characteristic of involvement of the natatory ligament in Dupuytren's disease?

- A) Palmar pits
- B) Metacarpophalangeal joint contracture
- C) Web space contracture
- D) Distal interphalangeal joint contracture
- E) Tender pads over the dorsal aspect of the proximal interphalangeal joints

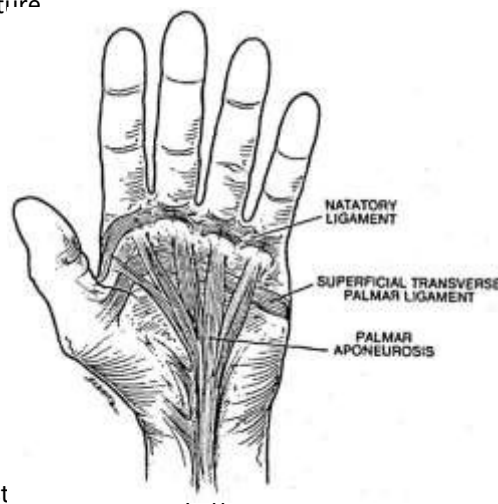
Discussion: The natatory ligament contributes to web space contracture. Specific pathological entities in Dupuytren's disease cause the following contractures: The pretendinous cord causes MCP contracture. The natatory ligament causes web space contracture. The spiral cord causes MCP and PIP contracture. The lateral cord causes PIP or DIP flexion contracture. The retrovascular cord causes DIP hyperextension contracture.

Strickland et al. discuss the pathogenesis of Dupuytren's disease. They found that the natatory ligaments course between the web spaces of all digits and tighten with abduction. As they cross the flexor tendons, they send fibers to attach to the tendon sheath over the MP joints. They also contribute to the web space coalescence.

McFarlane et al. studied the anatomy of Dupuytren's disease. They stated involvement causes web space and finger joint contracture. Fibers from the natatory ligament contribute to the lateral digital fascia, and thus contribute to PIPJ contracture.

Illustration A shows the natatory ligament.

Reference: Anatomy and pathogenesis of the digital cords and nodules. Strickland, HANDC 1991 The anatomy of Dupuytren's disease. McFarlane RM. 1984

**187. Answer: E**

A 56-year-old right hand dominant male presents to your office complaining of right thumb pain worsened with pincer grip and using his mobile phone. He is a writer, and is having difficulty holding his pen. Radiographs from this visit are shown in Figure A. Compared with trapeziectomy alone, which of the following treatment options is likely to result in superior pain relief and improvement of key-pinch strength?

- A) Trapeziometacarpal corticosteroid injection followed by aggressive occupational therapy
- B) Trapeziectomy with interpositional palmaris longus arthroplasty
- C) Trapeziectomy, interpositional arthroplasty, and palmar oblique ligament reconstruction using flexor carpi radialis autograft
- D) Partial trapeziectomy with capsular interpositional arthroplasty
- E) None of the above



Discussion: This patient has symptomatic basal joint arthritis with radiographic evidence of pantrapezialarthritis. Simple trapeziectomy has been shown to provide pain relief and improvement of key-pinch strength that is comparable to trapeziectomy plus interpositional arthroplasty.

Definitive surgical management of basal joint arthritis commonly involves excision of the diseased trapezium with concomitant interpositional arthroplasty at the carpometacarpal joint in an effort to maintain the height of the metacarpal. This is commonly done with flexor carpi radialis (FCR) or palmaris longus (PL) autograft. Recent studies have called into question the need for interpositional arthroplasty, suggesting that excision of the trapezium alone can provide non-inferior results.

Davis et. al. randomized 183 symptomatic trapeziometacarpal joints to one of three procedures: trapeziectomy alone, trapeziectomy with palmaris longus interpositional arthroplasty, or trapeziectomy with FCR interpositional arthroplasty and reconstruction of the palmar oblique ligament. For all patients, the thumb metacarpal was percutaneously pinned to the distal pole of the scaphoid to maintain the height of the digit. Patients were evaluated at three and 12 months post-operatively. At both time- points, they found no difference between groups with respect to subjective accounts of pain, function, stiffness, and weakness. Objective measures of thumb key-pinch strength were no different at either time point. The authors concluded that there may be no benefit to ligament reconstruction or tendon interposition in the short term.

Li et. al. performed a systematic review of four randomized controlled trials and two systematic reviews to evaluate outcomes of trapeziectomy with and without LRTI for treatment of basal joint osteoarthritis. In their review, there were no statistically significant differences in post-op grip strength, pinch strength, visual analog pain scores, DASH scores, and complications. The authors concluded that both procedures produced similar clinical results.

Raven et. al. performed a retrospective analysis of 54 patients who underwent one of three procedures for basal joint osteoarthritis: resection arthroplasty, trapeziectomy with tendon interposition, or trapeziometacarpal arthrodesis. The authors found resection arthroplasty to be a simple procedure with long-term results pain and functional outcomes comparable to trapeziectomy with tendon interposition.

Naram et. al. retrospectively reviewed 200 patients who underwent simple trapeziectomy with or without LRTI and with or without Kirschner wire stabilization, or a Weilby ligament reconstruction. They found that patients undergoing trapeziectomy with LRTI or a Weilby procedure had a greater incidence of complications compared to trapeziectomy alone, including infection and reoperation.

Figure A is a plain radiograph demonstrating pantrapezial arthritis with the thumb trapeziometacarpal joint being most significantly affected.

Reference: Excision of the trapezium for osteoarthritis of the trapeziometacarpal joint: a study of the benefit of ligament reconstruction or tendon interposition. Davis, JHS 2004

Comparison of trapeziectomy and trapeziectomy with ligament reconstruction and tendon interposition: a systematic literature review. Li, PRS 2011

Long term results of surgical intervention for osteoarthritis of the trapeziometacarpal joint : comparison of resection arthroplasty, trapeziectomy with tendon interposition and trapezio-metacarpal arthrodesis.

Raven, INTORT 2007

Increased Complications in Trapeziectomy With Ligament Reconstruction and Tendon Interposition Compared With Trapeziectomy Alone. Naram A 2016

188. Answer: E

A 62-year-old tennis player ruptured his Achilles tendon 12 months ago. He initially chose non-operative treatment but continued to have weakness and difficulty ambulating. During surgery extensive debridement there is a 6cm gap between viable tissue ends. Which of the following surgical techniques most likely will provide the best clinical outcome?

- A) Primary repair with the foot in maximal plantar flexion followed by a gradual stretching program
- B) Reconstruction with hamstring autograft
- C) Achilles repair augmented with transfer of the posterior tibial tendon
- D) Achilles repair augmented with transfer of the extensor digitorum longus
- E) Achilles repair augmented with transfer of the flexor hallucis longus

Discussion: The gap is not likely to be repairable primarily. The Flexor Hallucis Longus tendon transfer is adjacent to the Achilles, works in phase and has acceptable strength.

Reference: Team Orthobullets (D) MD

189. Answer: E

A 62-year-old right hand dominant nurse comes to your clinic with complaint of 3 years of off and on bilateral numbness and tingling. She reports symptoms in her thumb, index, and middle fingers that wakes her from sleep. Figure A shows a clinical photograph of her hands. Flexion of her wrist worsens her symptoms and tapping over her carpal tunnel causes sharp pain into her thumb, index, and middle fingers. She has two point discrimination to 3mm in her ring and small fingers and 10mm in the remainder of her fingers. Her colleague in neurology suggested electrodiagnostic studies to confirm the suspected diagnosis. Which of the following is true regarding an electrodiagnostic studies in this scenario?

- A) Electrodiagnostic studies would be useful to confirm compression of the median nerve at the elbow
- B) Electrodiagnostic studies would be useful to confirm compression of the median nerve at the wrist
- C) Electrodiagnostic studies would be useful to rule out compression of the median nerve at the wrist
- D) Electrodiagnostic studies would be useful to rule out compression of the median nerve at the elbow
- E) Electrodiagnostic studies are unlikely to change the probability of median nerve compression at the wrist

Discussion: Electrodiagnostic studies will not affect the probability of a patient having carpal tunnel syndrome when the clinical suspicion is high based on history and physical exam.

Carpal tunnel syndrome is a clinical diagnosis based on a set of symptoms and objective findings. The CTS-6 is a scoring tool for carpal tunnel which categorizes patients into a high probability (>.80) and low

probability (<0.25) of having carpal tunnel. In a high or low probability patient electrodiagnostic studies are unlikely to alter the probability that the patient does or does not have carpal tunnel syndrome.

Graham et al. collected the 8 most highly ranked criteria used to diagnose carpal tunnel syndrome based on expert opinion. All possible combinations of these 8 criteria were ranked by another panel of experts.

CTS-6	
A clinical aid for diagnosing carpal tunnel syndrome	
Symptoms and history	
Numbness predominately or exclusively in median nerve territory <i>Sensory symptoms are mostly in the thumb, index, middle and/or ring fingers</i>	3.5
Nocturnal numbness <i>Symptoms are prominent when patient sleeps; numbness wakes patient from sleep</i>	4
Physical examination	
Thenar atrophy and/or weakness <i>The bulk of the thenar area is reduced or manual motor testing shows strength of grade 4 or less</i>	5
Positive Phalen test <i>Flexion of the wrist reproduces or worsens symptoms of numbness in the median nerve territory</i>	5
Loss of 2 point discrimination <i>A failure to discriminate two points held 5mm or less apart from one another, in the median nerve innervated digits, is a positive test suggestive of CTS</i>	4.5
Positive Tinel sign <i>Light tapping over the median nerve at the level of the carpal tunnel causing radiating paraesthesiae into the median nerve innervated digits (not proximally) is a positive test</i>	4

They found the correlation between model and panel in predicting CTS was 0.71. They concluded improving the consistency of diagnosis of CTS should lead to more effective treatment. Graham used the CTS-6 to compare the pretest probability of carpal tunnel syndrome and the post-test probability following electrodiagnostic testing at a single institution. They found patients with a pretest probability of CTS of 0.80 had an average post-test probability change of -0.02 when stringent electrodiagnostic criteria were used. They concluded for the majority of patients with a high probability of carpal tunnel syndrome based on physical exam, electrodiagnostic studies do not change the probability of the diagnosis in a clinically meaningful manner. Keith et al provide clinical practice guidelines in diagnosis of carpal tunnel syndrome. They state physicians may obtain electrodiagnostic tests to differentiate among diagnoses or if there is the presence of thenar atrophy and/or persistent numbness. They state physicians should order electrodiagnostic tests if surgical management is being considered and clinical and provocative tests are positive. Figure A shows a patient with bilateral thenar atrophy secondary to compression of the median nerve. Illustration A shows the scoring for the CTS-6 (Graham JSJS 2008) with a score 12 corresponding to an 80% probability of carpal tunnel and a score <5 corresponding to a pretest probability of 25%.

Reference: Development and validation of diagnostic criteria for carpal tunnel syndrome. Graham, JHS 2006. The value added by electrodiagnostic testing in the diagnosis of carpal tunnel syndrome. Graham, JBJS 2008. Diagnosis of carpal tunnel syndrome. Keith, JAAOS 2009

190. Answer: D

A patient with Dupuytren's disease enquires about percutaneous needle fasciotomy and collagenase injections. Which of the following is true regarding these two treatment modalities?

- A) Collagenase injections are more expensive but require fewer treatments than percutaneous needle fasciotomy to achieve the same results
- B) Softening of Dupuytren cords and nodules is observed in cadaveric experiments after collagenase injections but not in a clinical setting
- C) Skin tears are seen following percutaneous needle fasciotomy but not after collagenase injections
- D) Pruritic rash and axillary lymphadenopathy may be observed after collagenase injections but are not typically seen after percutaneous needle fasciotomy
- E) Percutaneous needle fasciotomy has a higher incidence of iatrogenic flexor tendon rupture

Discussion: Pruritic rash and axillary lymphadenopathy is particular only to collagenase injections (CI). These reactions do not occur after percutaneous needle fasciotomy (PNF).

Regional subtotal fasciectomy is the gold standard of care for treatment of Dupuytren's contracture. However, because of high complication rates (up to 40%), nonoperative treatments are attractive. In PNF, a 22G or 25G needle is used to release palpable/visible cords in the office. This is followed by manipulation, and night orthosis wear. In CI, 0.25ml of collagenase is used for MCP contracture and 0.20ml for PIP contracture. Manipulation is performed the following day under local anesthesia. This is repeated at 4 weeks if the desired result is not achieved.

Black et al. reviewed Dupuytren's disease. They note that recurrence rates were higher for PNF (85%) compared with fasciectomy (24%) and conclude that PNF is acceptable for early disease with less severe contracture and elderly, sick patients. Regarding CI, they note that the most common complications are edema, contusion, pain, lymphadenopathy, and skin laceration. Major complications, such as complex regional pain syndrome and flexor tendon rupture, are rare.

Nydick et al. retrospectively compared PNF (30 patients) with CI (29 patients). Both groups achieved similar satisfaction, complication rates, and success rates defined as contracture reduction to 0-5 degrees. They concluded that both PNF and CI provide good alternatives to surgery.

References: Dupuytren disease: an evolving understanding of an age-old disease. Black, JAAOS 2011
A comparison of percutaneous needle fasciotomy and collagenase injection for Dupuytren disease. Nydick, JHS 2013

Oncology

191. Answer: E 2017

What is an appropriate treatment for a patient with history of breast cancer 15 years ago presenting with an isolated new painful intertrichantheric bone lesion?

- A) Antegrade femoral nailing with reamings sent to pathology for analysis
- B) Retrograde femoral nailing with adjuvant radiotherapy to the lesion
- C) Minimally invasive plating of the femur for stabilization and open cementation of the lesion
- D) Referral to medical oncology for chemo-radiotherapy
- E) Lesion biopsy with further treatment based on the results of the biopsy

Discussion: New bone lesions in a setting of previous malignancy are not always metastatic. Careful local and systemic staging should be performed prior to any surgical treatment. This could negatively affect both the mobility and mortality.

Reference: Menendez LR (Editor): Orthopaedic Knowledge Update. American Academy of Orthopaedic Surgeons. Rosemont IL. 2002. Page 232 -239

192. Answer: D 2017

67-year-old 40 pack smoker, male, retired musician presents to your office with painful left hip. Upon examination hip range of motion is normal. Radiograph shows scattered mixed but mostly sclerotic lesion in his pelvis and proximal femur. What test would you order next?

- A) SPEP/UPEP
- B) Thyroid biopsy
- C) CBC and blood smear
- D) Prostate biopsy
- E) Renal ultrasound

Discussion: Metastatic lesions to bone in prostate cancer are very common. Radiographic presentation in terms of appearance and location often offer excellent clues to the primary malignancy. Prostate cancer metastases are often mixed, sclerotic and lytic.

Reference: Greenspan A, Jundt G, Remagen W: Differential Diagnosis in Orthopaedic Oncology. Lippincott Williams & Wilkins: 2006.

193. Answer: D 2017

67-year-old 40 pack your smoker, mail, retard musician presents to your office with painful left hip. Upon examination hip range of motion is normal. Radiograph shows scattered mixed but mostly sclerotic lesion is in a pelvis and proximal femurs. What test would you order next?

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- H) CBC and blood smear
- I) Prostate biopsy
- J) Renal ultrasound

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Reference: Greenspan A, Jundt G, Remagen W: Differential Diagnosis in Orthopaedic Oncology. Lippincott Williams & Wilkins: 2006.

194. Answer: E 2017

70-year-old female with lung cancer with no metastatic disease to bone presents with impending fracture to the left intertrochanteric area. Which surgical treatment would you recommend?

- A) Total hip arthroplasty
- B) Hemiarthroplasty
- C) Sliding hip screw
- D) Dynamically locked cephalomedullary nail
- E) Statically locked cephalomedullary nail

Discussion: Impending intratrochanteric area fractures are best treated with statically locked cephalomedullary nails. **Reference:** Jacofsky DJ, Haidukewych GJ. Management of pathologic fractures of the proximal femur: state of the art. J Orthop Trauma. 2004 Aug;18(7):459-69.

195. Answer: D 2017

Together, bone and soft tissue sarcomas account for what percentage of all cancers in the U.S.?

- A) 50%
- B) 10%
- C) 33%
- D) <1%
- E) 5%

Discussion: Sarcomas are incredible rare - less than 1% of all cancers diagnosed in the U.S. This extreme rarity breeds unfamiliarity which can lead to misdiagnoses and inappropriate treatment, including unplanned excisions.

Reference: Tedesco NS, and Henshaw RM. Unplanned Resection of Sarcoma. J Am Acad Orthop Surg. 2016 Mar; 24(3): 150-159.

196. Answer: E 2017

What are the most common presumed diagnoses in unplanned resections of bone sarcoma?

- a. Osteomyelitis and Giant Cell Tumor
- b. Bone Cyst and Osteonecrosis
- c. Metastatic Disease
- d. A and C
- e. A, B, and C

Discussion: Most of the above diagnoses are treated with some manner of curettage and grafting which can compromise the options for limb salvage due to tumor contamination. Bone sarcoma in older adults can present with purely lytic lesions depending on the subtype, and can therefore be easily confused with metastatic disease if not biopsy-proven. The treatment of pathologic fractures that are presumed to be due to metastatic disease or the result of a benign tumor can have devastating consequences for future limb salvage. The most common reasons for unplanned resection of bone sarcoma are misdiagnosis, failure to recognize a bone lesion, and inappropriate treatment of pathologic fractures (Tedesco et al)

Reference: Tedesco NS, and Henshaw RM. Unplanned Resection of Sarcoma. J Am Acad Orthop Surg. 2016 Mar; 24(3): 150-159.

197. Answer: E 2017

Unplanned soft tissue sarcoma resections are often sarcomas that are:

- A) >5cm at presentation and deep to the fascia
- B) Painless
- C) <5cm at presentation and superficial to the fascia
- D) A and B
- E) B and C

Discussion: Tumors that are above the fascia, less than 5 cm and painless are assumed to be benign as the classic presentation of sarcoma is thought to be a mass that is greater than 5cm, deep to the fascia and may be painless or painful. Up to 1/3 of soft tissue sarcomas do not fit the classic presentation. (Tedesco et al)

Reference: Tedesco NS, and Henshaw RM. Unplanned Resection of Sarcoma. J Am Acad Orthop Surg. 2016 Mar; 24 (3): 150-159.

198. Answer: E 2017

Unplanned resection of a bone sarcoma can result in:

- A) Lower rates of limb salvage
- B) Lower rates of local control
- C) Smaller mean tumor volumes
- D) Shorter mean time to local recurrence and metastases
- E) All of the above

Discussion: Unplanned sarcoma resection has consequences that affect both limb and life. The ability to perform limb salvage is limited by unplanned resections of sarcoma - this can result in a higher rate of amputation. Decreased local control and increased rates of local recurrence can also result in amputations to obtain local control. Also, the smaller tumor volumes can compromise the analysis of the tumor necrosis which can affect decisions in regards to adjuvant chemotherapy. The overall survival data is contradictory in the available literature with one study showing a decreased 10-year survival and another study showing no difference in 5-year overall survival, while still another study shows the outcomes following an unplanned resection to be similar to those of a pathologic fracture through a bone sarcoma.

Reference: Tedesco NS, and Henshaw RM. Unplanned Resection of Sarcoma. J Am Acad Orthop Surg. 2016 Mar; 24 (3): 150-159.

199. Answer: C 2017

Which of the following is NOT a result of unplanned resection of soft tissue sarcoma?

- A) Greater need for flap coverage
- B) Worse functional scores
- C) Lower rates of local recurrence
- D) Increased wound complications
- E) Increased amputation rates

Discussion: While the literature is mixed on the overall outcomes following re-excision of soft tissue sarcoma, some studies show higher rates of local recurrences while other studies show, at best, similar rates of local recurrence. The increased rates of complications and need for flap coverage, etc. is due to multiple factors - difficulty in obtaining wide surgical margins following initial unplanned resection, poor initial surgery technique (transverse incisions, poor drain placement, hematoma, neurovascular contamination, etc.). The complications related to unplanned excision of soft tissue sarcoma can be limited by following traditional oncologic principles at the time of the unplanned resection. If all soft tissue masses are approached as potential malignancies, this can limit the morbidity of the re-excision procedure.

Reference: Tedesco NS, and Henshaw RM. Unplanned Resection of Sarcoma. J Am Acad Orthop Surg. 2016 Mar; 24 (3): 150-159.

200. Answer: A 2017

Which of the following is a concerning feature of a soft tissue mass in the extremity?

- A) Deep to fascia
- B) 0.8cm size
- C) Non-painful
- D) No recent change in size
- E) Mobile

Discussion: Deep tumors are more like to fall into benign aggressive and malignant categories. Benign tumors, especially lipomatous tumor can be deep to fascia.

References: Mankin, Henry J., Carole J. Mankin, and Michael A. Simon. "The hazards of the biopsy, revisited. For the members of the Musculoskeletal Tumor Society." J Bone Joint Surg Am 78.5 (1996): 656-63.

201. Answer: C

Biopsy of a bone or muscle mass at an institution which will not ultimately treat the lesion leads to higherrates of all of the following EXCEPT:

- A) Death from disease
- B) Misdiagnosis
- C) Patient Satisfaction
- D) Unnecessary procedures
- E) Amputation

Discussion: Biopsy at the treating institution gives lower rates of tumor management complications.

References: Mankin, Henry J., Carole J. Mankin, and Michael A. Simon. "The hazards of the biopsy, revisited. For the members of the Musculoskeletal Tumor Society." J Bone Joint Surg Am 78.5 (1996): 656-63.

202. Answer: C

Core needle biopsy yields diagnosis about what percent of the time?

- A) 5%
- B) 20%
- C) 50%
- D) 80%
- E) 99%

Discussion: Core needle biopsy is diagnostic about 80% of the time.

References: Layfield, Lester J., et al. "Diagnostic accuracy and clinical utility of biopsy in musculoskeletal lesions: A comparison of fine-needle aspiration, core, and open biopsy techniques." Diagnostic cytopathology 42.6 (2014): 476-486.

203. Answer: A 2017

Which is an advantage to open biopsy compared to core needle biopsy?

- A) No need to excise the biopsy track
- B) Higher chance to obtain diagnosis
- C) Lower cost
- D) Can be done in the office
- E) Can be done by ancillary service

Discussion: Open biopsy tracks should be excised. The local recurrence rate in a core needle track is negligible and the evidence supports not excise the core needle track.

References: Siddiqi, M. Ather, et al. "Association of core needle biopsy tract resection with local recurrence in extremity soft tissue sarcoma." *Skeletal Radiology* (2017): 1-6.

204. Answer: A 2017

Which of the following is a sound principle of open biopsy technique?

- A) Longitudinal incision
- B) Utilizing inter-nervous planes
- C) Exposing and protecting neurovascular structures
- D) Transverse incision
- E) Biopsy without imaging study

Discussion: Longitudinal incisions, direct access through one compartment avoiding neurovascular structures and hemostasis are sound open biopsy principles.

References: Cheung, Felix H. "The practicing orthopedic surgeon's guide to managing long bone metastases." *Orthopedic Clinics of North America* 45.1 (2014): 109-119.

205. Answer: B

Aldoxorubicin is a drug in phase III clinical trials for what tumor:

- A) Chordoma
- B) Soft tissue sarcoma
- C) Giant cell tumor
- D) Chondrosarcoma

Discussion: Doxorubicin is a primary drug used in the treatment of soft tissue sarcomas. Aldoxorubicin has a linker that attracts and links protein while circulating in the blood and has preferential absorption to tumor cells reducing the cardiac toxicity seen with doxorubicin.

Reference: First Line Aldoxorubicin vs Doxorubicin in Soft Tissue Sarcoma; Chawla; *JAMA Oncol.* 2015 Dec1 1(9): 1272-80.

206. Answer: C

Chordoma can be difficult to distinguish histologically from the following tumors:

- A) giant notochordal hamartoma, renal cancer and clear cell sarcoma
- B) chondrosarcoma, Clear cell sarcoma and renal cancer
- C) giant notochordal hamartoma, renal cancer, chondrosarcoma and clear cell sarcoma
- D) renal cancer and giant notochordal hamartoma

Discussion: All of these lesions have clear cells and may be difficult to differentiate from chordoma. Giant notochordal hamartoma has the most similar histologic findings as chordoma but this benign tumor should never break out into the soft tissue.

Reference: Mirra, J and Brien, E; *Skeletal Radiology*, Dec 2001 vol 12 pp 698-709.

207. Answer: A

Which aggressive benign tumor can be managed with an osteoporosis drug?

- A) Giant cell tumor
- B) Unicameral bone cyst
- C) Aneurysmal bone cyst
- D) Non ossifying fibroma

Discussion: Understanding the role of the receptor activator of nuclear factor- κ B ligand (RANKL) in giant cell tumor has led to the use of denosumab when a surgical approach would be morbid.

Reference: Giant cell tumor of bone: Singh et al. *Biologics*. 2015 Jul 14; 9: 69-74

208. Answer: C

Tumor implants addressing leg length discrepancy in a growing child can be done without reopening the incision through what mechanism:

- A) Screw extension mechanism
- B) Replacement of modular midsections
- C) Lengthening through electromagnetic field
- D) Lewis expandable adjustable prosthesis (LEAP)

Discussion: The distal femur and proximal tibia contribute 35% and 30% respectively of growth in the lower extremity. Children under the age of 10 can have significant leg length discrepancy after tumor resection in these areas. Lengthening through an electromagnetic field no longer requires an incision to lengthen the limb.

Reference: *Clin. Orthop. Relat. Res.* Wilkins et al. 2001 Jan; (382): 51-8.

209. Answer: D

Surgical management of metastatic bone disease has not changed in which cancer:

- A) Lung cancer
- B) Renal cancer
- C) Breast cancer
- D) Pancreatic cancer
- E) Thyroid cancer

Discussion: Pancreatic cancer rarely spreads to bone and chemotherapy has had less impact in pancreatic cancers than the more common malignancies that spread to bone.

Reference: *Skeletal Metastases in Pancreatic Cancer*; Borad, M et al. *yale J boil med*. 2009 Mar; 82 (1): 1-6.

210. Answer: B

Which soft tissue tumor have we altered our surgical management by do a more limited surgical approach:

- A) Synovial sarcoma
- B) Desmoid tumor
- C) Liposarcoma
- D) Undifferentiated sarcoma
- E) Pigmented villonodular synovitis

Discussion: Desmoid tumor or aggressive fibromatosis has an exceptionally high recurrence rate and surgical can lead to significant morbidity. Treatment includes low dose methotrexate and vinblastine with local surgery. Recurrence is common even with an attempt at wide excision and a less aggressive approach should be considered.

Reference: *Ann Surg Oncol*. 2015; 22 (9): 2817-23

211. Answer: A 2017

Management of a non-union after pathologic femur fracture in a patient who has received high dose radiation therapy should include:

- A) Endoprosthetic reconstruction
- B) Allograft reconstruction
- C) Repeat nailing
- D) Plate fixation

Discussion: Patients who have received radiation treatment have a high incidence of non-union after pathologic fracture. Proximal femoral replacement and a constrained liner should be considered to avoid multiple surgeries and immediate weight bearing.

Reference: Proximal Femoral Reconstruction...Jawad et al. Orthopedics;feb 2014 vol 37; 187-193.

212. Answer: D

Treatment for high grade sarcoma greater than 5 cm may include the following:

- A) Chemotherapy and surgery
- B) Chemotherapy and radiation
- C) Radiation and surgery
- D) Chemotherapy, radiation and surgery

Discussion: Large, high grade soft tissue sarcomas are commonly treated with neoadjuvant chemotherapy, radiation therapy followed by surgery. Variation in chemotherapy for specific sarcomas such as leiomyosarcoma may be indicated.

Reference: Wiki-Based Clinical Practice Guidelines for Management of Adult Onset Sarcoma: Neuhaus, s. et al. 2015; Feb 16

213. Answer: B

A new technique in improving spatial orientation in pelvic and sacral tumor surgery is:

- A) Intraoperative fluoroscopy
- B) Intraoperative O arm
- C) Intraoperative MRI
- D) Intraoperative radiographs

Discussion: Intraoperative O arm is a portable CT scan that can be used to navigate surgery in the pelvis. It accesses real time 3D images using navigation systems to confirm tumor location and resection margins potentially reducing local recurrence and improving function.

Reference: Computer Assisted Navigation During an A-P En Bloc Resection of a Sacral Tumor; Cureus: Elissa et al. 2015 Nov 4; 7(11) e373

214. Answer: A

Which bone tumor is treated with chemotherapy?

- A) Low grade chondrosarcoma
- B) Chordoma
- C) Adamantinoma
- D) Parosteal osteosarcoma

Discussion: All of these malignant tumors are low grade. Low grade sarcomas are not treated with chemotherapy. The primary treatment is surgery alone. Chordoma and other low grade sarcomas can be treated with radiation therapy (ie. Proton/carbon ion therapy) in an attempt to reduce the risk of local recurrence in very high risk patients.

Reference: Randomized phase II trial of hypofractionated proton versus carbon ion radiation for chordoma; Uhl, M et al. radiat oncol. 2014 9;100

215. Answer: A

Which primary solitary round cell tumor has the best prognosis?

- A) Lymphoma
- B) Ewing's sarcoma
- C) Myeloma
- D) Rhabdomyosarcoma

Discussion: The disease free survival with a solitary bone lymphoma is between 80-90% in patients under the age of 60. This is significantly better than the other round cell tumors discussed above.

Reference: Malignant lymphoma of bone; Demircay et al. clin orthop relat res; 2013 aug; 471 (8) 2684-2690.

216. Answer: D

The best way to differentiate well differentiated liposarcoma (atypical lipoma) and lipoma on MRI is the following:

- A) Size
- B) Location
- C) Shape
- D) Signal alteration

Discussion: Both lipoma and well differentiated liposarcoma have bright signal on T-1 and low signal on T-2. If there is a dark linear striations in the mass, one should be suspicious of the well differentiated liposarcoma. Local recurrence is not uncommon with this tumor.

Reference: MRI Web Clinic Jan 2014; Dr. Awh; Lipoma and liposarcoma;

217. Answer: D

Which of the following conditions has the most evidence supporting the use of leukocyte-rich PRP as viable treatment?

- A) Carpal Tunnel Syndrome
- A. Cervical Disc Disease
- B. Posterior Tibial Tendinopathy
- C. Gluteal Tendinopathy
- D. Hamstring Muscle Injuries

Discussion: Recent data from a prospective randomized clinical trial with two year follow up confirmed the value of leukocyte rich PRP in the treatment of chronic gluteal tendinopathy.

Reference: Team Orthobullets (D) MD

Osteoporosis

218. Answer: D

Which of the following medications inhibits release of neurotransmitters by binding to presynaptic calcium channels?

- A) Denosumab
- B) Sertraline
- C) Tramadol
- D) Gabapentin
- E) Linezolid

Discussion: Gabapentin acts by inhibiting presynaptic calcium channels, thus preventing the release of neurotransmitters.

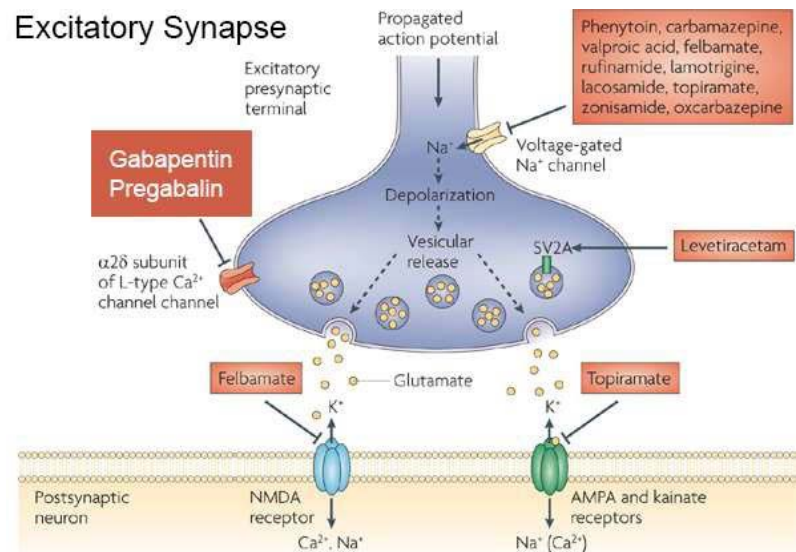
Gabapentin (also known as Neurontin) is a medication that is commonly used to treat neuropathic pain. It acts by binding the $\alpha 2\delta$ subunit of voltage-dependent calcium channels on the presynaptic membrane. This serves to increase GABA synthesis, as well as inhibit the release of excitatory neurotransmitters. These neurotransmitters are believed to be part of the pathway leading to neuropathic pain.

Bennett et al. provide a review of the pharmacology of gabapentin for the use of neuropathic pain. They note effective antihyperalgesic and antiallodynic properties of gabapentin but not significant anti-nociceptive action. Among patients with neuropathic pain they found an average pain score reduction of 2.05 points on an 11 point Likert scale, which compared favorably to placebo.

Mehta et al. explored outcomes of gabapentin and pregabalin (Lyrica) for use in patients with spinal cord injury. Both agents were found to decrease pain and secondary conditions such as sleep disturbance. They did not directly compare these agents to other analgesic medications.

Guy et al. present a meta-analysis of the use of anticonvulsants (such as gabapentin) to treat pain in patients with spinal cord injury. Large effect size was seen in 4 of 6 studies looking at the effectiveness of gabapentin.

Illustration A shows the mechanism of currently available antiepileptic drugs (AEDs) that target several molecules at the excitatory synapse. Gabapentin and pregabalin bind to the $\alpha 2\delta$ subunit of voltage-gated Ca^{2+} channels, which is thought to be associated with a decrease in neurotransmitter release.



Reference: Gabapentin in the treatment of neuropathic pain. Bennett MI 2004

Gabapentinoids are effective in decreasing neuropathic pain and other secondary outcomes after spinal cord injury: a meta-analysis. Mehta S 2014 Anticonvulsant medication use for the management of pain following spinal cord injury: systematic review and effectiveness analysis. Guy, SCORD 2014

219. Answer: C

How does PTH peptide (Teriparatide) effect bone metabolism and how is it used in the treatment of osteoporosis?

- A) Continual use for less than 3 years
- B) Continual use for 3-5 years
- C) Continual use for more than 5 years
- D) Intermittent use only

Discussion: Anabolic effect on bone and stimulates bone formation. Continual use leads to net bone loss.

Reference: OKU-10 Chapter 16 Page 188

220. Answer: A

What is the definition of osteoporosis?

- A) Patient with T score of less than -2.5
- B) Patient with T score of more than -2.5
- C) Patient with T score of less than -1.5
- D) Patient with T score of less than 1

Discussion: Criteria for Osteoporosis

Normal BMD within 1 SD of the young adult reference mean Osteopenia BMD between -1.0 to -2.5 SD of the young adult reference mean Osteoporosis BMD > 2.5 SD below the young adult reference mean BMD = bone mineral density; SD = standard deviation (Data from the World Health Organization, Reprinted with permission from Flynn, JM (ed), Orthopaedic Knowledge Update 10, Rosemont, IL American Academy of Orthopaedic Surgeons, 2011, Page 188)

Reference: OKU-10 Chapter 16 Page 188

221. Answer: C

What is the definition of osteopenia?

- A) Patient with T score between -.5 and -2.5
- B) Patient with T score between -.5 and -3.5
- C) Patient with T score between -1.0 and -2.5
- D) Patient with T score under -1.0

Discussion: Criteria for Osteoporosis

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References: Data from the World Health Organization

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OKU-10 Chapter 16 Page 188

222. Answer: A

What is a main category of treatment for osteoporosis?

- A) Calcium
- B) Iron
- C) Magnesium
- D) Vitamin C

Discussion: Calcium is important in the treatment of osteoporosis, however, large dosages of calcium can build up in the arteries and lead to heart problems.

Reference: OKU-10 Chapter 16 Page 188

223. Answer: A

A postmenopausal patient comes to your office for follow-up after a dual-energy x-ray absorptiometry (DEXA) test. The T-score is $-0.7SD$. The Z score is $-0.4SD$. By World Health Organization (WHO) criteria, these DEXA findings would merit a diagnosis of

- A) Normal
- B) Osteopenia based on Z-score findings
- C) Osteopenia based on T-score findings
- D) Osteopenia based on T- and Z-score findings
- E) Osteoporosis

Discussion: By WHO classification, her findings (T-score of $-0.7SD$) would merit a diagnosis of Normal bone mineral density (BMD).

The WHO classifies bone density in postmenopausal women based on T-scores. Patients are classified based on the lowest T score of the spine, femoral neck, trochanter, or total hip. The classification should not be used with peripheral measurements. Z-scores are used for premenopausal women, younger men, and in children. The Z score compares a patient with age-, sex-, and race-matched norms.

Blake and Fogelman reviewed the role of central DEXA in treatment of osteoporosis, compared with quantitative CT, peripheral DEXA and quantitative ultrasound. The advantages of central DEXA include results that can be interpreted using WHO T-score definitions, ability to predict fracture risk, and effectiveness at targeting antifracture treatments.

Templeton reviewed secondary osteoporosis. In women with osteoporosis, the most common causes of secondary osteoporosis include hypercalciuria, malabsorption, hyperparathyroidism, vitamin D deficiency, and exogenous hyperthyroidism. In men with osteoporosis, the most common causes of secondary osteoporosis include hypogonadism, corticosteroid use and alcoholism.

Unnanuntana et al. reviewed the assessment of fracture risk. The FRAX (World Health Organization Fracture Risk Assessment Tool) calculates 10-year risk of fracture based on the following variables: age, sex, race, height, weight, BMI, history of fragility fracture, parental history of hip fracture, use of oral glucocorticoids, secondary osteoporosis and alcohol use to calculate 10-year risk of fracture. They also discussed biochemical markers of bone formation and resorption, which are useful for monitoring the efficacy of antiresorptive / anabolic therapy, and may help identify patients at high risk for fracture.

Illustration A shows the WHO classification. Illustration B shows a comparison between central DEXA and other methods of BMD measurement.

World Health Organization criteria for diagnosing osteoporosis using bone density measurements

CATEGORY	T SCORE
Normal	Not more than 1.0 standard deviations (SD) below the young adult mean
Osteopenia	Between 1.0 and 2.5 SD below the young adult mean
Osteoporosis	More than 2.5 SD below the young adult mean
Severe or established osteoporosis	More than 2.5 SD below the young adult mean with a fracture

Figure A

Reference: Role of dual-energy X-ray absorptiometry in the diagnosis and treatment of osteoporosis. Blake GM 2007
Secondary osteoporosis. Templeton, JAAOS 2005
The assessment of fracture risk. Unnanuntana, JBJS 2010

224. Answer: B

When using lateral interbody fusion to correct degenerative scoliosis, which of the following is least likely to be corrected?

- A) Cobb angle
- B) Sagittal imbalance
- C) Foraminal stenosis
- D) Rotatory subluxation

Discussion: The biggest benefit of the lateral inter body fusion is that it is able to correct coronal deformity (Cobb angle) and increase foraminal height. It is also able to correct rotatory subluxations. However, it has been increasingly noted that it cannot correct sagittal imbalance and a pedicle subtraction osteotomy or Smith-Peterson osteotomy is necessary to correct sagittal imbalance.

Reference: Team Orthobullets (D) MD

225. Answer: B

A 68-year-old woman presents to review the results of a dual-energy x-ray absorptiometry scan. She was found to have a T-score of -2.6. When discussing treatment options, the patient mentions that she saw a commercial advertising a medication that builds new bone. Which of the following is the correct description of this drug?

- A) A protein that is produced by osteocytes and is encoded by the SOST gene.
- B) A recombinant form of a hormone that is produced by chief cells
- C) A competitive partial agonist of the estrogen receptor
- D) A polypeptide hormone produced by parafollicular cells
- E) A drug which contains a P-C-P backbone

Comparison of Different Bone Densitometry Techniques

Criteria	Central DXA	Peripheral DXA	QCT	QUS
Compatible with WHO T-scores	✓	×	×	×
Proven to predict fracture risk	✓	✓	?	✓
Compatible with new WHO fracture risk algorithm	✓	×	×	×
Proven for effective targeting of treatment	✓	?	?	?
Suitable for patient follow-up	✓	×	?	×
Stable calibration	✓	✓	✓	×
Good precision	✓	✓	✓	×
Reliable reference ranges available	✓	?	?	?

Abbv: DXA, dual-energy X-ray absorptiometry, QCT, quantitative computed tomography; QUS, quantitative ultrasound; WHO, World Health Organization.

Figure B

Discussion: Parathyroid hormone (PTH) is a hormone which is produced by chief cells in the parathyroid gland. Teriparatide is a recombinant protein form of PTH and is the only available anabolic agent in the United States.

PTH stimulates bone formation and resorption and can increase or decrease bone mass, depending on the mode of administration. Teriparatide or PTH (1-34), comprises the first 34 amino acids of the hormone and produces its chief biologic effects. Continuous infusions which will result in a persistent elevation of serum PTH concentration will lead to greater bone resorption and hypercalcemia compared to daily injections. Daily injections lead to only transient increases of PTH which may stimulate bone formation. Intermittent administration increases the number of osteoblasts, activation of pre-existing osteoblasts, increased differentiation of lining cells to become osteoblasts, and reduced osteoblast apoptosis.

Neer et al. performed a study to determine the effect of PTH for the treatment of postmenopausal women with prior vertebral fractures. They randomly assigned 1637 postmenopausal women with prior vertebral fractures to receive 20 or 40 µg of PTH (1-34) or placebo administered daily. They performed serial measurements of bone mass by dual-energy x-ray absorptiometry. They found new vertebral fractures in 14% of the placebo group compared to 5% in the treatment group. Compared with placebo, PTH increased bone mineral density by 9-13%. They conclude that treatment with PTH (1-34) decreases the risk of vertebral fractures and increases bone mineral density.

Deal wrote a review on the use of intermittent human PTH in the treatment of osteoporosis. He reports that biosynthetic human PTH (1-34) is also known as teriparatide. Its bioavailability is approximately 95% after subcutaneous administration and maximum serum levels are achieved after approximately 30 minutes. It is metabolized in the liver and kidney and no clinically important interactions with other drugs have been found. He reports that in a rat toxicology study in which PTH was administered in high doses of an extended period of time, osteosarcoma was seen. None of the patients in clinical trials have developed osteosarcoma, however.

Reference: Effect of parathyroid hormone (1-34) on fractures and bone mineral density in postmenopausal women with osteoporosis. Neer, NEJM 2001. The use of intermittent human parathyroid hormone as a treatment for osteoporosis. Deal C. 2004

226. Answer: D

A 61-year-old female smoker has a dual-energy x-ray absorptiometry scan at the femoral neck with a T-score of -1.5. She has a seizure disorder and takes phenytoin. According to the World Health Organization Fracture Risk Assessment Tool (FRAX), she has a ten-year probability of sustaining a hip fracture of 4.8% and a ten-year probability of sustaining a major osteoporotic fracture of 8%. In addition to a smoking cessation program, what is the most appropriate next step in treatment?

- A) Initiate 1200 mg of calcium and repeat scan in 6 months
- B) Initiate 800 units of Vitamin D and repeat scan in 6 months
- C) Initiate 1200 mg of calcium, 800 units of Vitamin D, and repeat scan in 1 year
- D) Initiate 1200 mg of calcium, 800 units of Vitamin D, bisphosphonate therapy, discontinue phenytoin and replace with phenobarbital, and repeat scan in 1 year
- E) Initiate 1200 mg of calcium, 800 units of Vitamin D, discontinue phenytoin and replace with phenobarbital, and repeat scan in 1 year

Discussion: This patient has osteopenia and the FRAX assessment shows a ten-year probability of sustaining a hip fracture of >3%, which necessitates pharmacologic treatment and repeat scan in 1 year.

Osteoporosis is a systemic skeletal disorder that is characterized by the loss of bone tissue, disruption of bone architecture, and bone fragility, leading to an increased risk of fractures. Bone loss and low bone mass are asymptomatic until fractures occur. Osteopenia is defined as a T score of -1 to -2.5 and osteoporosis is defined by a T score of < -2.5. Risk factors for osteoporosis are found in illustration A.

Unnanuntana et al. report that due to the limitations to DEXA, the FRAX was developed. The aim of FRAX is to provide an assessment tool for the prediction of fractures in men and women with use of clinical risk factors with or without femoral neck bone mineral density. When reviewing the FRAX results, they recommend initiating treatment when there is a ten-year risk of hip fracture >3% or a ten-year risk of a major osteoporosis-related fracture >20%.

Cosman et al. review the the 2008 National Osteoporosis Foundation guidelines and report that pharmacologic treatment for osteoporosis should be considered if patients are postmenopausal women or men > 50 AND meet one of the following criteria: have a prior hip or vertebral fracture, a T score -2.5 or less at the femoral neck or spine, a T

score between -1.0 and -2.5 at the femoral neck or spine AND a 10-year risk of hip fracture greater than 3% or 10-year risk of major osteoporosis-related fracture greater than 20%. DEXA scans should be repeated every 1-2 years if patients are on pharmacologic treatment.

Illustration A is a table listing the risk factors for osteoporosis.

Reference: The assessment of fracture risk. Unnanuntana, JBJS 2010
 Clinician's Guide to Prevention and Treatment of Osteoporosis. Cosman F 2004

Lifestyle	Medications
<ul style="list-style-type: none"> • Sedentary lifestyle • Caucasian woman of northern European descent • Smokers • Low body weight • Low protein intake • Heavy drinkers • Positive family history • Premature menopause • Breast feeders with low vitamin D diets 	<ul style="list-style-type: none"> • Phenytoin (Dilantin) therapy <ul style="list-style-type: none"> • reduces vitamin D metabolism • Cytotoxic/antineoplastic drugs • Selective serotonin reuptake inhibitors (SSRIs) <ul style="list-style-type: none"> • e.g. fluoxetine, sertraline, paroxetine • Antiretroviral therapy • Cyclosporine • Furosemide • High dose methotrexate • Oversupplementation with Levothyroxine • Omeprazole • Glucocorticoids • Unfractionated heparin and LMWH • Vitamin A • Thiazolidinediones <ul style="list-style-type: none"> • rosiglitazone (Avandia)
Genetic Polymorphisms	Diseases
<ul style="list-style-type: none"> • Calcitonin receptor • Estrogen receptor-1 • Type I collagen alpha-1 chain (COL1A1) <ul style="list-style-type: none"> • osteogenesis imperfecta in adults • Vitamin D receptor • LRP5 (low-density lipoprotein receptor-related protein) 	<ul style="list-style-type: none"> • Malabsorption syndromes • Liver disease • Hyperthyroidism • Type I diabetes mellitus • Cancer • Chronic renal failure • COPD • Rheumatoid arthritis • Sarcoidosis

Pediatrics

227. Answer: D 2017/2020

The above fracture is associated with which risk factor, what common intra-operative finding, and what post-operative complication after arthroscopic reduction internal fixation?

- A) Increased intercondylar roof angle, entrapment of the anterior horn medial meniscus, and malunion
- B) Decreased intercondylar roof angle, entrapment of anterior horn lateral meniscus, and arthrofibrosis
- C) Decreased intercondylar roof angle, entrapment of anterior horn medial meniscus, malunion
- D) Increased intercondylar roof angle, entrapment of anterior horn medial meniscus and arthrofibrosis
- E) Decreased intercondylar roof angle, entrapment of anterior horn lateral meniscus, malunion
- F) Increased intercondylar roof angle, entrapment of anterior horn lateral meniscus, arthrofibrosis



Discussion: In skeletally immature patients, a decreased intercondylar roof angle was associated with an intrasubstance ACL tear, and an increased intercondylar roof angle was associated with tibial spine fractures. Records of a consecutive series of 80 skeletally immature patients who underwent arthroscopic reduction and internal fixation of type 3 tibial eminence fractures or type 2 fractures that did not reduce in extension were reviewed. Entrapment of the anterior horn of the medial meniscus (36), intermeniscal ligament (6), or anterior horn of the lateral meniscus (1) was seen in 26% (6 of 23) of type 2 fractures and 65% (37 of 57) of type 3 fractures. An associated meniscal tear was seen in 3.8% of patients (3 of 80). Meniscal entrapment is common in patients with type 2 and 3 tibial eminence fractures. Arthroscopic or open reduction should be considered for type 3 fractures and for type 2 fractures that do not reduce in extension to remove the incarcerated meniscus, allowing for anatomic reduction. Children with tibial spine fractures are at risk for arthrofibrosis. Stabilization of the fracture is important to allow early postoperative rehabilitation. Should stiffness occur, manipulation of the knee should be performed only in conjunction with lysis of adhesions.

References:

1. Samora W, Beran M, Parikh S. Intercondylar Roof Inclination Angle: Is It a Risk Factor for ACL Tears or Tibial Spine Fractures? *J Ped Ortho* 2016;36(6):71-74.
2. Kocher MS, Micheli LJ, Gerbino P, et al. Tibial eminence fractures in children: Prevalence of meniscal entrapment. *Am J Sports Med* 2003;31:404-407.
3. VanderHave K, Ganley TJ, Kocher MS, et al. Arthrofibrosis after surgical fixation of tibial eminence fractures in children and adolescents. *Am J Sports Med*, 2010 38(2): 298-301.

228. Answer: A 2017

When performing an MPFL reconstruction on a skeletally immature patient, the correct placement of the MPFL insertion is located at _____ and the femoral tunnels should be angled in what direction?

- A) Between the medial epicondyle and adductor tubercle proximal to the physis, and angled 15 degrees anteriorly and proximally
- B) Between the gastrocnemius and adductor tubercles proximal to the physis, and angled 15 degrees anteriorly and proximally
- C) Between the medial epicondyle and adductor tubercle distal to the physis, and angled 15 degrees anteriorly and distally
- D) Between the gastrocnemius and adductor tubercles distal to the physis and angled 15 degrees anteriorly and distally
- E) Between the medial epicondyle and adductor tubercle distal to the physis, and angled 15 degrees anteriorly and proximally
- F) Between the gastrocnemius and adductor tubercles distal to the physis, and angled 15 degrees anteriorly and proximally

Discussion: Cadaver studies demonstrated that the footprint of the MPFL in skeletally immature patients lies at or distal to the physis, between the medial epicondyle and adductor tubercle. In patients with growth remaining, the MPFL reconstruction should be placed distal to the physis, otherwise the insertion will move proximally as the patients distal femur grows, which may overconstrain the MPFL graft. Using computer aided design, it was determined drilling the femoral tunnels 15 degrees anteriorly and proximally was the safest way to prevent injury to the distal femoral physis.

References:

1. Shea KG, Polousky JD, Jacobs JC, et al. The relationship of the femoral physis and the medial patellofemoral ligament in children: a cadaveric study. *J Pediatr Orthop.* 2014;34(8):808-813.
2. Nguyen CV, Farrow LD, Liu RW, Gilmore A. Safe Drilling Paths in the Distal Femoral Epiphysis for Pediatric Medial Patellofemoral Ligament Reconstruction. *Am J Sports Med* 2017; 45(5):1085-1089.

229. Answer: A 2017/2020

In a systematic review of the literature, the most common growth abnormality following ACL Reconstruction in the skeletally immature patient was:

- A) Distal femoral overgrowth following a physeal-sparing technique
- B) Distal femoral arrest following a transphyseal technique
- C) Angular malformation following a transphyseal technique
- D) Angular malformation following a physeal-sparing technique

Discussion: At present, there are 21 studies reporting 39 patients with growth abnormalities in the current literature, of which 29 cases were of limb length discrepancy and 16 of angular malformation. Of the 29 cases of limb length discrepancy, limb overgrowth accounted for 62% of cases. Perhaps most interestingly, physeal-sparing techniques were performed in 25% of the cases of angular malformation and 47% cases of limb length discrepancy, despite the commonly held belief that this technique mitigates the risks of ACL reconstruction by not violating the growth plate. According to this study, it is clear that growth abnormalities after ACL reconstruction in the skeletally immature patient are underreported, and our current understanding of the etiology of these abnormalities is limited.

References:

1. Collins MJ, Arns TA, Leroux T, et al. Growth Abnormalities Following Anterior Cruciate Ligament Reconstruction in the Skeletally Immature Patient: A Systematic Review. *Arthroscopy* 2016; 32(8):1714-1723.

230. Answer: B**2017/2020**

A 27-year-old woman presents with recurrent right anterior hip pain that is worse with weight-bearing activity. She was previously asymptomatic after undergoing a right hip arthroscopy one year ago to repair a torn acetabular labrum and to address a CAM deformity. Radiographs reveal a lateral center edge angle of 15 degrees and no joint space narrowing. MRI shows a recurrent labral tear and a normal femoral head-neck morphology. What is the most likely reason for her recurrent symptoms and labral tear?

- A) Residual CAM Deformity
- B) Acetabular Dysplasia
- C) Osteoarthritis
- D) Pincer Femoroacetabular Impingement
- E) Insufficient Rehabilitation After Surgery

Discussion: Acetabular dysplasia is a risk factor for failure after hip arthroscopy. Ross et al described patients who failed hip arthroscopy had an average lateral center edge angle of 14.7 degrees, a Tonnis angle of 16.3 degrees, and an anterior center edge angle of 16.8 degrees. Although residual CAM deformity is a common reason for residual pain in patients after hip arthroscopy, this scenario stated that the femoral head-neck junction had normal morphology. No signs of arthritis were seen on imaging. A hip with a lateral center edge angle less than 25 degrees is considered dysplastic, making pincer impingement due to acetabular overcoverage less likely. Finally, because the patient had a period of time without pain after recovering from hip arthroscopy, insufficient postoperative rehabilitation is less likely the cause of her current symptoms.

References: Ross JR, Clohisy JC, Baca G, Sink E; ANCHOR Investigators. Patient and disease characteristics associated with hip arthroscopy failure in acetabular dysplasia. *J Arthroplasty*. 2014 Sep;29(9 Suppl):160-3. Parvizi J, Bican O, Bender B, Mortazavi SM, Purtill JJ, Erickson J, Peters C. Arthroscopy for labral tears in patients with developmental dysplasia of the hip: a cautionary note. *J Arthroplasty*. 2009 Sep;24(6 Suppl):110-3.

231. Answer: D**2017/2020**

A 25-year-old man presents with left anterior hip pain that is worse with prolonged sitting, putting on his shoes, and getting in and out of the car. He can no longer play any sports and has pain that interferes with his daily activities and work. Physical exam reveals that when the hip is flexed to 90 degrees, internal rotation is restricted to minus 5 degrees. Radiographs show global acetabular retroversion with a positive cross-over sign, a positive posterior wall sign, and a positive ischial spine sign. There is no joint space narrowing. What are possible treatment options to discuss with the patient?

- A) Total Hip Arthroplasty
- B) Hip Arthroscopy for Acetabular Rim-trimming
- C) Anteverting Periacetabular Osteotomy
- D) B and C
- E) All of the above

Discussion: The patient has symptomatic acetabular retroversion causing pincer femoroacetabular impingement. Cranial acetabular retroversion has shown to be amenable to arthroscopic acetabular rim-trimming. Recent studies have shown that more severe, globally retroverted acetabula are volumetrically smaller than normal acetabula, suggesting that acetabular rim-trimming may deleteriously decrease the surface area of lunate articular cartilage and that anteverting periacetabular osteotomy may be a preferable alternative treatment to re-orient the acetabulum without decreasing cartilage surface area. Anteverting periacetabular osteotomy for acetabular retroversion has been shown to provide greater hip survivorship at 10 year followup when compared to retroverted acetabula that underwent acetabular rim-trimming through a surgical dislocation approach. The patient has no signs of osteoarthritis, so total hip replacement would be inappropriate.

References: Steppacher SD, Lerch TD, Gharanizadeh K, Liechti EF, Werlen SF, Puls M, Tannast M, Siebenrock KA. Size and shape of the lunate surface in different types of pincer impingement: theoretical implications for surgical therapy. *Osteoarthritis Cartilage*. 2014 Jul;22(7):951-8. Siebenrock KA, Schaller C, Tannast M, Keel M, Büchler L. Anteverting periacetabular osteotomy for symptomatic acetabular retroversion: results at ten years. *J Bone Joint Surg Am*. 2014 Nov 5;96(21):1785-92. Zurmühle CA, Anwander H, Albers CE, Hanke MS, Steppacher SD, Siebenrock KA, Tannast M. Periacetabular Osteotomy Provides Higher Survivorship Than Rim Trimming for Acetabular Retroversion. *Clin Orthop Relat Res*. 2017 Apr;475(4):1138-1150.

232. Answer: C **2017/2020**

A 14-year-old soccer player complains of bilateral hip pain. The pain is worse with activity and she notices that she has fatigue and pain that extends to the thighs and knees following a soccer match. She is nontender at the pubis symphysis and has no pain with resisted abdominal crunches. She has no pain with adduction of the hip. Hip flexion and rotation is normal. A radiograph of the right hip is demonstrates bilateral hip dysplasia. Which of the following surgical interventions is best indicated?

- A) Single innominate osteotomy (Salter)
- B) Double innominate osteotomy
- C) Peri acetabular osteotomy (Ganz)
- D) Triple innominate osteotomy (Steele)
- E) Dega osteotomy

Discussion: The clinical presentation is consistent with DDH in a patient with a closed triradiate cartilage. A peri-acetabular osteotomy (Ganz) is the most appropriate treatment.

The peri-acetabular osteotomy (Ganz) is a reconstructive osteotomy for DDH patients with a closed triradiate cartilage. It allows for a large degree of three-dimensional correction because the cuts are close to the acetabulum, it preserves the abductor muscles and allows for inspection of the joint.

Karami et al. performed a Level 4 study of 20 patients with an average 12 years of follow-up that underwent a Chiari osteotomy. They found that the Sharp angle, center-edge angle and coverage of the femoral head all improved with the osteotomy but noted that there was a 25% rate of graft resorption.

Gillingham et al., in a level 5 study, emphasizes the timeline of osteotomy indications for DDH patients. A single innominate osteotomy (Salter) or Pemberton procedure is generally appropriate for a child between the ages of 2 and 10. A triple innominate osteotomy (Steel) is applicable for the older child or adolescent where the triradiate cartilage remains open. After triradiate is closed the Ganz periacetabular osteotomy is an option for DDH reconstruction.

References: The results of Chiari pelvic osteotomy in adolescents with a brief literature review.

Karami M, Fitoussi F, Ilharborde B, Penneçot GF, Mazda K, Bensahel H. *J Child Orthop*. 2008 Feb;2(1):63-8. Epub 2008 Jan 3. PMID: 19308604

Pelvic osteotomies for the treatment of hip dysplasia in children and young adults.

Gillingham BL, Sanchez AA, Wenger DR

J Am Acad Orthop Surg. 1999 Sep-Oct;7(5):325-37. PMID: 10504359

233. Answer: D 2017/2020

Which of the following concepts regarding pediatric hips is true?

- A) The proximal femoral physis and greater trochanteric apophysis develop from different cartilaginous physes
- B) The proximal femoral physis grows at a rate of 9 mm per year
- C) Normal infant femoral anteversion is between 10-20 degrees
- D) The ossific nucleus of the proximal femur is visible on radiographs by 6 months of age in most children
- E) Slipped capital femoral epiphysis (SCFE) typically occurs through the zone of proliferation

Discussion: The ossific nucleus of the proximal femur is visible on radiographs by 6 months of age in most children. The proximal femoral physis and greater trochanteric apophysis develop from the same cartilage physis in the infant which undergoes apoptotic division in the child. The distal femoral physis (not proximal) grows at a rate of 9 mm per year. The normal infant femoral anteversion is between 30-40 degrees. SCFE typically occurs through the zone of hypertrophy, not the zone of proliferation.

Vitale and Skaggs review the history, diagnosis, treatment, and outcome of developmental dysplasia of the hip. Wientroub and Gill review the use of ultrasonography in the diagnosis and prognosis of developmental dysplasia of the hip. They recommend detection with ultrasound because of the delayed femoral head ossification (~5 months) and discuss the cost ineffectiveness of routine screening of all newborns.

References: Developmental dysplasia of the hip from six months to four years of age.

Vitale MG, Skaggs DL

J Am Acad Orthop Surg. 9(6):401-11. PMID: 11730331

Ultrasonography in developmental dysplasia of the hip.

Wientroub S, Grill F.

J Bone Joint Surg Am. 2000 Jul;82-A(7):1004-18. PMID: 10901315

234. Answer: B 2017

Figure 1 is the radiograph of a 22-month-old boy who has infantile idiopathic scoliosis. What is the preferred initial treatment to minimize curve progression?

- A) Observation
- B) Serial casting
- C) Rib to spine growing rods
- D) Spine to spine growing rods
- E) Posterior spinal fusion with instrumentation



Discussion: Infantile idiopathic scoliosis includes scoliosis seen in patients from 0 to 3 years of age without other structural or congenital causes. Many patients with infantile idiopathic scoliosis with less than a 20-degree rib vertebral angle difference (RVAD) and phase 1 ribs will have resolution of their curvature with no treatment. However, in this child the RVAD is clearly greater than 20 degrees at the apex with significant overlap of the rib head over the vertebral body at the apex (phase 2 ribs). Thus the best initial treatment for this child is serial body casting with de-rotational molding (i.e. Cotrel-Mehta casting). Serial casting is most effective on children less than 2 years of age, and effectiveness falls off as a child gets older. Even if the casting does not completely resolve the scoliosis, it can often be used to delay future surgery.

Growing rod instrumentation would be indicated in a child less than 10 years of age who fails treatment with serial body casting. Posterior spinal fusion would be indicated after 10 years of age in a child who has progressive deformity or has graduated from growing rod treatment.

References: Sanders JO, D'Astous J, Fitzgerald M, Khoury JG, Kishan S, Sturm PF. Derotational casting for progressive infantile scoliosis. *J Pediatr Orthop.* 2009 Sep;29(6):581-7. doi: 10.1097/BPO.0b013e3181b2f8df. PubMed PMID: 19700987.

Tis JE, Karlin LI, Akbarnia BA, Blakemore LC, Thompson GH, McCarthy RE, Tello CA, Mendelow MJ, Southern EP; Growing Spine Committee of the Scoliosis Research Society. Early onset scoliosis: modern treatment and results. *J Pediatr Orthop.* 2012 Oct-Nov;32(7):647-57. Review. PubMed PMID: 22955526.

Waldron SR, Poe-Kochert C, Son-Hing JP, Thompson GH. Early onset scoliosis: the value of serial risser casts. *J Pediatr Orthop.* 2013 Dec;33(8):775-80. doi: 10.1097/BPO.000000000000072. PubMed PMID: 23965912.

235. Answer: C

The approximate increase in risk of complications with each surgical procedure for spinal growing rod lengthening is:

- A) 5%
- B) 10%
- C) 25%
- D) 50%
- E) 90%

Discussion: Bess et al. show that growing rods carry a significant risk of complications with each lengthening, even though the actual surgical procedure itself is relatively minor. Complications are quite common and should be expected and patients should be counseled regarding this risk. Their reported increase in risk of complications with each surgical procedure was 24%, with a total of 58% of all patients receiving at least one complication. Complications include skin dehiscence, implant failure, anchor failure, superficial and/or deep infection. Submuscular implantation of growing rods has a lower risk of complications overall than subcuticular implantation.

References: Bess S, Akbarnia BA, Thompson GH, Sponseller PD, Shah SA, El Sebaie H, Boachie-Adjei O, Karlin LI, Canale S, Poe-Kochert C, Skaggs DL. Complications of growing-rod treatment for early-onset scoliosis: analysis of one hundred and forty patients. *J Bone Joint Surg Am.* 2010 Nov 3;92(15):2533-43.

236. Answer E

A Ponte osteotomy of T6-T7 involves the excision of which anatomic structures?

- A) Ligamentum flavum, inferior articular process of T6
- B) Ligamentum flavum, superior articular process of T6, inferior articular process of T7
- C) Ligamentum flavum, superior articular process of T7, inferior articular process of T6
- D) Ligamentum flavum, superior articular process of T6, inferior articular process of T7, transverse processes of T6 and T7
- E) Ligamentum flavum, superior articular process of T7, inferior articular process of T6, transverse processes of T6 and T7

Discussion: The Ponte osteotomy is a very powerful procedure that is used in the correction of many different types of spinal deformity. The procedure was initially described to increase spinal flexibility in correcting Scheuermann's kyphosis, but this has been adapted to increase spinal flexibility in other diagnoses, including adolescent idiopathic scoliosis, early onset scoliosis, congenital scoliosis, and others.

The osteotomy involves the excision of all midline tissues posterior to the thecal sac and epidural fat. The ligamentum flavum, the inferior articular process of the level above, and the superior articular process of the level below are all excised to increase spinal flexibility, utilizing the disk as the hinge anteriorly. Excision of the transverse processes are not involved in a Ponte osteotomy, although they are often removed or debulked to increase bony surface area for fusion and increase area for pedicle screws to be placed.

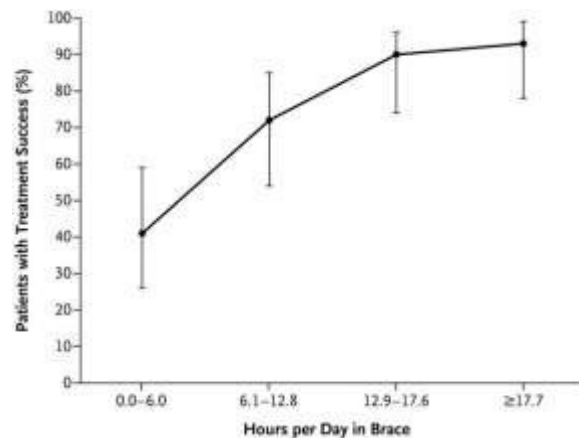
References: Geck MJ, Macagno A, Ponte A, Shufflebarger HL. The Ponte procedure: posterior only treatment of Scheuermann's kyphosis using segmental posterior shortening and pedicle screw instrumentation. *J Spinal Disord Tech.* 2007 Dec;20(8):586-93. PubMed PMID: 18046172.

Ponte A. Posterior column shortening for Scheuermann's kyphosis. In: *Hafer TR, Merola AA, eds. Surgical Techniques for the Spine.* 1st ed. New York: Thieme Verlag; 2003:107–113.

237. Answer: B

The use of a thoracolumbar orthosis for treatment of adolescent idiopathic scoliosis has been shown to significantly decrease the rate of progression of the curvature. The threshold for achieving a 90% success rate of treatment was shown to be approximately:

- A) 6 hours
- B) 12 hours
- C) 18 hours
- D) 20 hours
- E) 24 hours



Discussion: The recent BRAIST study showed that thoracolumbar orthosis treatment for adolescent idiopathic scoliosis was quite effective in preventing patients from reaching a surgical threshold of 50 degrees, with a reported treatment success rate of 72% for bracing versus 48% for observation alone. Temperature monitors in the TLSO braces were used to determine compliance and hours worn. Patients who wore the brace 12.9 hours or more had over a 90% rate of treatment success. As patients wore the brace longer than this, the rate of treatment success improved up to 93% at greater than 17.7 hours of wear, indicating diminishing returns for brace wear beyond 12.9 hours daily.

References: Weinstein SL, Dolan LA, Wright JG, Dobbs MB. Effects of bracing in adolescents with idiopathic scoliosis. *N Engl J Med.* 2013 Oct 17;369(16):1512-21

238. Answer: D 2017/2020

Which of the following is not a pediatric manifestation of a proximal femoral cam deformity?

- A) SCFE
- B) Legg-Calve-Perthes
- C) Multiple epiphyseal dysplasia
- D) Coxa Valga
- E) Coxa Vara
- F) Repetitive microtrauma to the lateral physis of the proximal femur

Discussion: Slipped capital femoral epiphysis results in a posteriorly displaced femoral head and a femoral shaft that moves anteriorly creating a cam deformity. Legg-Calve-Perthes and multiple epiphyseal dysplasia both result in femoral head deformity and shortening of the femoral head-neck junction. Coxa vara results in a shortened head-neck offset causing a cam deformity. Repetitive microtrauma to the lateral physis is believed to be cause the formation of a cam deformity in an athletic population. Coxa valga generally does not result in cam impingement.

References: Siebenrock KA, Wahab KH, Werlen S, Kalhor M, Leunig M, Ganz R. Abnormal extension of the femoral head epiphysis as a cause of cam impingement. *Clin Orthop Relat Res.* 2004 Jan;(418):54-60.

Ganz R, Parvizi J, Beck M, Leunig M, Nötzli H, Siebenrock KA. Femoroacetabular impingement: a cause for osteoarthritis of the hip *Clin Orthop Relat Res.* 2003 Dec;(417):112-20.

239. Answer: B 2017/2020

When does the proximal femoral physis typically close in males and females?

- A) Around age 10 in males and age 12 in females
- B) Around age 16 in males and age 14 in females
- C) Around age 8 in both males and females
- D) Around age 18 in both males and females

Discussion: Males typically fuse later than females. The timing of this closure and remaining growth left may influence the resection of the femoral head-neck junction.

Reference: Dvonch VM, Bunch WH Pattern of closure of the proximal femoral and tibial epiphyses in man. J Pediatr Orthop. 1983 Sep;3(4):498-501.

240. Answer: B 2020

Treatment of a young athletic patient with a labral tear and concomitant combined femoroacetabular impingement is best done by:

- A) Open surgical dislocation approach with resection of the labrum
- B) Arthroscopic treatment of the femoroacetabular impingement with repair of the labrum
- C) Peri-acetabular osteotomy

Discussion: While there is no established superior surgical approach to address FAI, multiple studies have demonstrated superiority of labral repair compared to labral debridement.

References: Espinosa N, Beck M, Rothenfluh DA, Ganz R, Leunig M. J Treatment of femoro-acetabular impingement: preliminary results of labral refixation. Surgical technique. Bone Joint Surg Am. 2007 Mar;89 Suppl 2 Pt.1:36-53.

Philippon MJ, Briggs KK, Yen YM, Kuppersmith DA. Outcomes following hip arthroscopy for femoroacetabular impingement with associated chondrolabral dysfunction: minimum two-year follow-up. J Bone Joint Surg Br. 2009 Jan;91(1):16-23.

241. Answer: B 2017/2020

What is the prevalence of radiographic femoroacetabular impingement in asymptomatic adolescents compared with an adult population?

- A) Similar in incidence to adults regardless of physeal status
- B) Similar in incidence to adults as the physis closes
- C) Significantly higher than adults
- D) Non-existent

Discussion: Multiple studies based upon CT scans of asymptomatic adolescents have demonstrated an incidence of radiographic FAI similar to adults as the physis nears closing.

References: Bixby SD, Kienle KP, Nasreddine A, Zurakowski D, Kim YJ, Yen YM. Reference values for proximal femoral anatomy in adolescents based on sex, physis, and imaging plane. Am J Sports Med. 2013 Sep;41(9):2074-82.

Carsen S, Moroz PJ, Rakhra K, Ward LM, Dunlap H, Hay JA, Willis RB, Beaulé PE. The Otto Aufranc Award. On the etiology of the cam deformity: a cross-sectional pediatric MRI study. Clin Orthop Relat Res. 2014 Feb;472(2):430-6

Monazzam S, Bomar JD, Dwek JR, Hosalkar HS, Pennock AT. Development and prevalence of femoroacetabular impingement-associated morphology in a paediatric and adolescent population: a CT study of 225 patients. Bone Joint J. 2013 May;95-B(5):598-604

242. Answer: D

When x-rays suggest a diagnosis of osteochondroma, the next study most appropriate to clarify the diagnosis is:

- A) Ultrasound
- B) MRI
- C) CAT Scan
- D) Additional x-rays including a tangential view
- E) Bone Scan

Discussion: Plain x-rays taken with the appropriate orientation will almost always show the pathognomonic findings of osteochondroma without the need for more costly studies.

Reference: OKU Musculoskeletal Tumors 2 p.104

243. Answer: B 2020

The short leg gait pattern is characterized by all of the following factors EXCEPT:

- A. Stance time reduced on the short side
- B. Increased pelvic rotation on the short side
- C. Stride length reduced on the short side
- D. Cadence (steps/minute) increased
- E. Walking velocity marginally reduced

Discussion: Due to the difference in limb lengths, an individual will spend less time with a shorter stride length, increased cadence, and a slight decrease in velocity on the short side. Pelvic rotation is not significantly affected by a limb length inequality.

Reference: Principles of Deformity Correction. Dror Paley. Springer. 2005.

244. Answer: A 2020

Patients with limb length discrepancy use all of these compensatory mechanisms EXCEPT:

- A. Hip flexion on the long side
- B. Equinus of the ankle on the short side
- C. Pelvic tilt with lowering of the pelvis on the short side
- D. Knee flexion on the long side
- E. Reduced stride length on the short side

Discussion: In order to compensate for a short lower limb, the patient will tilt his/her pelvis forward and plantarflex the ankle on the short side to gain more length. It follows that the short limb will have a decreased stride length compared to the contralateral side. To balance both sides, the individual tends to flex their knee rather than their hip on the long side.

Reference: Principles of Deformity Correction. Dror Paley. Springer. 2005.

245. Answer: C

When x-rays suggest a diagnosis of osteoid osteoma, the next study most appropriate to clarify the diagnosis is:

- A) Ultrasound
- B) MRI
- C) CAT Scan
- D) Bone Scan
- E) Incision Biopsy

Discussion: CAT Scan provides best imaging for the “nidus.” Ultrasound is unhelpful. MRI and bone scan findings are non-specific and are often “over-read” as suggesting a more serious lesion.

Reference: OKU Musculoskeletal Tumors 2 p. 94

246. Answer: B

Fibrous cortical defect and non-ossifying fibroma:

- A) Often are present with a pathologic fracture
- B) Often are “incidental findings” on x-rays taken after trauma
- C) Have persistent pain and tenderness
- D) Have a significant risk of malignant transformation
- E) Tend to persist long after skeletal maturity

Discussion: These conditions are most often identified as “incidental findings.” They seldom present with a fracture, are rarely painful, have minimal risk of malignant transformation, and often regress in late adolescence.

Reference: OKU Musculoskeletal Tumors 2 p. 121

247. Answer: C

The Precise2 nail can lengthen to a maximum of:

- A) 10 cm
- B) 6 cm
- C) 8 cm
- D) 9 cm
- E) 12 cm

Discussion: Limb lengthening places significant stress on the surrounding soft tissue envelope (muscle/tendons, nerves, vessels) as well as the proximal and distal joints. In order to avoid complications such as neuropraxia and joint contractures or dislocations, it is recommended that gradual lengthening not exceed 8cm in any limb segment. The Precise2 nail settings do not allow lengthening greater than 8cm.

Reference: Principles of Deformity Correction. Dror Paley. Springer. 2005.

248. Answer: E

All of these factors characterize the Precise2 nail EXCEPT:

- A) It is currently the only FDA-approved lengthening device on the market
- B) It has a reverse mechanism
- C) It uses an internal magnet to lengthen
- D) It can be inserted either antegrade or retrograde into the femur
- E) It is designed to lengthen only once a day

Discussion: The Precise2 nail is the only FDA-approved lengthening device on the market. Internal settings are activated and allow the nail to lengthen using an external magnet applied over a skin marking. If there is a lack of regenerate bone in the gap, the device settings can be temporarily changed or reversed to allow compression across the gap to stimulate and regenerate bone formation. The technique allows for insertion into the femur in either an antegrade or retrograde manner depending on the circumstance and also offers options in terms of nail length. The technique follows previously published Ilizarov bone lengthening principles of 1mm lengthening/day divided in three separate sessions or 0.33mm three times per day. The daily frequency and amount of lengthening can be adjusted as necessary.

Reference: Principles of Deformity Correction. Dror Paley. Springer. 2005.

249. Answer: D

All of these are potential complications of lengthening EXCEPT:

- A) Premature consolidation of osteotomy
- B) Hip or knee dislocation
- C) Loosening of interlocking screw
- D) Decreased soft tissue tension
- E) Delayed regenerate bone formation

Discussion: Complications are not all that uncommon especially with large amounts of limb length discrepancy correction. If the frequency of the lengthening is not sufficient, the external magnet is not properly applied or the initial osteotomy is incomplete, and premature consolidation of the regenerate can occur. If pre-operative work-up has not identified an unstable or mal-aligned joint, or if the lengthening proceeds too aggressively without proper therapy or splinting as necessary, joint subluxation or dislocation can occur due to the increased soft tissue tension in the limb. Due to the fact that only the distal aspect of the interlocking screw is threaded and the shank is smooth, screw back-out has been reported. Placement of a fully threaded titanium screw can help avoid screw back-out. If the osteotomy is performed in diaphyseal bone, or the lengthening proceeds too quickly, delay in regenerate bone formation in the gap may occur requiring either an increase in weight-bearing especially indoors, temporary reversal of the lengthening and/or placement of either synthetic or autogenous graft material in the regenerate gap.

Reference: Principles of Deformity Correction. Dror Paley. Springer. 2005.

250. Answer: C

How do physicians determine the realistic functional goals of interdisciplinary management?

- A) Routine physical therapy evaluation
- B) Patient examination without review of previous examinations
- C) Complete interdisciplinary evaluation with team meeting to establish functional status based on established criteria
- D) Ignore fluctuation in neurologic pathology
- E) Do not allow patients to participate in community activities

References: Principles of Orthopaedic Practice, copyright 1997, McGraw-Hill, Chapter 34: Orthopaedic Management in Myelomeningocele.

Mercado, E. et al Does Spinal Fusion influence quality of life in neuromuscular scoliosis? Spine2007; 32(19, Suppl): S 120-S125

251. Answer: E

What are the significant physical impairments leading to the inability to maintain ambulatory status?

- A) Define objective criteria for ambulation
- B) Define muscle requirements for ambulation
- C) Define range of motion requirements for ambulation
- D) Evaluate physical impairments
- E) All of the above

References: Principles of Orthopaedic Practice, copyright 1997, McGraw-Hill, Chapter 34: Orthopaedic Management in Myelomeningocele. Mercado, E. et al Does Spinal Fusion influence quality of life in neuromuscular scoliosis? Spine2007; 32(19, Suppl):S 120-S125

252. Answer: B

What are the significant physical impairments leading to the inability to maintain independent sitting activities?

- A) Ignore physical impairments for wheelchair patients
- B) Define criteria needed for independent wheelchair activities
- C) Lumbar kyphosis and pelvic obliquity do not interfere with wheelchair activities
- D) Hip contractures do not matter in wheelchair patients
- E) Spinal orthotic management not necessary

References: Principles of Orthopaedic Practice, copyright 1997, McGraw-Hill, Chapter 34: Orthopaedic Management in Myelomeningocele.

Mercado, E. et al Does Spinal Fusion influence quality of life in neuromuscular scoliosis? Spine2007; 32(19, Suppl): S 120-S125

253. Answer: E

What are the orthotic requirements to prevent deformity and loss of functional skills?

- A) Orthotic management coincidental with initiation of ambulatory skills
- B) Foot surgery only to facilitate orthotic management
- C) Ankle orthotic management needs rigid hindfoot control in neutral
- D) Orthotic management must maintain hip and knee extension for weight-bearing
- E) All of the above

References: Principles of Orthopaedic Practice, copyright 1997, McGraw-Hill, Chapter 34: Orthopaedic Management in Myelomeningocele.

Mercado, E. et al Does Spinal Fusion influence quality of life in neuromuscular scoliosis? Spine2007; 32(19, Suppl): S 120-S125

Spine

254. Answer: C

Figure A demonstrates the molecular structure of a cell membrane protein important in propagating the action potential of a neuron. Which of the following medications acts by binding to the location marked with an X in the illustration?

- A. Phentolamine
- B. Rocuronium
- C. Bupivacaine
- D. Midazolam
- E. Fentanyl



Discussion: Bupivacaine exerts its actions through blockade of the voltage gated sodium channel.

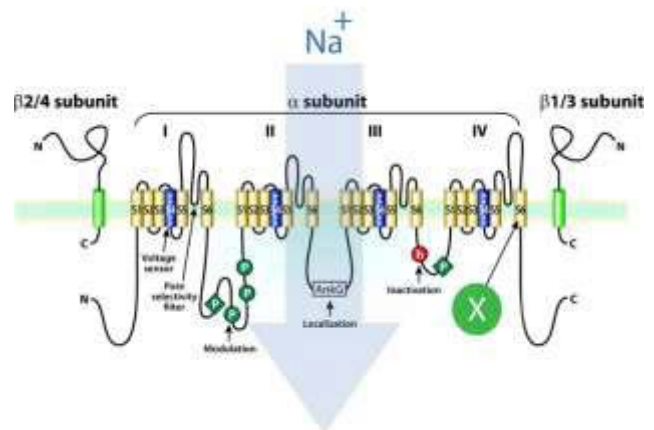
Local anesthetics of the amide family (lidocaine, bupivacaine) bind to the intracellular portion of voltage-gated sodium channels to block sodium influx. This prevents depolarization and the initiation or conduction pain. Lidocaine and bupivacaine have a duration of action of 2 and 4 hours, respectively (4 and 8 hours with epinephrine), and maximum doses are 4.5mg/kg and 2.5mg/kg, respectively (7mg/kg and 3mg/kg with epinephrine respectively). Both are metabolized in the liver, and excreted by the kidneys.

Phillips et al. review specific analgesics. Agents used to manage chronic pain include tricyclic antidepressants, anticonvulsants, GABA agonists, local anesthetic analogs, and NMDA antagonists. Opiates may trigger tolerance and lack of efficacy may develop. In those with refractory chronic pain, centrally administered analgesics may be considered, including opiates, dilute local anesthetic, NMDA receptor antagonists, clonidine, midazolam, baclofen, or calcium channel blockers. Single agents may be less effective than analgesic combinations.

Scholz discussed the function of local anesthetics and sodium channels. There are 3 states to sodium channels:

- (1) The closed state at potentials below -70mV. In this state, Na⁺ ions cannot pass from 1 side to another.
- (2) The open state, initiated by depolarization of the membrane to above -40mV. The channel opens to allow Na⁺ ions to diffuse through the pore, causing an inward current, depolarizing the membrane further.
- (3) The inactivated state follows activation during prolonged depolarization. In this state, inactivation is seen in macroscopic currents.

Figure A shows the voltage gated sodium channel. Local anesthetics such as lidocaine and bupivacaine act at the binding site marked "X".



Reference: Analgesic pharmacology: II. Specific analgesics. Phillips, JAAOS 2004

Mechanisms of (local) anaesthetics on voltage-gated sodium and other ion channels. Scholz A. 2002

255. Answer: A 2017

For a patient with concomitant hip and spinal pathology, which of the following is not true:

- A) surgery is never recommended because it will not help
- B) this found in up to a third of spine patients
- C) they will do worse after hip replacement than average
- D) more complications may occur if surgery is performed on the hip.
- E) surgical planning should include consideration of both sites

Discussion: Patients after THR overlapped with spine patients in 18-33% of patients. Complication rates were more common in patients who had both conditions.

References: Blizzard, DJ, et al. The Impact of Lumbar spine disease and deformity on THA outcomes. Ortho Clin of NA. 47:19-28. 2016.

Prather, H et al, Impact of Coexistent lumbar spine disorders on clinical outcomes and physician charges associated with total hip arthroplasty. The Spine Journal 12: 363-369. 2012

256. Answer: B 2017

In patients with adult scoliosis, the most reliable radiographic predictor of poor functional outcome is:

- A) Coronal imbalance
- B) Sagittal imbalance
- C) Curve location (thoracic, thoracolumbar, lumbar)
- D) Apical rotation
- E) Rotatory subluxation

Discussion: Positive sagittal balance was the most reliable predictor of clinical symptoms in both operative and non-operative patient groups. Thoracolumbar and lumbar curves generated less favorable scores than thoracic curves in both patient groups. Significant coronal imbalance of greater than 4 cm was associated with deterioration in pain and function scores for unoperated patients but not in patients with previous surgery.

Reference: Glassman SD, Berven S, Bridwell K, Horton W, Dimar JR. Correlation of radiographic parameters and clinical symptoms in adult scoliosis. Spine (Phila Pa 1976). 2005; 30(6): 682-688.

257. Answer: E 2017

In adult patients with spinal deformity, posterior pelvic rotation (retroversion) can help to compensate for sagittal imbalance while secondary coronal curves may help compensate for coronal imbalance. Following successful surgical realignment, the greatest improvement in functional outcome was observed:

- A) In those with pre-operative uncompensated coronal imbalance
- B) In those with pre-operative compensated coronal imbalance
- C) In those with pre-operative uncompensated sagittal imbalance
- D) In those with pre-operative compensated sagittal imbalance
- E) Equally in those with pre-operative uncompensated and compensated sagittal imbalance

Discussion: A study of 125 patients with flatback deformity compared surgical outcomes in 27 patients with compensated flatback (pelvic incidence-lumbar lordosis mismatch [PI-LL] > 10° and increased sagittal vertical axis [SVA] < 5 cm) and 98 patients with decompensated flatback (SVA > 5 cm). Surgical correction of flatback deformity demonstrated similar functional outcome score improvements for patients in both groups at one-year postoperatively. The authors conclude that evaluation of flatback deformity should extend beyond measuring SVA. Among patients with concordant pain and disability, PI-LL mismatch must be evaluated for flatback deformity patients and can be considered a primary indication for surgery.

References: Smith JS, Singh M, Klineberg E, Shaffrey CI, Lafage V, Schwab FJ, Protosaltis T, Ibrahim D, Scheer JK, Mundis G Jr, Gupta MC, Hostin R, Deviren V, Kebaish K, Hart R, Burton DC, Bess S, Ames CP; International Spine Study Group. Surgical treatment of pathological loss of lumbar lordosis (flatback) in patients with normal sagittal vertical axis achieves similar clinical improvement as surgical treatment of elevated sagittal vertical axis: clinical article. *J Neurosurg Spine*. 2014;21(2):160-70.

258. Answer: C 2017

That region of the spine most commonly injured in trauma is:

- A) Cervical spine
- B) Cervicothoracic junction
- C) Thoracolumbar junction
- D) Mid-lumbar spine
- E) Lumbosacral junction

Discussion: The thoracolumbar junction from T10-L2 is that most commonly injured in traumatic situations as it represents, biomechanically, the transition from the rigid thoracic spine with its rib cage and the more flexible lumbar spine below.

References: Phan, et al, *Skeletal Trauma: Basic Science, Management, and Reconstruction*. Browner, et al eds. pg 920-935

259. Answer: B 2017

Biomechanically, that component of the functional spine unit most responsible for stability following trauma is:

- A) The intervertebral disc complex
- B) The posterior osteoligamentous complex
- C) The supporting musculature bundles posteriorly
- D) The anterior aspect of the vertebral body
- E) The laminae

Discussion: Denis, in 1984, described his theory of spinal stability following trauma by creating three columns, two of which, if injured, would render the segment unstable. The most important was the "middle" column represented by the back half of the vertebral body. James, in subsequent in-vitro biomechanics segments, sequentially sectioned components of the functional spine unit and discovered that it was, in fact, the posterior ligaments that, when injured, created the least stable condition of all. Those caring for and classifying spine fractures today, have returned to a two column approach popularized by Holdsworth in the early 1960s

References: Denis *Spine* 1983 (8): 817-31. James *Spine* 1994 Aug 1; 19(15): 1731-40. Holdsworth, *JBS-Br* 1963; (45): 6-20

260. Answer: A 2017

All the reasons listed below are valid for considering surgery for someone with a neurologically intact, mechanically stable burst fracture of the thoracolumbar spine except:

- A) Loss of more than 50% vertebral body height
- B) A progressive neurological deficit
- C) Disruption of the ligamentum flavum.
- D) Concomitant injuries, fractures, to extremities
- E) Pain unresponsive to early bracing

Discussion: Although originally considered an indication for operative treatment, simple loss of anterior vertebral body height has not been shown to be associated with either early or late sequelae, and does not influence ultimate outcomes.

Reference: Wood, et al *JBS* 2003 May; 85(5) 773-81 Weinstein, et al. Thomas, et al *J Neurosurg Spine* 2006 May; 4(5): 351-8

261. Answer: D 2017

When counseling a patient with a neurologically intact, mechanically stable thoracolumbar burst fracture as to expected post treatment outcomes, that most likely to be true is:

- A) Equivalent outcomes early, but better results late with surgery
- B) Better early results with non-operative care, but similar outcomes late.
- C) Better early results with surgery, but equivalent results late.
- D) Similar early results, but better late results with non-operative care.
- E) Similar results for both early and late outcomes.

Discussion: Wood, et al, showed that at 4-5 years post surgery, there was no real advantage to surgery compared with non-operative care, the functional outcomes being similar. Gnanthiran, et al found similar equivalence at the 4 year level in their meta-analysis.

By 20 years, however, Wood, et al, showed that those treated non-operatively were, in fact, functioning much better.

References: Wood, et al JBJS 2003; May 85(5) 773-81

Wood, et al, JBJS 2015 Jan 7 97(1) 295

Gnanenthiran, et al, CORR 2012 Feb; 470 (2): 567-77

262. Answer: E 2017

Other than surgery or wearing a brace, validated options would also include:

- A) Prolo therapy
- B) Early physical therapy
- C) Anti-inflammatory medications
- D) Bed Rest
- E) Education and activity modification

Discussion: In two recent randomized reports, Bailey and colleagues at the University of British Columbia reported that patients with neurologically intact, mechanically stable thoracolumbar burst fractures, at one year, reported similar outcomes whether they wore a brace, or simply modified their activities until the pain resolved.

References: Bailey, et al J Neurosurg Spine 2009 Sep; 11(3): 295-303

Bailey, et al Spine J 2014 Nov 1; 14(11): 2557-64

263. Answer: B

When compared to open surgery, minimally invasive surgery has the following effect on the spinal muscles:

- A) Greater rate of muscular atrophy after surgery
- B) Lesser rate of muscular atrophy after surgery
- C) Equal rate of muscular atrophy after surgery

Discussion: Animal and human studies have looked at muscle injury in open and minimally invasive surgery. MRI studies have evaluated the muscles and the results have shown that there is less muscle atrophy in minimally invasive spine surgeries. In particular, the multifidus muscle is affected the most. There have also been further studies that show that muscle strength may be better with the preserved muscle and this may be a reason why patients who undergo minimally invasive surgery recover faster.

Reference: Fan S, Hu Z, Zhao F, et al. Multifidus muscle changes and clinical effects of one-level posterior lumbar interbody fusion: minimally invasive procedure versus conventional open approach. Eur Spine J. 2010 Feb;19(2):316-24

264. Answer: C

The primary concern of lateral interbody fusions at this time are:

- A) Greater rate of blood loss
- B) Greater post-operative times
- C) Post-operative neurologic palsy
- D) Vascular injury

Discussion: Lateral interbody fusion is a transposas procedure where the psoas muscle is split and a tubular retractor is placed to create a working window. This tends to result in less blood loss and shorted operative time compared to an anterior lumbar inter body fusion. Also, there is less risk to the vena cava and aorta. However, the biggest risk is the potential for a post-operative femoral nerve palsy and this has been noted even in cases where the neuromonitoring remains normal.

Reference: Rodgers WB, Gerber EJ, Patterson JR. Intraoperative and early postoperative complications in extreme lateral interbody fusion (XLIF): An analysis of 600 cases. Spine (Phila Pa 1976). 2011 Jan 1;36(1):26-32.

265. Answer: B

When using lateral interbody fusion to correct degenerative scoliosis, which of the following is least likely to be corrected?

- A) Cobb angle
- B) Sagittal imbalance
- C) Foraminal stenosis
- D) Rotatory subluxation

Discussion: The biggest benefit of the lateral inter body fusion is that it is able to correct coronal deformity (Cobb angle) and increase foraminal height. It is also able to correct rotatory subluxations. However, it has been increasingly noted that it cannot correct sagittal imbalance and a pedicle subtraction osteotomy or Smith-Peterson osteotomy is necessary to correct sagittal imbalance.

Reference: Alimi M, Hofstetter CP, Cong GT. et al. Radiological and clinical outcomes following extreme lateral interbody fusion. J Neurosurg Spine. 2014 Jun;20(6):623-35.

266. Answer: D

What is the only FDA approved use of BMP-2?

- A) Lateral interbody fusion
- B) Posterolateral instrumented fusion
- C) TLIF
- D) Anterior lumbar interbody fusion in a LT cage

Discussion: At this time, the only approved indication of BMP-2 is for anterior lumbar inter body fusion in a LT cage. All the other procedures are considered off-label use of BMP-2.

Reference: Burkus JK, Gornet MF, Dickman CA, et al. Anterior lumbar interbody fusion using rhBMP-2 with tapered interbody cages. J Spinal Disord Tech. 2002 Oct;15(5):337-49.

267. Answer: D

The primary benefit of minimally invasive surgery at this time is:

- A) It is less costly
- B) Surgical time is less
- C) Better outcomes when compared to open surgery
- D) Fewer risks of complications such as wound infections

Discussion: At this time, the best support for minimally invasive surgery is that there are fewer complications such as would infections.

Reference: Parker SL, Adogwa O, Witham TF, et al. Post-Operative Infection after Minimally Invasive versus Open Transforaminal Lumbar Interbody Fusion (TLIF): Literature Review and Cost Analysis. *Minim Invasive Neurosurg.* 2011 Feb;54(1):33-7.

268. Answer: C

Compared with standing radiographs of the spine, measurement of the magnitude of scoliosis on non-weight-bearing radiographs typically:

- A) Estimates accurately
- B) Underestimates by about 5 degrees
- C) Underestimates by about 10 degrees
- D) Underestimates by about 15 degrees
- E) Underestimates by about 20 degrees

Discussion: Supine MRI images tend to underestimate plain radiographs by 10° on average. However, radiographical and MRI measures showed a strong positive correlation ($r=0.90-0.94$) for all curves, structural or nonstructural, and this correlation was not influenced by patient age or body mass index. The relationship allowed the development of a simple linear equation for converting MR image measures to radiograph measures with an acceptable absolute error of $\pm 5^\circ$.

References: Lee MC, Solomito M, Patel A. Supine magnetic resonance imaging Cobb measurements for idiopathic scoliosis are linearly related to measurements from standing plain radiographs. *Spine (Phila Pa 1976).* 2013; 38(11):E656-661.

269. Answer: B

In patients with adult scoliosis, the most reliable radiographic predictor of poor functional outcome is:

- A) Coronal imbalance
- B) Sagittal imbalance
- C) Curve location (thoracic, thoracolumbar, lumbar)
- D) Apical rotation
- E) Rotatory subluxation

Discussion: Positive sagittal balance was the most reliable predictor of clinical symptoms in both operative and non-operative patient groups. Thoracolumbar and lumbar curves generated less favorable scores than thoracic curves in both patient groups. Significant coronal imbalance of greater than 4 cm was associated with deterioration in pain and function scores for unoperated patients but not in patients with previous surgery.

Reference: Glassman SD, Berven S, Bridwell K, Horton W, Dimar JR. Correlation of radiographic parameters and clinical symptoms in adult scoliosis. *Spine (Phila Pa 1976).* 2005; 30(6): 682-688.

270. Answer: E

In adult patients with spinal deformity, posterior pelvic rotation (retroversion) can help to compensate for sagittal imbalance while secondary coronal curves may help compensate for coronal imbalance. Following successful surgical realignment, the greatest improvement in functional outcome was observed:

- A) In those with pre-operative uncompensated coronal imbalance
- B) In those with pre-operative compensated coronal imbalance
- C) In those with pre-operative uncompensated sagittal imbalance
- D) In those with pre-operative compensated sagittal imbalance
- E) Equally in those with pre-operative uncompensated and compensated sagittal imbalance

Discussion: A study of 125 patients with flatback deformity compared surgical outcomes in 27 patients with compensated flatback (pelvic incidence-lumbar lordosis mismatch [PI-LL] > 10° and increased sagittal vertical axis [SVA] < 5 cm) and 98 patients with decompensated flatback (SVA > 5 cm). Surgical correction of flatback deformity demonstrated similar functional outcome score improvements for patients in both groups at one-year postoperatively. The authors conclude that evaluation of flatback deformity should extend beyond measuring SVA. Among patients with concordant pain and disability, PI-LL mismatch must be evaluated for flatback deformity patients and can be considered a primary indication for surgery.

References: Smith JS, Singh M, Klineberg E, Shaffrey CI, Lafage V, Schwab FJ, Protopsaltis T, Ibrahim D, Scheer JK, Mundis G Jr, Gupta MC, Hostin R, Deviren V, Kebaish K, Hart R, Burton DC, Bess S, Ames CP; International Spine Study Group. Surgical treatment of pathological loss of lumbar lordosis (flatback) in patients with normal sagittal vertical axis achieves similar clinical improvement as surgical treatment of elevated sagittal vertical axis: clinical article. *J Neurosurg Spine*. 2014;21(2):160-70.

271. Answer: E

Perioperative complication rates in scoliosis surgery among elderly patients between the ages of 65 to 85 are reported to be approximately:

- A) 30%
- B) 40%
- C) 50%
- D) 60%
- E) 70%

Discussion: A multicenter spinal deformity database study of 206 patients distributed patients among age groups as follows: 25 to 44 (n = 47), 45 to 64 (n = 121), and 65 to 85 (n = 38) years of age. Perioperative complication rates of 17%, 42%, and 71% were observed, respectively (P < 0.001). Within each age group, at 2-year follow-up there were significant improvements in ODI (P ≤ 0.004), SRS-22 (P ≤ 0.001), back pain (P < 0.001), and leg pain (P ≤ 0.04). Improvement in ODI and leg pain NRS were significantly greater among elderly patients (P = 0.003, P = 0.02, respectively), when compared with younger patients. Collectively, these data demonstrate the potential benefits of surgical treatment for adult scoliosis and suggest that the elderly, despite facing the greatest risk of complications, may stand to gain a disproportionately greater improvement in disability and pain with surgery.

References: Smith JS, Shaffrey CI, Glassman SD, Berven SH, Schwab FJ, Hamill CL, Horton WC, Ondra SL, Sansur CA, Bridwell KH; Spinal Deformity Study Group. Risk-benefit assessment of surgery for adult scoliosis: an analysis based on patient age. *Spine (Phila Pa 1976)*. 2011; 36(10):817-24.

272. Answer: C

In adults over 50 years of age with degenerative (de novo) lumbar scoliosis, the majority of patients would experience a 10-year curve progression of approximately:

- A) 10 degrees
- B) 20 degrees
- C) 30 degrees
- D) 40 degrees
- E) 50 degrees

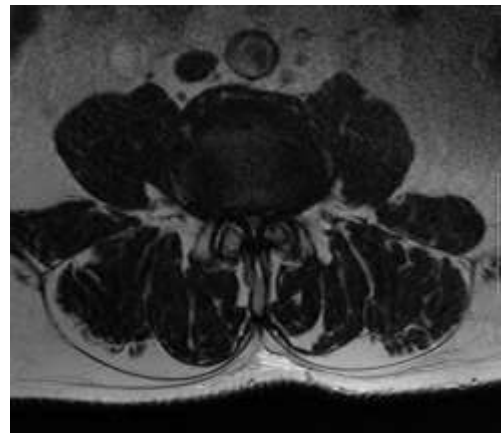
Discussion: The authors studied 200 patients older than age 50 years with back pain and recent onset of scoliosis with curves from T12 to L5 and the apex at L2 or L3 and not exceeding 60 degrees. The curves progressed an average of 3 degrees per year over a 5-year period in 73% of patients. Grade 3 apical rotation, a Cobb angle of 30 or more, lateral vertebral translation of 6 mm or more, and the prominence of L5 in relation to the intercrest line were important factors in predicting curve progression.

Reference: Pritchett JW, Bortel DT. Degenerative symptomatic lumbar scoliosis. *Spine (Phila Pa 1976)*. 1993;18(6):700-3.

273. Answer: D

A 63-year-old female presents to your office with 2 months of bilateral buttock and leg pain. She reports she can only walk about 10 blocks until she needs to sit down to relieve her symptoms. Her MRI can be seen in figures A and B. Which of the following symptoms is most consistent with lumbar spinal stenosis as the cause of her problem?

- A) Numbness on the dorsal aspect of the left foot
- B) Leg pain with flexion of her right hip to 60 degrees with the knee extended
- C) Pain relief when coming to a stationary standing position after prolonged walking
- D) Decrease in pain when cycling on a stationary bicycle
- E) 4 beats of clonus bilaterally

**Figure A****Figure B**

Discussion: Buttock and leg pain from lumbar spinal stenosis is relieved from the seated posture of cycling. Patients with vascular claudication will potentially have increased buttock and leg pain due to the exertion from cycling.

It is important to differentiate vascular claudication from neurogenic claudication due to lumbar spinal stenosis. This starts with a good physical examination, which includes evaluation of the peripheral pulses. Ankle brachial indices and/or vascular referral should be considered for patients with abnormal findings. Patients with neurogenic claudication from lumbar spinal stenosis will present with pain, paresthesias, and occasionally weakness in the back, buttocks and legs. They will describe pain that is alleviated with sitting and leaning forward and exacerbated by walking downhill, standing up straight, or lying down supine. Lumbar spinal stenosis should also be differentiated from lumbar disc herniation.

Patients with lumbar disc herniations will generally have worse symptoms when bending forward in contrast to patients with lumbar spinal stenosis who will have decreased pain when bending forward.

Weinstein et al. (2010, 2008), as part of the SPORT trial, found that surgical management of symptomatic lumbar stenosis with decompressive laminectomy resulted in greater improvement in pain, function, and

satisfaction as compared to nonsurgical management. These advantages were maintained at both two and four years of follow up.

Grimm et al. review mimickers of lumbar radicular disease and note that peripheral arterial disease (PAD) can present in a similar fashion. Examination of a patient with PAD will show diminished pulses, hairless or dystrophic skin changes, and ABIs will be less than 0.9.

Issack et al. review the management of spinal stenosis and report that the recent literature suggests surgical management is superior to nonsurgical management with regard to pain and function. Wide decompressive laminectomy is the most common procedure utilized to address lumbar spinal stenosis.

Figure A is a sagittal T2-weighted MRI of the lumbar spine showing multilevel spondylosis and spinal canal narrowing. Figure B is an axial T2-weighted MRI of the lumbar spine showing hypertrophy of the facets and ligamentum flavum in addition to posterior disc bulging, all contributing to severe spinal canal stenosis.

References: Mimickers of lumbar radiculopathy. Grimm, JAAOS 2015 Degenerative lumbar spinal stenosis: evaluation and management. Issack, JAAOS 2012 Surgical versus nonoperative treatment for lumbar spinal stenosis four-year results of the Spine Patient Outcomes Research Trial. Weinstein, SPINE 2010

274. Answer: B

Figure A is the sagittal lumbar spine MRI image of a 59-year-old female complaining of low back pain, which radiates into her bilateral buttocks and posterior thighs. Occasionally she has pain distal to her knee on the left side. Her low back pain is exacerbated when standing up from a sitting position.

Prolonged standing and walking seems to worsen the painful radiation to her legs, but says she finds some relief when sitting. Flexion and extension radiographs of the lumbar spine demonstrate 4mm of translation of L4 on L5. She has unsuccessfully completed a six week course of physical therapy. Which of the following treatments is likely to have the greatest effect on bodily pain, physical function, and Oswestry Disability Index (ODI)?



Figure A

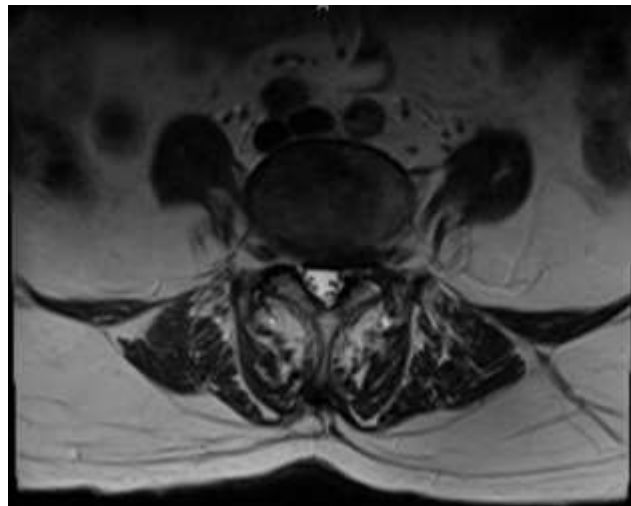


Figure B

- A) L4-5 decompression
- B) L4-5 decompression and instrumented fusion

- C) Transforaminal epidural injection
- D) Left sided L4-5 laminotomy and discectomy
- E) L4-5 anterior lumbar interbody fusion

Discussion: The patient has low back pain and neurogenic claudication in both legs secondary to a grade 1 degenerative spondylolisthesis at L4-5. Startup pain from sitting to standing as well as flexion- extension radiographs suggest instability of the listhesis. The best answer is L4-5 decompression and instrumented fusion.

In the Spine Patient Outcomes Research (SPORT) Trial, Weinstein et. al. performed a randomized controlled trial comparing non-operative treatment to decompression with or without fusion for lumbarstenosis in the setting of degenerative spondylolisthesis. Their as-treated analysis found that at 4 years post-operatively, those patients treated surgically with decompression and fusion had significant improvements in bodily pain, physical function, and the ODI.

Abdu et. al. also reported 4-year outcomes of the SPORT trial evaluating the method of fusion of degenerative spondylolisthesis. They compared outcomes of decompressive laminectomy with one of three fusion techniques: posterolateral in situ fusion (PLF), posterolateral instrumented fusion with pedicle screws (PPS), and PPS plus interbody fusion (360° fusion). Despite early results favoring PPS, and mid-term results favoring 360°, by the fourth year of follow up, there was no difference seen between the PLF, PPS, or 360° fusions with respect to SF-36 bodily pain, physical function, and the ODI.

Figure A demonstrates a T2 weighted sagittal lumbar spine MRI demonstrating grade 1 degenerative spondylolisthesis at L4-5. Figure B is an axial T2 weighted MRI demonstrating bilateral foraminal stenosis at the level of the L4-5 disc space.

Reference: Surgical compared with nonoperative treatment for lumbar degenerative spondylolisthesis. four-year results in the Spine Patient Outcomes Research Trial (SPORT) randomized and observational cohorts. Weinstein, JBJS 2009

Degenerative spondylolisthesis: does fusion method influence outcome? Four-year results of the spine patient outcomes research trial. Abdu, SPINE 2009

275. Answer: B

When compared to open surgery, minimally invasive surgery has the following effect on the spinal muscles

- A) Greater rate of muscular atrophy after surgery
- B) Lesser rate of muscular atrophy after surgery
- C) Equal rate of muscular atrophy after surgery

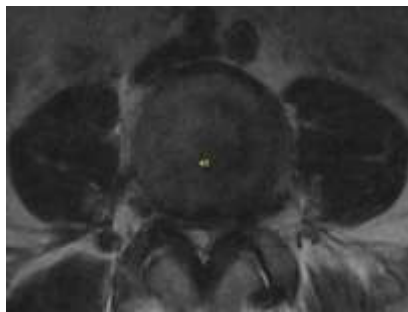
Discussion: Animal and human studies have looked at muscle injury in open and minimally invasive surgery. MRI studies have evaluated the muscles and the results have shown that there is less muscle atrophy in minimally invasive spine surgeries. In particular, the multifidus muscle is affected the most. There have also been further studies that show that muscle strength may be better with the preserved muscle and this may be a reason why patients who undergo minimally invasive surgery recover faster.

Reference: Team Orthobullets (D) MD

276. Answer: D

A 69-year-old man presents to clinic with 9 months of worsening back and lower extremity pain that is worse with walking. Pain is improved by sitting down and leaning forward. He has attempted physical therapy without improvement in symptoms. A T2-weighted midline sagittal image is shown in Figure A. A T2-weighted axial image at the L4/5 disc space is shown in Figure B. A flexion and extension lateral radiograph are shown in Figure C and D. Performing a lumbar decompressive laminectomy alone at L4/5 will lead to which of the following?

- A) Increased risk of adjacent segment degeneration requiring surgery
- B) No improvement in symptoms compared to epidural steroid injection (ESI) at 4 years
- C) Improvement in pain, function and disability compared to nonoperative treatment at 2 years but not 4 years
- D) Improvement in pain, function and disability compared to nonoperative treatment at 2 and 4 years
- E) No improvement in pain, function, and disability compared to nonoperative treatment at 2 and 4 years

**Figure A****Figure B****Figure C****Figure D**

Discussion: The patient is presenting with symptoms and imaging consistent with lumbar spinal stenosis. He has failed conservative measures and so the most appropriate surgical intervention is lumbar laminectomy, which has been shown to improve pain, function and disability scores compared to nonoperative treatment at 2 and 4 year follow up.

Lumbar laminectomy is the mainstay of surgical management of lumbar spinal stenosis in the absence of instability. Conservative measures, including epidural steroid injections, have shown varying efficacy. Data from the Spine Patient Outcomes Research Trial (SPORT) have shown improvement in multiple domains in the operatively managed group. While newer 8-year data shows convergence of some endpoints, the benefit of surgery is still present

Weinstein et al. looked at surgical and nonsurgical treatment of spinal stenosis in both a randomized and observational study arm. Due to significant cross-over, the randomized arm showed limited benefit for surgery. However, the observational cohort showed improvement in pain, function and disability.

Atlas et al. completed a prospective cohort study of surgical and nonsurgical management of lumbar spinal stenosis with one year follow up. They found benefit from surgery at year 1 in multiple patient reported outcomes, including back and leg pain

Figure A is T2-weighted midline sagittal image showing multi-level disc bulging and ligamentum flavum hypertrophy. Figure B is a T2 axial image showing lateral recess stenosis at the L4-5 level. Figure C and D are flexion and extension lumbar radiographs, respectively, with no evidence of spondylolisthesis.

Reference: Surgical versus nonsurgical therapy for lumbar spinal stenosis. Weinstein, NEJM 2008. The Maine Lumbar Spine Study, Part III. 1-year outcomes of surgical and nonsurgical management of lumbar spinal stenosis. Atlas, SPINE 1996

277. Answer: D

A 69-year-old male presents with acute on chronic neck pain. He denies trauma, fevers, or chills. He has noticed some clumsiness in his hands recently and change in his handwriting. He has had progressive deterioration of his gait. Physical exam shows a positive grip and release test, a positive Hofmann sign, and 3+ patellar reflexes. MRI image is shown in Figure A. The procedure shown in Figure B is performed. Which of the following statements is true regarding this treatment option?

- A) This procedure is contra-indicated in patients with an ossified posterior longitudinal ligament.
- B) Significant loss of motion can be expected due to fusion of the facet joints
- C) The spinal cord is decompressed by increasing the medial to lateral dimension of the spinal canal
- D) The spinal cord is decompressed by increasing the anterior to posterior dimension of the spinal canal
- E) A unilateral approach allows less blood loss than a laminectomy and instrumented fusion

Discussion: Figure B shows a multilevel laminoplasty, which can be used in the treatment of cervical myelopathy. The spinal cord is decompressed by increasing the anterior to posterior dimension of the spinal canal.

The treatment of cervical myelopathy is dictated by the number of stenotic levels, sagittal alignment of the spine, and more recently attempt to retain motion. Anterior cervical discectomy and fusion (ACDF) is used for one or two level disease with pathology localized to anterior spine. Posterior decompression and fusion is typically used for disease at more than two levels and is contraindicated with kyphosis greater than 13 degrees. Laminoplasty and cervical disc arthroplasty are thought to be motion-preserving alternatives, although there can be unintended loss of motion with both techniques. The open door laminoplasty technique involves the use of a suture anchor or small plate to maintain the opening on one side while the french door technique involves hinges bilaterally and opening in the midline.

Emery reviewed the diagnosis and management cervical myelopathy. Surgical management is advocated for patients with functional impairment. Depending on location and extent of pathology, anterior procedures may require corpectomy and use of strut grafting.

Gerard et al. reviewed techniques of surgical management of myelopathy. They describe a minimally invasive posterior decompression using a tubular retractor system. Patients are carefully selected and should have less than 3 levels of disease, no evidence of instability, and normal lordosis.

Figure A is a T2 sagittal MRI image showing multilevel cervical stenosis. Figure B is lateral radiograph of a patient who underwent multilevel laminoplasty. Illustration A shows the open door technique.

Reference: Cervical spondylotic myelopathy: diagnosis and treatment. Emery, JAAOS 2001

Current techniques in the management of cervical myelopathy and radiculopathy. Gerard CS 2014

Figure A**Figure B**

278. Answer: D

Which of the following is NOT a significant risk factor for airway complications after the procedure depicted in Figure A?

- A) Surgical time of more than 5 hours
- B) Blood loss > 300 mL
- C) Exposing more than three vertebral bodies during the surgical approach
- D) A history of smoking
- E) Surgical exposures involving C2, C3, or C4

Discussion: Evidence from the literature suggests that a history of smoking does NOT correlate with an increased risk of airway complications after anterior cervical spinal surgery, which is depicted in Figure A by a two-level anterior cervical discectomy and fusion (ACDF).

Anterior approaches to the cervical spine for decompression, fusion, and instrumentation are performed for many conditions including degenerative, traumatic, tumorous, and infectious etiologies. Potential complications from the surgical approach include transient sore throat, dysphagia, hoarseness, dysphonia, recurrent laryngeal nerve paralysis, esophageal perforation, and respiratory insufficiency as a result of upper airway obstruction.

Sagi et al. conducted a retrospective review of 311 anterior cervical procedures in order to identify potential risk factors for airway complications. Variables that were found to be statistically associated with an airway complication ($p < 0.05$) were exposing more than three vertebral bodies, a blood loss greater than 300 mL, exposures involving C2, C3, or C4, and an operative time longer than 5 hours. A history of myelopathy, spinal cord injury, pulmonary problems, smoking, anesthetic risk factors, and the absence of a drain did not correlate with an airway complication.



Figure A depicts a lateral radiograph of the cervical spine with a two level ACDF spanning C3-C5.

Reference: Airway complications associated with surgery on the anterior cervical spine. Sagi, SPINE 2002

279. Answer: B

Which of the following is the strongest contraindication for expansive open door laminoplasty for cervical myelopathy?

- A) Multi-level cervical spondylosis
- B) C2-C7 rigid kyphosis of 15 degrees
- C) Ossification of the posterior longitudinal ligament
- D) C7 sagittal vertical axis of +5cm
- E) Compression ratio of 0.3

Discussion: Expansive open door laminoplasty is a method of posterior cervical decompression. It is contraindicated for patients with cervical kyphosis unless the surgical plan includes concomitant correction of deformity.

Open door laminoplasty allows decompression direct posterior decompression of the neural elements, as well as an indirect anterior decompression by allowing the cord to drift posteriorly. Posterior drift of the cord relies upon the presence of natural cervical lordosis. In the setting of kyphosis, the cord is tensioned ventrally over the vertebral bodies and discs, and does not have the redundancy to drift backward. Patients without lordosis would therefore be expected to show less post-operative improvement than those with normal cervical curvature.

Chiba et al. performed a retrospective review of patients treated with expansive open door laminoplasty for cervical spondylotic myelopathy (CSM) and ossification of the posterior longitudinal ligament (OPLL). They found that for patients with OPLL, cervical kyphosis was associated with lower recovery rates than those patients with pre-operative lordosis. The authors recommended against posterior decompression for CSM in the setting of OPLL with concomitant cervical kyphosis.

Suda et al. performed a retrospective review of 114 patients who underwent expansive open door laminoplasty for cervical myelopathy in order to evaluate clinical outcomes and effects on cervical alignment. They found patients with C2-C7 kyphosis $>13^\circ$ had much lower rates of improvement compared with those patients with less kyphosis. The authors suggest an anterior decompression be used for patients with kyphosis greater than 13° , unless kyphotic correction was planned in addition to laminoplasty.

Illustrations:

Illustration A demonstrates a lateral cervical spine x-ray which shows kyphotic alignment over multiple levels.

Illustration B demonstrates the C7-sagittal vertical axis. Illustration C demonstrates the compression ratio.



Figure A

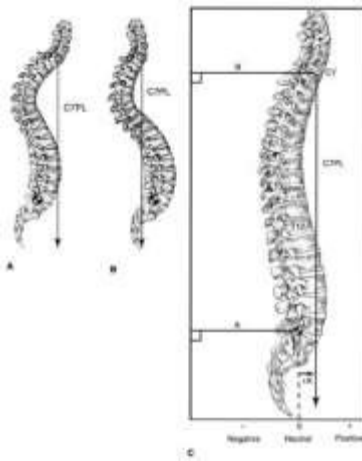


Figure B



Compression Ratio = A/B
 $CR < 0.4 = \text{poor prognosis}$

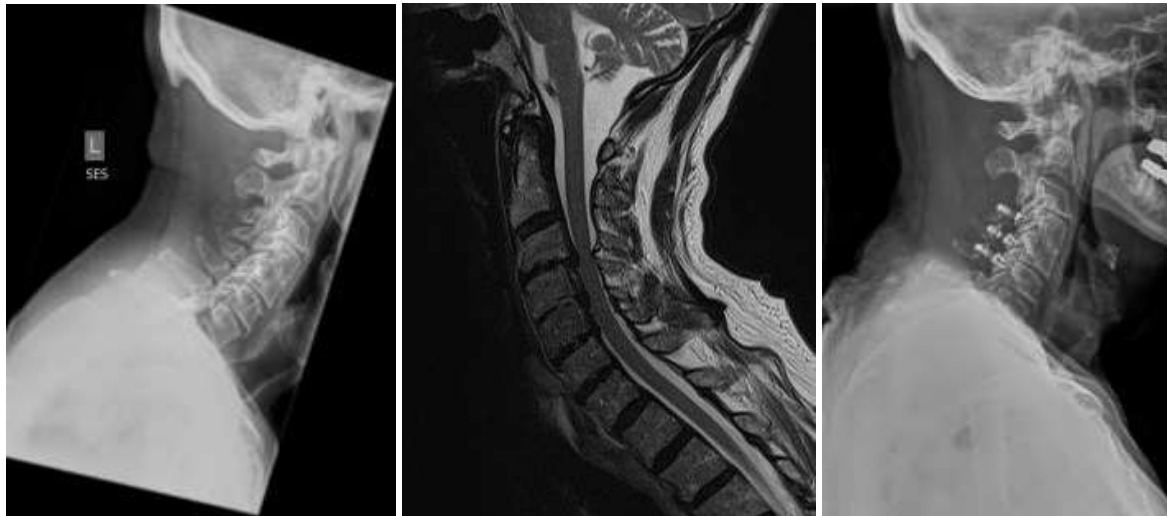
Figure C

Reference: Local kyphosis reduces surgical outcomes of expansive open-door laminoplasty for cervical spondylotic myelopathy. Suda K 2003. Long-term results of expansive open-door laminoplasty for cervical myelopathy--average 14-year follow-up study. Chiba, SPINE 2006

280. Answer: C

A 69-year-old man presents with several months of worsening balance, gait, and problems with manual dexterity. Physical exam shows bilateral Hoffman signs and hyperreflexia of his patellar reflexes. His radiograph and MRI are shown in figures A and B, respectively. He undergoes the procedure shown in figure C. Which of the following statements is true regarding this procedure?

- A) It leads to less blood loss than anterior cervical discectomy and fusion (ACDF)
- B) It is contraindicated in patients with > 10 degrees of cervical lordosis
- C) It preserves more range of motion than laminectomy and fusion
- D) It has a lower rate of post operative C5 palsy than laminectomy and fusion
- E) It has a higher risk of adjacent segment degeneration than laminectomy and fusion

**Figure A****Figure B****Figure C**

Discussion: The patient is presenting with symptoms and imaging findings consistent with cervical spondylotic myelopathy (CSM) and undergoes a cervical laminoplasty. Cervical laminoplasty is useful because it helps preserve cervical range of motion.

Patients with myelopathy may present with any combination of fine motor loss, gait disturbance, pain, and bowel/bladder symptoms. While patients can have a myriad of physical exam findings, a positive Hoffmann's sign is seen in about 80% of patients and is more common with more severe myelopathy. Treatment consisted of anterior and/or posterior surgery, traditionally in the form of fusion. Cervical laminoplasty is a newer, motion-sparing technique for decompression that avoids the complications of fusion. While laminoplasty helps preserve more motion than fusion, studies show there can still be some loss of mobility.

Blizzard et al. retrospectively studied patients with CSM who underwent laminoplasty and laminectomy and fusion. While both groups lost range of motion, the laminoplasty group lost less than the LF group. Most clinical outcomes were similar in the two groups.

Sung et al. studied 16 asymptomatic patients with positive Hoffmann's sign and found a high incidence of cervical spondylosis and cord compression on imaging studies. However, this work-up did not change management or clinical course and so they do not recommend routine imaging for a positive reflex.

Yoon et al. conducted a systematic review looking at laminoplasty versus laminectomy and fusion (LF) for CSM.

They found no difference in outcomes for these two procedures, but conclusions were limited due to the few number of studies.

Figure A is a standing lateral cervical spine radiograph showing multi-level spondylosis. Figure B is an accompanying MRI with significant canal stenosis from C3-C6 secondary to disc-osteophyte complexes. Figure C is a postoperative radiograph of the same patient after cervical laminoplasty.

Reference: What's new in spine surgery. Bridwell, JBS 2008

Correlation between a positive Hoffmann's reflex and cervical pathology in asymptomatic individuals. Sung, SPINE 2001

Outcomes after laminoplasty compared with laminectomy and fusion in patients with cervical myelopathy: a systematic review. Yoon, SPINE 2013

Laminoplasty versus laminectomy with fusion for the treatment of spondylotic cervical myelopathy: short-term follow-up. Blizzard, ESPNJ 2017

281. Answer: C

A 79-year-old male presents with worsening low back and bilateral leg pain for 3 years. Radiographs are depicted in Figures A-D. He has failed conservative management and you recommend surgery in the form of single-level decompression and posterolateral fusion. Which of the following is true regarding the outcomes of successful fusion versus pseudoarthrosis?

- A) Increased risk of infection
- B) Improved short-term relief of leg and back pain
- C) Improved long-term relief of leg and back pain
- D) Decreased incidence of new peripheral neurologic deficits
- E) Equal activity level

Discussion: Successful arthrodesis is associated with improved long-term relief of both leg and back pain. In patients undergoing single-level decompression and posterolateral arthrodesis for spinal stenosis with concurrent spondylolisthesis, instrumentation results in a higher rate of fusion.

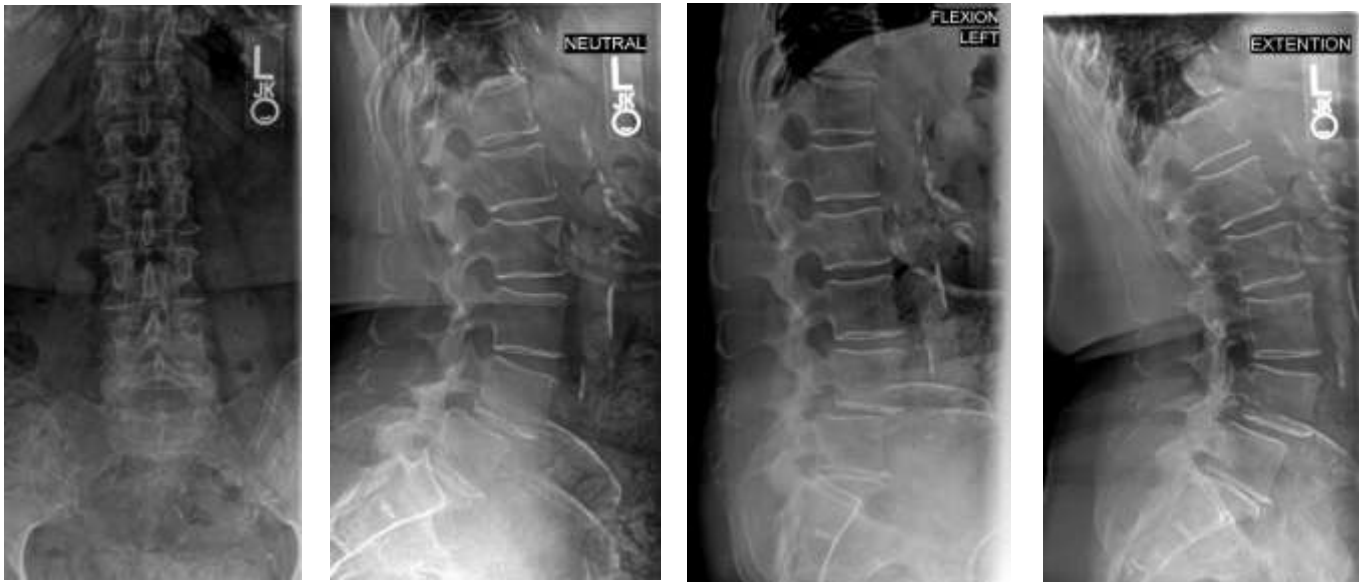
Degenerative lumbar spondylolisthesis with spinal stenosis most commonly occurs at the L4-L5 level. Patients often present with neurogenic claudication, radiculopathy and low back pain. Nonoperative treatment consists of PT and NSAIDs. Surgical management involves both decompressive laminectomy and posterolateral fusion of the unstable segments with instrumentation.

Fischgrund et al prospectively analyzed the outcomes of instrumented versus non-instrumented single-level fusion for patients with degenerative spondylolisthesis and spinal stenosis over a two-year period. Successful arthrodesis occurred in significantly more of the instrumented cases versus the non-instrumented cases (82% versus 45%, $P = 0.0015$). However, there was no significant difference in clinical outcomes including pain relief and activity level.

Kornblum et al performed a more long-term prospective analysis looking at outcomes of successful arthrodesis versus pseudoarthrosis following posterior lumbar decompression and bilateral posterolateral fusion, with an average follow up of 7 years. Patients with a solid arthrodesis had improved pain relief and increased in activity as compared to patients with a pseudoarthrosis ($P = 0.01$). There were no postoperative infections or new neurologic deficits in either group.

Majid et al reviewed the management of degenerative spondylolisthesis with spinal stenosis. Surgical options include decompression with or without fusion. Fusion is recommended to provide the best long-term outcome and is often achieved with autologous bone graft. Some prospective studies have demonstrated improved fusion rate and clinical outcomes with use of rhBMP-2 and OP-1 (BMP-7).

Figures A-D are anteroposterior, lateral, flexion and extension radiographs of the lumbar spine demonstrating degenerative L4-L5 spondylolisthesis with dynamic instability.



Reference: 997 Volvo Award winner in clinical studies. Degenerative lumbar spondylolisthesis with spinal stenosis: a prospective, randomized study comparing decompressive laminectomy and arthrodesis.

Fischgrund, SPINE 1997

Degenerative lumbar spondylolisthesis with spinal stenosis: a prospective long-term study comparing fusion and pseudarthrosis. Kornblum, SPINE 2004

Degenerative lumbar spondylolisthesis: trends in management. Majid, JAAOS 2008

282. Answer: C

The primary concern of lateral interbody fusions at this time are:

- A) Greater rate of blood loss
- B) Greater post-operative times
- C) Post-operative neurologic palsy
- D) Vascular injury

Discussion: Lateral interbody fusion is a transpoas procedure where the psoas muscle is split and a tubular retractor is placed to create a working window. This tends to result in less blood loss and shorter operative time compared to an anterior lumbar inter body fusion. Also, there is less risk to the vena cava and aorta. However, the biggest risk is the potential for a post-operative femoral nerve palsy and this has been noted even in cases where the neuromonitoring remains normal.

Reference: Team Orthobullets (D) MD

283. Answer: D

What is the only FDA approved use of BMP-2?

- A) Lateral interbody fusion
- B) Posterolateral instrumented fusion
- C) TLIF
- D) Anterior lumbar interbody fusion in a LT cage

Discussion: At this time, the only approved indication of BMP-2 is for anterior lumbar inter body fusion in a LT cage. All the other procedures are considered off-label use of BMP-2.

Reference: Team Orthobullets (D) MD

Sports Medicine - Lower Extremity

284. Answer: C 2022

Patients with horizontal cleavage tears of the meniscus:

- A) Cannot be improved with a repair
- B) Who undergo repair have a success rate that is significantly lower than repair of other types of meniscus tears
- C) Can undergo repair with a success rate of 78%
- D) Usually do not have knee pain
- E) Can be treated as an incidental finding during arthroscopy

Discussion: Although horizontal cleavage tears often have a degenerative component, they can be repaired with a success rate comparable to other tear configurations.

Reference: Kurzweil PR, Lynch NM, Coleman S, and Kearney B. Repair of Horizontal Meniscus Tears: A Systematic Review. Arthroscopy: The Journal of Arthroscopic and Related Surgery, Vol 30, No 11 (November), 2014: pp 1513-1519

285. Answer: C 2022

Root Tears of the Meniscus:

- A) Are most commonly seen in males in their 40s
- B) Typically occur in teenage girls
- C) Are usually found in females in their 50s
- D) Can be ignored as an incidental finding in arthroscopy
- E) Repair is typically unsuccessful

Discussion: 83% of patients undergoing repair for root tears were female, with a mean age of 55 years. Complete or near-complete healing was seen in 96% with significant improvement in outcome scores.

Reference: Feucht MJ, Kuhle J, Bode G, Mehl J, Schal, Sudkamp NP, Niemeier P. Arthroscopic Transtibial Pullout for Repair of Posterior MM Root Tears: A Systematic Review of Clinical, Radiographic, and Second-Look Arthroscopic Results. Arthroscopy: The Journal of Arthroscopic and Related Surgery, Vol 31, No 9 (September), 2015: pp 1808-1816

286. Answer: C 2022

Which of the following is true regarding medial meniscus root repair?

- A) Patients have higher rates of arthritis if repaired, lower if debrided
- B) Patients have lower rates of arthritis if repaired or debrided
- A) Patients have lower rates of arthritis if repaired, higher if debrided
- B) Patients have higher rates of arthritis if repaired, lower if debrided
- C) Patients have lower rates of arthritis if treated non-operatively

Discussion: Meniscus root repair leads to significantly less arthritis progression and need for total knee arthroplasty compared partial meniscectomy or non-operative treatment.

Reference: (Bernard et al, AJSM 2020 Jan; 48(1):128-132)

287. Answer: E 2022

Which of the following is true for post-op rehabilitation after isolated meniscus repair?

- A) Early motion with non-weightbearing results in lower meniscus healing rates
- B) Early motion with weightbearing results in lower meniscus healing rates
- C) Delayed motion with weightbearing results in lower meniscus healing rates
- D) Delayed motion with non-weightbearing results in lower meniscus healing rates
- E) Early motion and weightbearing have no detrimental effect on meniscus healing rate

Discussion: Early motion and weightbearing were found to have no detrimental effect for isolated meniscus repair healing in a systematic review of rehabilitation protocols.

Reference: AJSM 2017 Jun;45(7):1687-1697

288. Answer: A 2022

Compared to bucket-handle tear meniscus repair, radial tear meniscus repair has

- A) Similar clinical outcomes and reoperation rate
- B) Better clinical outcome but higher reoperation rate
- C) Poorer clinical outcome and higher reoperation rate
- D) Better clinical outcome and higher reoperation rate
- E) Poorer clinical outcome but lower reoperation rate

Discussion: Full-thickness radial meniscal tears render the meniscus non-functional and have traditionally been treated with partial meniscectomy. Increased emphasis has been placed on repair of these tear patterns. Satisfactory clinical outcomes are achievable for radial meniscus tear repair and show similar outcome scores and reoperation rates as bucket-handle tear patterns.

Reference: Wu et al, AJSM 2018 Aug;46(11):2653-2660

289. Answer: E 2022

PCL Injuries in athletes occur most frequently with which of the following injury mechanisms?

- A) Fall on flexed knee with foot plantarflexed
- B) Hyperflexion
- C) Hyperextension
- D) Posteriorly directed force applied to proximal tibia with the knee flexed (“dashboard injury”)
- E) Varus stress

Discussion: The most common mechanism of PCL injury in athletes is a posterior-directed blow to the proximal tibia with the knee in flexion and the foot plantar flexed. However, hyperflexion or hyperextension in the presence or absence of a posterior-directed tibial force have also been implicated as injury mechanisms.

Reference: F. Petrigliano, D. McAllister: Isolated posterior cruciate ligament injuries of the knee. Sports Med Arthrosc. 2006 Dec;14(4):206-12. PMID: 17135970

290. Answer: B 2022

What is the best physical examination maneuver to make the diagnosis of an isolated PCL injury?

- A) Anterior drawer test
- B) Posterior drawer test
- C) Pivot shift test
- D) Jerk test
- E) McMurray’s test

Discussion: The most accurate test for assessing PCL integrity is the posterior drawer test. The posterior drawer test is performed with the patient supine with the hip flexed to 45 degrees, the knee flexed to 90 degrees, and the foot in neutral position. Both hands are placed behind the subject’s proximal tibia and a posterior-directed force is applied to the tibia, assessing the position of the medial tibial plateau relative to the medial femoral condyle. It is important to realize that the tibial plateau will sublux posteriorly in this position with a PCL injury. Thus, the examiner must first reduce the tibia by pulling anteriorly. This is followed by applying a posteriorly directed force. The magnitude of posterior translation is assessed and this measurement is utilized to grade the degree of laxity. Posterior displacement of 0-5 mm is designated a Grade I injury, 5-10 mm a Grade II injury, and greater than 10 mm a Grade III injury.

References: Petrigliano, D. McAllister: Isolated posterior cruciate ligament injuries of the knee. Sports Med Arthrosc. 2006 Dec;14(4):206-12. PMID: 17135970 D. McAllister, F. Petrigliano: Diagnosis and treatment of posterior cruciate ligament injuries. Curr Sports Med Rep. 2007 Oct;6(5):293-9. PMID: 17883964

291. Answer: E 2022

What is the best treatment option for an 18 year old soccer player with an acute isolated grade 1 PCL injury?

- A) Open reduction, internal fixation
- B) Single bundle PCL reconstruction
- C) ACL reconstruction
- D) Double bundle PCL reconstruction
- E) Physical therapy

Discussion: Currently, there is no clinical data to suggest that contemporary reconstruction techniques can improve knee stability in low-grade (I/II) PCL injury or improve outcomes in this cohort of patients. As such, isolated, low-grade PCL injuries are often treated non-operatively with a regimen that includes protected weightbearing in the acute stage followed by structured rehabilitation focused on improving quadriceps strength. Collectively, the current literature suggests that most of these patients will return to sport.

References: F. Petrigliano, D. McAllister: Isolated posterior cruciate ligament injuries of the knee. Sports Med Arthrosc. 2006 Dec;14(4):206-12. PMID: 17135970

D. McAllister, F. Petrigliano: Diagnosis and treatment of posterior cruciate ligament injuries. Curr Sports Med Rep. 2007;6(5):293-9. PMID: 17883964

292. Answer: C 2022

Which of the following is NOT a stabilizing component of the posterior medial corner?

- A) Posterior oblique ligament (POL)
- B) Semimembranosus fascial expansion
- C) Superficial medial collateral ligament
- D) Oblique popliteal ligament
- E) Posterior horn medial meniscus

Discussion: The superficial MCL is a separate medial stabilizer of the knee. The posterior medial corner are important stabilizers that anatomically are distinct and expand off the posterior border of the superficial MCL.

Reference: Tibor et al, AJSM 2001 Jun;39(6):1332-40

293. Answer: E 2022

Which of the following is the best treatment for an isolated LCL grade 3 injury in a professional American Football player?

- A) Primary repair with internal brace
- B) Allograft reconstruction
- C) Autograft reconstruction
- D) Primary repair with PRP injection
- E) Non-operative management with brace

Discussion: Isolated LCL grade 3 injuries can be treated non-operatively with bracing. Return to play in NFL athletes treated non-operatively returned to play at an average 10 days, compared to those treated operatively who returned at an average of 3.5 months. Care must be taken to make sure it is truly an isolated injury, as more commonly there is combined ligament injury in this patient group.

Reference: Bushnell et al, AJSM 2010 Jan;38(1):86-91

294. Answer: D 2022

Focal chondral defects are seen in about what percentage of all knee arthroscopies?

- A) 10%
- B) 20%
- C) 30%
- D) 66%
- E) 100%

Discussion: Focal chondral defects are seen in up to 2/3 of patients undergoing knee arthroscopy.

Reference: Curl et al, Arthroscopy 1997;13:456-460

295. Answer: C 2022

Which of the following is NOT an advantage of Osteochondral Autograft Transfer?

- A) Defect filled with mature, hyaline cartilage rather than fibrocartilage
- B) Can be done in single stage
- C) The area treated can be over 4 cm²
- D) Can be done arthroscopically in many cases
- E) Good results are seen at 10 years for femoral condyle

Discussion: OAT technique allows the defect to be filled with mature, hyaline cartilage, in a single stage, and often arthroscopically with good results at 10 years. The area treated should not exceed 4cm² due to increased donor site morbidity.

Reference: Hangody et al, JBJS Am 2003;85-A 25-32.

296. Answer: E 2022

Which of the following is NOT a disadvantage of First-Generation Autologous Chondrocyte Implantation?

- A) The need for two-stage surgery
- B) High cost compared to OAT and Microfracture
- C) Significant rate of reoperation for graft hypertrophy
- D) Outcomes not superior to Microfracture for lesions smaller than 2cm²
- E) It is not available in the United States.

Discussion: Autologous chondrocyte implantation is most useful for single defects larger than 2cm. It required two stages and an open arthrotomy, is expensive, and has been approved in the United States since it uses a periosteal flap rather than a collagen 1/III scaffold seen in 3rd generation ACI. Some 3rd generation ACI procedures, such as MACI, are now approved in the US as well.

Reference: Breitberg et al, N Eng J Med 1994;331. 889-895

297. Answer: C 2022

Which of the following is NOT an advantage of Fresh Osteochondral Allograft Transplantation?

- A) It can be used for defects that are too large for Osteochondral Autograft Transplantation.
- B) It can be used after failed cartilage repair procedures.
- C) It can be used in the setting of extensive subchondral bone loss
- D) It can be stored for 3 months with good cartilage viability
- E) It is showing promising results in athletes

Discussion: Fresh Osteochondral Autograft can be used for large defects that have subchondral bone loss. Some studies are showing promise in the athletic population. Best results are correlated to cartilage cell viability and should be implanted within 3-4 weeks from harvest.

Reference: Richter et al, Sports Health 2015; 8(2) 153-160

298. Answer: C 2022

Which of the following is TRUE?

- A) Smaller lesions (less than 2cm²) are best treated with First Generation ACI
- B) Intermedial size lesions (2-4 cm²) have shown clearly superior results when treated by ACI rather than OAT.
- C) For larger lesions (greater than 4cm²), ACI or Osteochondral Allograft have shown the best results
- D) Patient age and containment of defect should not be taken into consideration when choosing cartilage repair options.
- E) Outcomes are best for cartilage repair of bipolar lesions.

Discussion: For larger lesions, ACI and OCA have shown the best results, with OCA best if significant subchondral plate involvement. Smaller lesions are best treated by Microfracture or OAT. Best results are seen in patients under 40y.o and a well-contained lesion that is unipolar.

Reference: Richter et al, Sports Health 2015; 8(2) 153-160

299. Answer: C

The most common type of femoroacetabular impingement is:

- A) Cam
- B) Pincer
- C) Combined
- D) Crossing Sign
- E) SCFE

Discussion: Combined type femoroacetabular impingement – where patients have radiographic features of both cam and pincer type of impingement, is the most common. Cam impingement is more common in young males, and occurs more commonly than isolated pincer impingement. The crossing sign is a radiographic feature of cranial retroversion, a type of pincer impingement. SCFE – slipped capital femoral epiphysis is a cause of cam impingement.

Reference: Team Orthobullets (D) MD

300. Answer: D 2020

Typical intra-articular pathology seen in patients with pincer type of impingement includes which of the following:

- A) Labral-chondral separation
- B) Chondral Flap Located in the Anterolateral Femoral Head
- C) Focal Acetabular Anterolateral Chondral Damage
- D) Posterior femoral head chondral damage
- E) Ligamentum Teres Tear

Discussion: Pincer impingement results in crushing of the labrum, chondral damage which is just a few millimeters from the acetabular rim, but is global, and contra-coup damaged – damage of the posterior femoral head and posterior acetabulum. Labral chondral separation, with anterolateral acetabular chondral flaps is classically seen with cam impingement. Anterior Femoral head lesions are not commonly seen as part of the pathophysiology of pincer impingement.

Reference: Team Orthobullets (D) MD

301. Answer: B 2020

One of the major criteria for definitive diagnosis of periprosthetic joint infection is in positive identification of the organism. Pathogens may be inaccessible, such as when embedded in biofilm. What procedure improves the ability to identify the organisms in such case?

- A) Repeat aspiration
- B) Implant sonication
- C) Swab cultures
- D) Frozen section
- E) Extended cultures

Discussion: Implant sonication improves the diagnostic sensitivity for presence of bacteria in occult infections. With sonication, there is a greater ability to identify the pathogen as well, either through cultures of the sonicate fluid or using PCR. A meta-analysis of sonication fluid PCR evaluated nine studies; pooled sensitivity was 75%, and pooled specificity was 96%. Extending culture duration does not change the ability to identify more PJI. Frozen section evaluation of neutrophils may assist in diagnosis but not with organism identification. Swab cultures are not as sensitive as tissue cultures.

Reference: Team Orthobullets (D) MD

302. Answer: A 2020

Typical Intra-articular pathology seen in patients with cam type impingement includes:

- A) Labral-chondral separation
- B) Chondral Flap Located in the Anterolateral Femoral Head
- C) Global Acetabular Anterolateral Chondral Damage
- D) Posterior femoral head chondral damage
- E) Ligamentum Teres Tear

Discussion: Cam impingement results in Labralchondral separation, with deep anterolateral acetabularchondral flaps also commonly seen. Crushing of the labrum, global chondral damage which is just a few millimeters from the acetabular rim, and contra-coup damage – damage of the posterior femoral head and posterior acetabulum are hallmarks of pincer impingement. Femoral head lesions are not commonly seen as part of the pathophysiology of cam impingement.

Reference: Team Orthobullets (D) MD

303. Answer: A 2020

Which of the following most accurately describes suprapatellar nailing of the tibia:

- A) It may cause articular damage if not done with proper technique
- B) it results in decreased knee range of motion when compared to infrapatellar nailing
- C) it can be done with the patient in the prone position
- D) it allows the surgeon to address meniscal tears through the same incision
- E) it should not utilize reaming in order to avoid spilling debris into the joint

Discussion: Sanders et al performed arthroscopy before and immediately following SP nailing and noted a couple cases where minor cartilage injury had occurred. The other answers are not accurate with the exception of (e) - however, proper technique can avoid this from occurring and therefore reaming should not be avoided as this may decrease fracture union rates

Reference: Team Orthobullets (D) MD

304. Answer: E 2020

Which of the following best describes the benefits of suprapatellar nailing over infrapatellar nailing:

- A) easier to lock nail proximally and distally
- B) less reaming required with open fractures
- C) easier to remove nail through same incision
- D) less blood loss and decreased incision length
- E) easier to position and maintain reduction of proximal third fractures

Discussion: There is no evidence to support a, b, c, or d. Suprapatellar nailing has been shown to allow for easier positioning in the semi-extended position and avoid excessive flexion of the knee causing extension of the proximal fragment in proximal third fractures

Reference: Team Orthobullets (D) MD

305. Answer: C 2020

What is the average version of the humeral head (with respect to the transepicondylar axis)

- A) 60 degrees retroversion
- B) 40 degrees retroversion
- C) 20 degrees retroversion
- D) 20 degrees anteversion
- E) 40 degrees anteversion

Discussion: Although there is considerable variability in humeral head retroversion among individuals, multiple anatomic studies have found mean humeral head retroversion to be approximately 20 degrees.

One of the goals of primary anatomic total shoulder arthroplasty (TSA) is recreation and reconstruction of proximal humeral anatomy. Modular prostheses have evolved to provide surgeons with better capability to recreate proximal humeral morphology based on humeral head inclination, retroversion, offset, height and size. In terms of size, humeral head thickness has been found in cadaver studies to be 70% of its radius of curvature. This can be helpful to avoid 'over-stuffing' the joint or leaving it too loose.

Boileau and Walch took digitized measurements of 65 humeri in order to create a computer model for proximal humeral morphology. They found that retroversion varied from -6.7 to 47.5 degrees, with a mean of 17.9. They advocate for prosthetic adaptability to recreate proximal humeral anatomy in a way that earlier generations of more geometrically constrained TSA implants could not.

Robertson et al. made 3D computed tomographic models of 60 humeri (30 pairs) to study proximal humeral morphology. They found mean retroversion to be 19 degrees, with a range of 9 to 31 degrees. They found that proximal canal version was similar to head version but that canal version in the middle and distal sections of the canal was variable.

Illustration A shows key proximal humeral morphologic parameters found by Robertson et al. in comparison with earlier studies (including Boileau's).

Reference: The three-dimensional geometry of the proximal humerus. Implications for surgical technique and prosthetic design. Boileau, BJJ 1997

Three-dimensional analysis of the proximal part of the humerus: relevance to arthroplasty. Robertson, JBJS 20

COMPARISON WITH PRIOR STUDIES

	Current Study		Prior Studies	
	Mean	Range	Mean	Range
Head retroversion* (degrees)	19	9-31	22 ¹² 18 ^{3,18}	0-60 ¹² -5-50 ^{3,18}
Head inclination (degrees)	41	34-47	45 ⁹ 41 ¹⁰ 40 ^{11,18}	30-55 ⁹ 32-51 ¹⁰ 33-46 ^{11,18}
Head radius (mm)	23	17-28	25 ¹² 24 ⁹ 22 ¹ 23 ^{3,18}	20-32 ¹² 19-28 ⁹ 20-26 ¹ 19-28 ^{3,18}
Head thickness (mm)	19	15-24	19 ¹² 20 ⁹ 15 ^{3,18}	15-22 ¹² 15-24 ⁹ 12-18 ^{3,18}
Medial head center offset (mm)	7	4-12	10 ¹² 11 ¹ 7 ^{3,18}	6-12 ¹² 7-14 ¹ 3-11 ^{3,18}
Posterior head center offset (mm)	2	-1-8	5 ¹² 2 ¹ 3 ^{3,18}	0-11 ¹² -3-4 ¹ -1-6 ^{3,18}
Lateral hinge point offset (mm)	7	4-11	<1 ^{3,18}	-2-3 ^{3,18}
Humeral length (cm)	33	27-41	33 ¹⁰	28-36 ¹² 30-38 ¹⁰

*Retroversion was measured with reference to the transepicondylar axis.

306. Answer: D 2017/2020

Which factor below has not been shown to negatively affect rotator cuff healing rates?

- A) Muscle atrophy
- B) Age of patient
- C) Size of tear
- D) Hypothyroidism

Discussion: Muscle quality has been shown to be an important factor in rotator cuff repair and outcomes (Gladstone, AJSM 2006; Chung AJSM 2011). Age of the patient is also an important factor with increasing age being a key factor in increased re-tear rates. Cheung et al found that osteoporosis, as well as fatty infiltration, and tear retraction, were independent factors in re-tear rates (Chung AJSM 2011). There has been no correlation reported with hypothyroidism and failure of rotator cuff repairs, however, there has been reported correlation with incidence of rotator cuff tears in hypothyroid patients (Oliva, Muscles Ligaments Tendons J. 2014).

References: Fatty infiltration and atrophy of the rotator cuff do not improve after rotator cuff repair and correlate with poor functional outcome. - <http://www.ncbi.nlm.nih.gov/pubmed/17337727> Gladstone JN, Bishop JY, Lo IK, Flatow EL. Am J Sports Med. 2007 May;35(5):719-28

Factors affecting rotator cuff healing after arthroscopic repair: osteoporosis as one of the independent risk factors. - <http://www.ncbi.nlm.nih.gov/pubmed/21813440> Chung SW, Oh JH, Gong HS, Kim JY, Kim SH. Am J Sports Med. 2011 Oct;39(10):2099-107. doi: 10.1177/0363546511415659. Epub 2011 Aug 3. PMID: 21813440

Epidemiology of the rotator cuff tears: a new incidence related to thyroid disease. Oliva F1, Osti L2, Padulo J3, Maffulli N4.

Muscles Ligaments Tendons J. 2014 Nov 17;4(3):309-14. eCollection 2014.

307. Answer: C 2017/2020

The rate of asymptomatic full thickness rotator cuff tears in patients in their seventh decade of life is?

- A) 0-10%
- B) 10-20%
- C) 20-30%
- D) 30-40%

Discussion: MRI and Ultrasound studies have shown that 20-30 percent of patients in their 60's have asymptomatic rotator cuff tears. These results, along with other studies suggest an initial trial of non-surgical treatment in patients with non-traumatic symptomatic rotator cuff tear in this age group is reasonable.

References: Age-related prevalence of rotator cuff tears in asymptomatic shoulders. Tempelhof S1, Rupp S, Seil R. J Shoulder Elbow Surg. 1999 Jul-Aug;8(4):296-9.

Abnormal findings on magnetic resonance images of asymptomatic shoulders. Sher JS1, Uribe JW, Posada A, Murphy BJ, Zlatkin MB. J Bone Joint Surg Am. 1995 Jan;77(1):10-5.

308. Answer: D 2017/2020

When comparing double-row and single-row rotator cuff tear repair outcomes which is true?

- A) Double-row repairs have shown consistently superior clinical improved outcomes.
- B) Single-row repairs have shown consistently superior clinical improved outcomes.
- C) There is no clear clinical outcome data that suggest double-row repairs are superior to single-row repairs.
- D) There is no clear difference in clinical outcomes, but double-row repairs allow a more accelerated rehabilitation program.

Discussion: There have been a multitude of studies comparing single- to double-row rotator cuff repairs, however, there has been no clear evidence to suggest one technique is clinically superior to the other. When stratified to tear size, some studies have suggested larger tears have an improved healing rate with double-row repairs, however this has also been disputed.

Reference: A Prospective Randomized Clinical Trial Comparing Arthroscopic Single-and Double-Row Rotator Cuff Repair

Robert T. Burks, MD, Julia Crim, MD, Nick Brown, PhD, Barbara Fink, PT, Patrick E. Greis, MD
American Journal of Sports Medicine. Vol 37, Issue 4, 2009.

Arthroscopic Single-Row Versus Double-Row Repair for Full-Thickness Posterosuperior Rotator Cuff Tears: A Critical Analysis Review.

Roth KM1, Warth RJ, Lee JT, Millett PJ, ElAttrache NS.

J Shoulder Elbow Surg. 2014 Apr;23(4):586-97. doi: 10.1016/j.jse.2013.10.006. Epub 2014 Jan 8.

Prospective Randomized Clinical Trial of Single- Versus Double-Row Suture Anchor Repair in 2- to 4-cm Rotator Cuff Tears: Clinical and Magnetic Resonance Imaging Results.

Kyoung Hwan Koh, M.D., Kyung Chung Kang, M.D., Tae Kang Lim, M.D., Min Soo Shon, M.D., Jae Chul Yoo, M.D.

Arthroscopy: The Journal of Arthroscopic & Related Surgery

Volume 27, Issue 4, April 2011, Pages 453–462

309. Answer: A 2017/2020

The incidence of positive Propionibacterium Acnes cultures in revision arthroscopic shoulder surgery for pain, stiffness, and weakness has been shown to be as high as ____%. If this is suspected intra-operative cultures should be held at least ____ days.

- A) 23, 14
- B) 23, 3
- C) 10, 14
- D) 10, 3
- E) 5, 14

Discussion: Propionibacterium Acnes is a known pathogen that has been found to be the cause of symptomatic post-surgical infections in both open and arthroscopic procedures. These infections tend to be indolent, and often present with non-specific pain, stiffness, and weakness. Baseline intravenous laboratories studies have been found to be of little assistance in diagnosis. Intraoperative cultures are the gold-standard in diagnosis, and need to be held for at least 14 days. There is new rapid PCR study recently developed if available.

Reference: Propionibacterium acnes infection in shoulder arthroscopy patients with postoperative pain.

Horneff JG 3rd1, Hsu JE2, Voleti PB1, O'Donnell J1, Huffman GR3.

J Shoulder Elbow Surg. 2015 Jun;24(6):838-43. doi: 10.1016/j.jse.2015.03.008.

310. Answer: B 2017/2020

Patients with ACL retaining TKA can expect to have which of the following outcomes?

- A) More posterior rollback than posterior stabilized (PS) TKA
- B) Less paradoxical motion than posterior cruciate retaining (CR) TKA
- C) Greater range of motion than PS or CR TKA
- D) Equivalent 20-year survivorship to conventional PS and CR TKA
- E) Equivalent stability in comparison to CR TKA

Discussion: ACL retaining TKA provides more normal kinematics (less paradoxical motion) and stability than CR TKA since the ACL limits anterior tibial translation during knee flexion (1,2). Posterior rollback of a PS TKA is provided by the cam post mechanism. Prior studies of ACL retaining TKA used 3 to 4 decades ago have shown high rates of mechanical failure and stiffness, although some reports indicate favorable survivorship at 10 years (3,4). Modern ACL retaining TKA's have been developed with currently available implant materials and instrumentation and functional outcomes have been favorable, but the long-term durability of these implants has not been established (5).

References:

1. J.B. Stiehl, R.D. Komistek, J.M. Cloutier, D.A. Dennis. The cruciate ligaments in total knee arthroplasty: a kinematic analysis of 2 total knee arthroplasties. *J Arthroplasty*, 15 (5) (2000), p. 545
2. C. Halewood, A. Traynor, J. Bellemans, J. Victor, A.A. Amis. Anteroposterior laxity after bicruciate-retaining total knee arthroplasty is closer to the native knee than ACL-resecting TKA: a biomechanical cadaver study. *J Arthroplasty*, 30 (12) (2015), p. 231
3. F.H. Gunston. Polycentric knee arthroplasty: prosthetic simulation of normal knee movement. *Clin Orthop Relat Res*, 446 (1971), p. 11
4. J.M. Cloutier, P. Sabouret, A. Deghrar. Total knee arthroplasty with retention of both cruciate ligaments. A nine to eleven-year follow-up study. *J Bone Joint Surg Am*, 81 (5) (1999), p. 697
5. J.C. Christensen, J. Brothers, G.J. Stoddard, et al. Higher frequency of reoperation with a new bicruciate-retaining total knee arthroplasty. *Clin Orthop Relat Res*, 475 (1) (2017), p. 62

311. Answer: B 2017/2020

In the normal knee which pattern of motion occurs during knee flexion?

- A) Posterior tibial translation and femoral external rotation
- B) Anterior tibial translation and femoral external rotation
- C) Posterior tibial translation and femoral internal rotation
- D) Anterior tibial translation and femoral external rotation

Discussion: Knee kinematics are influenced by the interaction of the cruciate and collateral ligaments, menisci, articular surface geometry, and in vivo muscular and weight bearing forces acting on the knee. During flexion the lateral femoral condyle moves posteriorly while the position of the medial femoral condyle is relatively stationary (1). This produces relative internal tibial rotation or external femoral rotation during knee flexion. In deep flexion both condyles move posteriorly.

References:

1. P. Johal, A. Williams, P. Wragg, D. Hunt, W. Gedroyc. Tibio-femoral movement in the living knee. A study of weight bearing and non-weight bearing knee kinematics using 'interventional' MRI. *Journal of Biomechanics*, Volume 38, Issue 2, February 2005, Pages 269-276

312. Answer: B 2017

Mini - Posterior approach has been used since 2000, and 10 year results show patients grade their result as:

- A) Failure
- B) 93% excellent
- C) 70% satisfactory
- D) 100% successful

Discussion: Ten year results prove mini-posterior incisions are safe and provide results equivalent to any other approach with published results of that longevity. DAA does not have results published beyond 2 years' direct lateral does have long term results.

Reference: Yukizawa, et al. Posterior Mini-incision with Primary Total Hip Arthroplasty: A Nine to Ten Year Follow-up. *J Arthroplasty* 2016; 31: 168-171

313. Answer: A&B 2017

Dislocation after the posterior approach versus the anterior lateral and direct anterior approaches has the following expectations: (write all that apply)

- A) Posterior and direct anterior approaches have similar rates of dislocation
- B) Direct lateral approach has fewer revisions for dislocation than the other 2
- C) Direct anterior approach is far superior to the other two approaches
- D) Dislocation has no relation to the approach

Discussion: Although early publications describing the Direct Anterior Approach (DAA) predicted fewer dislocations, recent publications have not confirmed that. Dislocation rates are not statistically different between DAA and posterior approaches. Large femoral heads, repair of the posterior capsule have improved posterior results. Direct anterior approach has the least revision for dislocation in a recent study by Menegheni et al.

References: Poehling-Monaghan KL, et al. Direct anterior versus mini posterior THA with the same advanced perioperative protocols: Surprising early results. *Colin Orthop Relat Res* 2015;473: 623-631
 Tripuraneni KR, et al. Acetabular abduction and dislocations indirect anterior vs posterior total hip Arthroplasty: A retrospective matched cohort study. *J Arthroplasty* 2016 Mar 15 Epub
 Direct Anterior Approach: Risk factor for early femoral failure of cementless total hip Arthroplasty. *JBJS* 2017; 99:99-105

314. Answer: C 2017

Spinopelvic mobility has a direct influence on preoperative planning for the cup position of total hip replacement, and this decision making is based on

- A) AP pelvis X-ray
- B) lateral hip X-ray
- C) standing and sitting lateral Spinopelvic X-rays
- D) clinical ROM of the hip to be operated

Discussion: Spinopelvic mobility is now known to be an influential factor in planning for cup position if the construct has become stiff. The stiffer this construct becomes, the more important it is to adjust cup position to the pattern of stiffness. 40% of primary THA have some spinal imbalance, and it is consequential in 20%; it is consequential in 70% Of revision hip surgery. Patients over the age of 60, those with degenerative disc disease, and those with surgical fusion are the most likely to need special attention. The lateral standing and sitting Spinopelvic Xrays are the most efficient diagnostic imaging to diagnose this stiffness.

References: 1) Lazennac JY et al. Hip-spine relationship: a radio-anatomical study for optimization in acetabular cup positioning. *Surg Radiol Anat* 2004; 26:136-144
 Kanawade et al. Predictability of acetabular component angular change with postural shift from standing to sitting position. *J Bone Joint Surg Am* 2014; 96A: 978-986
 Stefl M et al. Spinopelvic Mobility and acetabular component position for total hip Arthroplasty. *Bone Joint J* 2017; 99B (1 Supple A): 37-46.

315. Answer: B 2017/2020

Which autologous biologic has been shown to be most effective at treating the symptoms of osteoarthritis?

- A) Leukocyte-rich PRP
- B) Leukocyte-poor PRP
- C) Platelet poor plasma (PPP)
- D) Whole Blood

Discussion: Only non-neutrophil containing PRP has shown efficacy greater than hyaluronic acid for the treatment of symptoms of OA.

Reference: Riboh et al. Effect of leukocyte concentration on the efficacy of PRP in the treatment of knee osteoarthritis.

316. Answer: A 2017/2020

Platelet Rich Plasma has been shown by randomized controlled trials to successfully treat all of the following conditions EXCEPT:

- A) Rotator cuff tears
- B) Lateral epicondylitis
- C) Patellar tendinopathy
- D) Symptoms of OA

Discussion: Multiple randomized controlled trials (RCT) show no effect of PRP use with surgical repair of the rotator cuff. RTC's show an effect of PRP treatment that is greater than other standard treatments (different for each study) for the other conditions listed.

Reference: Saltzman et al. Does the use of PRP at the time of surgery improve clinical outcomes in arthroscopic rotator cuff repair. *Arthroscopy*, 2015.

317. Answer: A 2017/2020

The maximum volume of bone marrow that should aspirated at each iliac crest harvest site in order to maximize stem cell recovery is:

- A) 1-4cc
- B) 10-12cc
- C) 5-30cc
- D) 520-60cc

Discussion: Maximum recovery of bone marrow mesenchymal cells occurs with the first 1cc of marrow aspiration. Additional aspiration dilutes the cells with peripheral blood, so no more than a 4cc aspiration is recommended at each harvest site.

Reference: Muschler GF et al. Aspiration to obtain osteoblast progenitor cells from human bone marrow: The influence of aspiration volume. *J Bone Joint Surg Am*. 1997 Nov; 79(11): 1699-709.

318. Answer: C 2017/2020

The FDA allows all of the following procedures during autologous stem cell harvest and treatment EXCEPT:

- A) Concentrating cells using a centrifuge
- B) Mincing and grinding of tissue to maximize cell recovery
- C) Culturing cells to increase cell volume
- D) Sorting cells in the clinic/OR to improve purity

Discussion: Harvested autologous cells are not allowed to leave the operating or clinic room where they were harvested per FDA regulations. If cells are taken outside the harvest room, the procedure do not meet criteria for minimal manipulation and is subject to regulation by the FDA.

Reference: Docket No. FDA-2014-D-1696-0001: Minimal Manipulation of Human Cells, Tissues, and Cellular and Tissue-Based Products: Draft Guidance for Industry and Food and Drug Administration Staff (December 2014)

319. Answer D 2020

Which of the following is not a known factor in rotator cuff healing after rotator cuff repair?

- Muscle quality
- Osteoporosis
- Age of the patient
- Quality of the rotator cuff tissue

Discussion: Muscle quality has been shown to be an important factor in rotator cuff repair and outcomes (Gladstone, AJSM 2006; Chung AJSM 2011). Age of the patient is also an important factor with increasing age being a key factor in increased re-tear rates. Cheung et al found that osteoporosis, as well as fatty infiltration, and tear retraction, were independent factors in re-tear rates (Chung AJSM 2011). Although quality of the rotator cuff is likely also a factor, it is unable to be quantified.

References: Fatty infiltration and atrophy of the rotator cuff do not improve after rotator cuff repair and correlate with poor functional outcome. - <http://www.ncbi.nlm.nih.gov/pubmed/17337727> Gladstone JN, Bishop JY, Lo IK, Flatow EL. Am J Sports Med. 2007 May;35(5):719-28

Factors affecting rotator cuff healing after arthroscopic repair: osteoporosis as one of the independent risk factors. - <http://www.ncbi.nlm.nih.gov/pubmed/21813440> Chung SW, Oh JH, Gong HS, Kim JY, Kim SH. Am J Sports Med. 2011 Oct;39(10):2099-107. doi: 10.1177/0363546511415659. Epub 2011 Aug 3. PMID: 21813440

320. Answer: C

Which of the following regarding microfracture of the footprint is true?

- A) Improved outcomes at 2 years
- B) Improved healing rates at 2 years
- C) No change in outcomes or function at 2 years
- D) Increased PRP delivery postoperatively

Discussion: Osti et al (Int Orthop 2013) evaluated microfracture of the footprint in a randomized study of rotator cuff tears. They found that patients that had a microfracture of the footprint had early decreases in pain, but no differences in function, healing at 2 years.

References: Microfractures at the rotator cuff footprint: a randomised controlled study. <http://www.ncbi.nlm.nih.gov/pubmed/23760681>

Osti L, Del Buono A, Maffulli N.

Int Orthop. 2013 Nov;37(11):2165-71. doi: 10.1007/s00264-013-1952-z. Epub 2013 Jun 13.

PMID: 23760681

321. Answer: C 2020

In a patient with a degenerative rotator cuff tear who opts for physical therapy, which is the most likely outcome?

- A) Surgery within 3 months due to increased pain and loss of function
- B) Injections at 6 weeks to improve function despite a decrease in pain
- C) Significant improvement at 6 weeks and 3 months in ASES scores
- D) Failure of physical therapy

Discussion: Based on the Neer Award paper from 2012, physical therapy was shown to improve ASES scores at 6 weeks and 3 months in a majority of patients. The patients overall had excellent outcomes with non-operative management of their atraumatic rotator cuff tears.

References:

Effectiveness of physical therapy in treating atraumatic full-thickness rotator cuff tears: a multicenter prospective cohort study. - <http://www.ncbi.nlm.nih.gov/pubmed/23540577>

Kuhn JE, Dunn WR, Sanders R, An Q, Baumgarten KM, Bishop JY, Brophy RH, Carey JL, Holloway BG, Jones GL, Ma CB, Marx RG, McCarty EC, Poddar SK, Smith MV, Spencer EE, Vidal AF, Wolf BR, Wright RW; MOON Shoulder Group.

J Shoulder Elbow Surg. 2013 Oct;22(10):1371-9. doi: 10.1016/j.jse.2013.01.026. Epub 2013 Mar 27.

PMID: 23540577

322. Answer: A

What is the likely outcome of a tear that disrupts the anterior aspect of the supraspinatus tendon compared to one in the central aspect of the supraspinatus (crescent)?

- A) Increased likelihood of greater tear size and more muscle degeneration
- B) Increased pain and worse patient reported outcomes preoperatively
- C) Worse outcomes post operatively
- D) Decreased likelihood of tear progression

Discussion: From Namdari et al (JSES 2014) "In the setting of painful small and medium-sized rotator cuff tears, disruption of the anterior supraspinatus tendon was associated with greater tear size and more advanced supraspinatus muscle degeneration. However, anterior supraspinatus tendon integrity had no influence on the clinical presentation or the functional and structural results of cuff repair surgery."

References:

Characteristics of small to medium-sized rotator cuff tears with and without disruption of the anterior supraspinatus tendon. - <http://www.ncbi.nlm.nih.gov/pubmed/23937927>

Namdari S, Donegan RP, Dahiya N, Galatz LM, Yamaguchi K, Keener JD.

J Shoulder Elbow Surg. 2014 Jan;23(1):20-7. doi: 10.1016/j.jse.2013.05.015. Epub 2013 Aug 9.

PMID: 23937927

323. Answer: D

Typical intra-articular pathology seen in patients with pincer type of impingement includes which of the following:

- A) Labral-chondral separation
- B) Chondral Flap Located in the Anterolateral Femoral Head
- C) Focal Acetabular Anterolateral Chondral Damage
- D) Posterior femoral head chondral damage
- E) Ligamentum Teres Tear

Discussion: Pincer impingement results in crushing of the labrum, chondral damage which is just a few millimeters from the acetabular rim, but is global, and contra-coup damaged – damage of the posterior femoral head and posterior acetabulum. Labralchondral separation, with anterolateral acetabularchondral flaps is classically seen with cam impingement. Anterior Femoral head lesions are not commonly seen as part of the pathophysiology of pincer impingement.

Reference: Beck M, Kalhor M, Leunig M, Ganz R: Hip Morphology Influences The Pattern of Damage to the Acetabular Cartilage: Femoroacetabular Impingement As A Cause of Early Arthritis of the Hip. J Bone Joint Surg 87(B): 1012 – 1018, 2005

324. Answer: A

Typical Intra-articular pathology seen in patients with cam type impingement includes:

- A) Labral-chondral separation
- B) Chondral Flap Located in the Anterolateral Femoral Head
- C) Global Acetabular Anterolateral Chondral Damage
- D) Posterior femoral head chondral damage
- E) Ligamentum Teres Tear

Discussion: Cam impingement results in Labralchondral separation, with deep anterolateral acetabularchondral flaps also commonly seen. Crushing of the labrum, global chondral damage which is just a few millimeters from the acetabular rim, and contra-coup damage – damage of the posterior femoral head and posterior acetabulum are hallmarks of pincer impingement. Femoral head lesions are not commonly seen as part of the pathophysiology of cam impingement.

Reference: Beck M, Kalhor M, Leunig M, Ganz R: Hip Morphology Influences The Pattern of Damage to the Acetabular Cartilage: Femoroacetabular Impingement As A Cause of Early Arthritis of the Hip. J Bone Joint Surg 87(B): 1012 – 1018, 2005

325. Answer: C 2017/2020

The most common type of femoroacetabular impingement is:

- A) Cam
- B) Pincer
- C) Combined
- D) Crossing Sign
- E) SCFE

Discussion: Combined type femoroacetabular impingement – where patients have radiographic features of both cam and pincer type of impingement, is the most common. Cam impingement is more common in young males, and occurs more commonly than isolated pincer impingement. The crossing sign is a radiographic feature of cranial retroversion, a type of pincer impingement. SCFE – slipped capital femoral epiphysis is a cause of cam impingement.

References: Beck M, Kalhor M, Leunig M, Ganz R: Hip Morphology Influences The Pattern of Damage to the Acetabular Cartilage: Femoroacetabular Impingement As A Cause of Early Arthritis of the Hip. J Bone Joint Surg 87(B): 1012 – 1018, 2005

326. Answer: E 2017

Literature has shown the best approach for management of combined type of femoroacetabular impingement in a young athletic male with Tonnis 0 radiographic changes is:

- A) Open surgical dislocation
- B) Mini-open approach combined with arthroscopy
- C) Arthroscopy
- D) Peri-acetabular osteotomy
- E) No single approach has been shown to be superior

Discussion: Current meta-analyses have not demonstrated superiority of one approach (open surgical dislocation, mini-open and arthroscopy) over another at this time. Tonnis 0 is a rating for no arthritis. Peri-acetabular osteotomy is performed for hip dysplasia.

References: Matsuda DK, Carlisle JC, Arthurs SC, Wierks CH, Philippon MJ: Comparative Systematic Review of the Open Dislocation, Mini-Open and Arthroscopic Surgeries for Femoroacetabular Impingement. Arthroscopy 27(2): 252-269, 2011. Botser IB, Smith TW Jr, Nasser R, Domb BG: Open Surgical Dislocation versus Arthroscopy for Femoral Acetabular Impingement. A Comparison of Clinical Outcomes. Arthroscopy 27(2): 270 – 278, 2011. Ng VY, Arora N, Best TM, Pan X, Ellis TJ: Efficacy of Surgery for Femoroacetabular Impingement. American Journal of Sports Medicine, 38(11): 2337 – 2345, 2010

327. Answer: B 2017

Many hip arthroscopists perform hip arthroscopy with just 2 portals – the Anterior and the Anterolateral portals. To allow for maneuverability, most surgeons also connect the two portals. Connecting these two portals results in cutting what structures:

- A) The Zona Orbicularis
- B) The Iliofemoral Ligament
- C) The Ischiofemoral Ligament
- D) The Pubofemoral Ligament
- E) The Ligamentum Teres

Discussion: The Iliofemoral Ligament is the capsuloligamentous structure that is cut when connecting the anterior and anterolateral portals.

Reference: Telleria JM, Lindsey DP, Giori NJ, Safran MR: An Anatomic Arthroscopic Description of the Hip Capsular Ligaments for the Hip Arthroscopist. *Journal of Arthroscopy and Related Research* 27(5): 628-636, 2011

328. Answer: A 2017

The Figures show the radiographs of a 75-year-old man who underwent a revision total knee arthroplasty with a long-stemmed tibial component. In rehabilitation, he reports fullness and tenderness in the proximal medial leg (at the knee). What strategy would best limit this postoperative problem?

- A) A base plate with an offset tibial stem attachment
- B) A bone ingrowth surface on the augment
- C) A non-stemmed tibial base plate
- D) Allograft bone instead of metal augments
- E) Bone cement to smooth the outline of the proximal medial tibia

Discussion: The problem with this reconstruction is the medial protrusion of the base plate. The use of a base plate with an offset stem can prevent the protrusion and thus the impingement and pain. Allograft bone or smoothing the outline with cement would be just as prominent and likely to cause pain. An ingrowth surface may improve soft-tissue attachment but would still leave the implant protruding medially and likely to cause pain. A nonstemmed tibial base plate would lead to less medial protrusion but at the expense of a smaller area for load carriage on the proximal tibia.



Reference: Gustke K: Cemented tibial stems are not requisite in revision. *Orthopedics* 2004;27:991-992

329. Answer: B 2017

The Figure shows the radiograph of a patient who underwent a total knee revision with a posterior stabilized mobile-bearing prosthesis and now has recurrent knee dislocations. What is the most likely cause?

- A) Loose extension gap
- B) Loose flexion gap
- C) Malrotation of the tibial component
- D) Malrotation of the femoral component
- E) Poor prosthetic design

Discussion: The patient has a posterior stabilized total knee revision, and the femoral component has dislocated over the tibial polyethylene cam/post. This usually indicates a loose flexion gap, or "flexion instability." A loose flexion gap can occur due to undersizing of the femoral component, anteriorization of the femoral component, excessive distal augmentation of the distal femur, or collateral ligament insufficiency, especially if combined with posterior capsular insufficiency. Isolated laxity of the extension gap (with a well-balanced flexion gap) causes varus/valgus instability, but it rarely causes the femoral component to "jump" the tibial cam of a posterior stabilized tibial insert. Malrotation of the components may cause patellar instability or a rotational instability of the tibiofemoral joint but should not cause a frank posterior dislocation of



the tibia, unless combined with other errors of balancing. Although a mobile-bearing total knee arthroplasty may be more sensitive to errors in balancing than a fixed-bearing total knee arthroplasty, this complication does not reflect a faulty prosthetic design.

References: Pellicci PM, Tria AJ Jr, Garvin KL (eds): Orthopaedic Knowledge Update: Hip and Knee Reconstruction Rosemont, IL, American Academy of Orthopaedic Surgeons, 2000, pp 339-365. Lotke PA, Garino JP: Revision Total Knee Arthroplasty. New York, NY, Lippincott-Raven, 1999, pp 173-186, 227-249. Clarke HD, Scuderi GR: Flexion instability

330. Answer: B 2017

The Figure shows the radiograph of an active 60-year-old woman. Which of the following variables is considered the strongest contraindication to a unicompartmental knee arthroplasty in this patient?

- A) Obesity
- B) Fixed varus deformity of more than 15 degrees
- C) Five degree flexion contracture
- D) Contralateral knee osteoarthritis
- E) Joint subluxation of 5 mm



Discussion: Unicompartmental arthroplasty of the knee for single compartment arthrosis has recently become more popular.

Contraindications to unicompartmental knee arthroplasty include fixed varus or valgus deformity of more than 5 degrees, restricted range of motion, fixed flexion contracture, joint subluxation of 5 mm or greater, and arthrosis of the opposite and/or patellofemoral compartment.

Reference: Cossey AJ, Spriggins AJ: The use of computer-assisted surgical navigation to prevent malalignment in unicompartmental knee arthroplasty. *J Arthroplasty* 2005; 20:29-34.

Iorio R, Healy WL: Unicompartmental arthritis of the knee. *J Bone Joint Surg Am* 2003; 85:1351-1364.

Argenson JN, Chevrol-Benkedache Y, Aubaniac JM: Modern unicompartmental knee arthroplasty with cement: A three to ten-year follow-up study. *J Bone Joint Surg Am* 2002; 84:2235-2239.

331. Answer: C

Which of the following is the strongest contraindication to unicompartmental knee arthroplasty (UKA)?

- A) Patient age of younger than 60 years
- B) Patient age of older than 80 years
- C) Anterior cruciate ligament (ACL) deficiency
- D) Varus deformity of 5 degrees
- E) Outerbridge grade II chondromalacia of the patella

Discussion: UKA prostheses cannot substitute for an absent ACL, and if arthroplasty is indicated, these patients should receive a total knee arthroplasty rather than a UKA. Age is not an absolute contraindication, and the procedure has been advocated for young patients as well as older patients if they meet the appropriate indications for an arthroplasty. Varus deformities of the mechanical axis of up to 10 degrees generally are not a contraindication to unicompartmental arthroplasty, as long as the knee can be properly balanced at the time of surgery. Modest chondromalacia of the patellofemoral joint, especially if asymptomatic, is not a contraindication to UKA.

References: Lotke PA (ed): Knee Arthroplasty: Master Techniques in Orthopaedic Surgery. New York, NY, Raven Press, 1995, pp 275-293. Insall JN, Windsor RE, Scott WN, et al (eds): Surgery of the Knee, ed 2. New York, NY, Churchill Livingstone, 1993, pp 805-814.

Tabor OB Jr, Tabor OB: Unicompartmental arthroplasty: A long-term follow-up study. *J Arthroplasty* 1998;13:373-379.

332. Answer: D

A 38-year-old man who is an avid tennis player has had persistent pain over the medial aspect of his knee for the past 6 years. He notes that the pain occurs on a daily basis with any significant activity. Nonsteroidal anti-inflammatory drugs have failed to provide relief. What is the best course of action?

- A) Total knee arthroplasty
- B) Unicompartmental arthroplasty
- C) Insertion of a unispacer
- D) Tibial osteotomy
- E) Knee arthroscopy

Discussion: In a relatively young patient who is an avid tennis player, the treatment of choice is a joint preserving procedure. The radiographs reveal varus alignment with loading of the medial compartment. After all nonsurgical management options have been used, the best treatment option is a medial opening wedge osteotomy. A lateral closing wedge osteotomy of the proximal tibia is also a reasonable option, but it is not one of the choices. Unicompartmental arthroplasty or a total knee arthroplasty would place significant restrictions in this patient. A unispacer may be a temporizing procedure but is controversial and without substantial data in the literature. The knee arthroscopy will not address the medial compartment osteoarthritis.



References: Nagel A, Insall JN, Scuderi GR: Proximal tibial osteotomy: A subjective outcome study. *J Bone Joint Surg Am* 1996;78:1353-1358.

Rinonapoli E, Mancini GB, Corvaglia A, et al: Tibial osteotomy for varus gonarthrosis: A 10- to 21-year followup study. *Clin Orthop* 1998;353:185-193.

Manifold SG, Kelly MA, Richardson L, et al: Osteotomies about the knee, in Fitzgerald RH, Kaufer H, Malkani AL (eds): *Orthopaedics*. St Louis, MO, Mosby, 2002, pp 947-961.

333. Answer: B

Which of the following statements best describes the outcome of the routine use of continuous passive motion (CPM) machines after total knee arthroplasty (TKA)?

- A) CPM is likely to improve early range of motion and final range of motion
- B) CPM may improve early range of motion but is unlikely to improve final range of motion
- C) CPM is likely to decrease postoperative pain
- D) CPM is likely to improve extension but not flexion
- E) CPM is likely to restore quicker ambulatory ability

Discussion: Although CPM machines are used widely in the United States for patients undergoing TKA, the benefit seems to be marginal, if any. Numerous randomized trials have shown that final outcomes after total knee arthroplasty are unaffected by the use of CPM machines postoperatively. Some studies have suggested that use of CPM may improve flexion in the first few weeks, but any short-term benefit from the machine was lost by intermediate-term follow-up. Aside from potential improvement in flexion within the first few postoperative weeks, there does not appear to be any benefit from the machines. There is no improvement in pain, ambulation, or extension. The cost-effectiveness of these machines has been questioned by many authors.

References: Pellicci PM, Tria AJ, Garvin KL (eds): *Orthopaedic Knowledge Update: Hip and Knee Reconstruction 2*. Rosemont, IL, American Academy of Orthopaedic Surgeons, 2000, pp 287-293.

McInnes J, Larson MG, Daltroy LH, et al: A controlled evaluation of continuous passive motion in patients undergoing total knee arthroplasty. *JAMA* 1992;268:1423-1428.

Kumar PJ, McPherson EJ, Dorr LD, et al: Rehabilitation after total knee arthroplasty: A comparison of 2 rehabilitation techniques. *Clin Orthop* 1996;331:93-101.

334. Answer: A

Figure 25 shows the radiograph of an 84-year-old woman who has pain and is unable to extend her knee. History reveals that she underwent total knee arthroplasty 8 years ago. Aspiration and studies for infection are negative. During revision surgery, management of the tibial bone loss should consist of:

- A) Reconstruction with a metal augmented revision tibial implant
- B) Reconstruction with a hinged prosthesis
- C) Reconstruction with a structural allograft
- D) Reconstruction with iliac crest bone graft
- E) Filling the defect with cement

Discussion: Massive bone loss encountered in revision total knee arthroplasty remains a significant challenge. Recent reports have shown high success rates using structural allograft to reconstruct large structural bone defects. A hinged prosthesis is not required in this setting. In this patient, a large amount of posterior cortex has been lost, making the area too large to fill with cement or iliac crest bone graft. Because of her age, the treatment of choice is a revision tibial implant and metal augments. Structural allograft would be suitable in a younger patient.



References: Mow CS, Wiedel JD: Structural allografting in revision total knee arthroplasty. *J Arthroplasty* 1996;11:235-241.

Engh GA, Herzurm PJ, Parks NL: Treatment of major defects of bone with bulk allografts and stemmed components during total knee arthroplasty. *J Bone Joint Surg Am* 1997;79:1030-1039.

Clatworthy MG, Ballance J, Brick GW, et al: The use of structural allograft for uncontained defects in revision total knee arthroplasty: A minimum five-year review. *J Bone Joint Surg Am* 2001;83:404-411.

335. Answer: D

A 78-year-old patient undergoing revision total knee arthroplasty has bone loss throughout the knee at the time of revision. A distal femoral augment is used to restore the joint line. One month after surgery, the patient reports pain and is unable to ambulate. A lateral radiograph is shown in the Figure. What is the most likely etiology of this problem?

- A) Inadequate restoration of the joint line
- B) Patellar tendon rupture
- C) Excessive internal rotation of the tibial component
- D) Flexion gap instability
- E) Hyperextension of the femoral component

Discussion: Instability is a leading cause of failure following total knee arthroplasty. Instability can present as global instability, extension gap (varus/valgus) instability, or flexion gap (anterior/posterior) instability. Treatment options are numerous based on the exact pathology. The radiograph reveals anterior/posterior instability with dislocation consistent with flexion gap instability. A loose flexion gap can allow the femoral component to ride above the tibial cam post mechanism, resulting in dislocation. Distal femoral augments treat extension gap instability, whereas tibial augments can treat both flexion and extension gap instability. Posterior condyle augments at the distal femur can also be used to treat flexion gap instability. Flexion gap instability is further aggravated by extension mechanism incompetence. Note the excessively thin patella on the lateral radiograph.

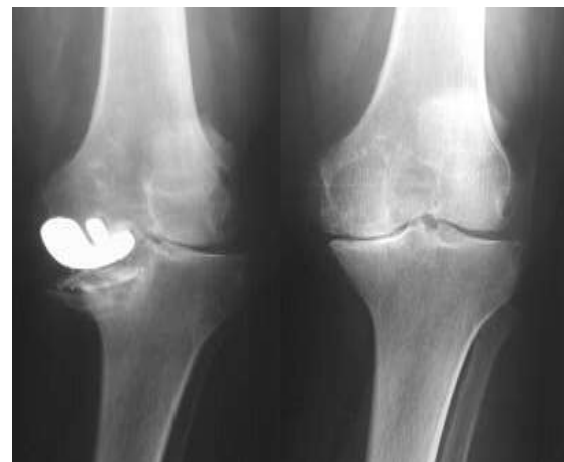


References: Pagnano MW, Hanssen AD, Lewallen DG, et al: Flexion instability after primary cruciate retaining total knee arthroplasty. *Clin Orthop* 1998;356:39-46.
 McAuley J, Engh GA, Ammeen DJ: Treatment of the unstable total knee arthroplasty. *Inst Course Lect* 2004;53:237-241.
 Naudie DD, Rorabeck CH: Managing instability in total knee arthroplasty with constrained and linked implants. *Instr Course Lect* 2004;53:207-215.

336. Answer: D

One Figure shows the AP radiograph of a 70-year-old patient who is scheduled to undergo unicompartmental knee arthroplasty. The second Figure shows the immediate postoperative radiograph, and the radiograph obtained 6 months after surgery, shows a medial tibial plateau fracture. The etiology of the fracture is best related to:

- A) Marked osteoporosis
- B) Reduced contact area of a unicompartmental knee arthroplasty for load transmission
- C) Excessive medial placement of the tibial component of the unicompartmental knee arthroplasty
- D) Multiple drill holes that violate the medial cortex
- E) Osteonecrosis of the medial tibial plateau



Discussion: While all of the above may contribute to the etiology of a tibial plateau fracture following unicompartmental knee arthroplasty, the recent literature has clearly noted that pin placement for fixation of tibial resection guides is the most critical factor associated with a tibial plateau fracture following unicompartmental knee arthroplasty. Vince and Cyran suggest that fractures associated with unicompartmental knee arthroplasty might be avoidable by limiting the number and paying attention to the location of the pin holes that are created to secure the tibial resection guides. Brumby and associates suggest avoiding multiple guide pin holes in the proximal tibia for unicompartmental knee arthroplasty. They currently recommend the use of one centrally placed pin and an ankle clamp to stabilize the resection guide. Yang and associates note that a medial tibial plateau fracture in association with minimally invasive unicompartmental knee arthroplasty can be eliminated by avoiding fixation pins close to the medial tibial cortex.

References: Brumby SA, Carrington R, Zayontz S, et al: Tibial plateau stress fracture: A complication of unicompartmental knee arthroplasty using 4 guide pinholes. *J Arthroplasty* 2003;18:809-812.
 Yang KY, Yeo SJ, Lo NN: Stress fracture of the medial tibial plateau after minimally invasive unicompartmental knee arthroplasty: A report of 2 cases. *J Arthroplasty* 2003;18:801-803.
 Vince KG, Cyran LT: Unicompartmental knee arthroplasty: New indications, more complications? *J Arthroplasty* 2004;19:9-16.

337. Answer: D

What of the following are viable options for managing bone loss in revision TKA?

- A) Cement augmentation for small defects
- B) Modular metal augments and/or allograft for larger defects
- C) Tibial and/or femoral porous cones/sleeves
- D) All of the above



Discussion: Managing defects in Revision TKA can be challenging. Pre-operative planning is required and the defect size, location, and containment may require one or all of the above augmentation options during reconstruction to provide both length and rotational stability to the final implant construct.

References:

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Barnett, Mayer, Gondusky, Patel, Gorab. The Use of Stepped Porous Metaphyseal Sleeves for Tibial Defects in Revision TKA. *Journal of Arthroplasty* 29 (2014) 1219-1224

338. Answer: E

A 69-year-old patient presents to the emergency room with wound healing problems three weeks following total knee arthroplasty. Blood tests are done with C-reactive protein= 12.6 mg/L and Erythrocyte sedimentation rate=56 mm/hr. What is the next step in management?

- A) Administration of oral antibiotic and recheck of wound in two weeks
- B) Admission for observation and intravenous antibiotic administration
- C) Irrigation and debridement
- D) One or two stage exchange
- E) Aspiration of the joint

Discussion: According to the Guidelines issued by the American Academy of Orthopedic Surgeons (AAOS) for diagnosis of periprosthetic joint infection, patients with abnormal serology should undergo aspiration of the joint. The aspirate needs to be sent for cell count, neutrophil percentage, and culture. Recent studies have determined the appropriate threshold for cell count and neutrophil percentage both in the acute setting (as is the case here) and later time points for patients with suspected chronic periprosthetic joint infection.

References: Della Valle C, Parvizi J, Bauer TW, Dicesare PE, Evans RP, Segreti J, Spnaghel M, Watters WC, Keith M, Turkleson CM, Wies JL, Hitchcock K. American Academy of Orthopaedic Surgeons Clinical Guideline on: The Diagnosis of periprosthetic joint infections. *J Bone Joint Surg* 20:93(14): 1355-7, 2011

Bedair H, Ting N, Jacovides C, Saxena A, Moric M, Parvizi J, Della Valle CJ. The Mark Coventry Award: Diagnosis of Early Postoperative TKA Infection Using Synovial Fluid Analysis. *ClinOrthopRelat Res* 469(1): 34-40, 2011.

Ghanem E, Parvizi J, Burnett S, Sharkey PF, Keshavarzi N, Aggarwal A, Barrack RA. Cell count and differential of aspirated fluid in the diagnosis of infected total knee arthroplasty. *J Bone and Joint Surg*, 90(8): 1637-43, 2008

339. Answer: D

A 72 year-old-patient has undergone a prior two-stage exchange arthroplasty of the knee for infection. Recent recurrence of infection lead to resection arthroplasty and antibiotic cement spacer insertion of the same knee. The infecting organism is *Candida Albicans*. Which of the following anti-fungal agents is known to have activity against *Candida* species and be thermostable with good elution profile when added to polymethylmethacrylate?

- A) Amphotericin
- B) Anidulafungin
- C) Itraconazole
- D) Voriconazole
- E) Flucytosine

Discussion: Treatment of periprosthetic joint infection caused by fungal agents is challenging. Excision arthroplasty and prolonged intravenous antifungal agents appear to be the mainstay of therapy. Delivery of local antifungal agents by addition to PMMA is also preferred. Although amphotericin can be added to PMMA and appears to be thermostable, its elution from cement is very poor. An agent with excellent elution profile is fluconazole. Unfortunately the latter is not available in sterile powder form and hence cannot be added to PMMA spacer. Voriconazole is available in powdered form and is thermostable which makes it suitable for incorporation in polymethylmethacrylate spacer. Using this method, very high local concentrations of voriconazole are achieved

which would be expected to sterilize the operative site, whilst avoiding any potential systemic side effects of voriconazole. Although all of the agents listed have activity against *C. albicans*, only voriconazole is thermostable with good elution profile from PMMA.

References: Grimsrud C, Raven R, Fothergill AW, Kim HT. The in vitro elution characteristics of antifungal-loaded PMMA bone cement and calcium sulfate bone substitute. *Orthopedics*.8;34(8), 2011.

Azzam K, Parvizi J, Jungkind D, Hanssen A, Fehring T, Springer B, Bozic K, Della Valle C, Pulido L, Barrack R. Microbiological, clinical, and surgical features of fungal prosthetic joint infections: a multi-institutional experience. *J Bone Joint Surg Am*. 2009 Nov;91Suppl 6:142-9.

340. Answer: D

A 56 year old woman undergoes irrigation and debridement of an infected total knee arthroplasty and is placed on an antibiotic. She develops redness of skin involving her entire body. The antibiotic is discontinued. Which of the following antibiotics is likely to have been used:

- A) Clindamycin
- B) Tobramycin
- C) Erythromycin
- D) Vancomycin
- E) Gentamycin

Discussion: The culprit here is likely to be vancomycin. This is the typical “red man syndrome” that has been associated with vancomycin. Vancomycin can cause two types of hypersensitivity reactions, the red man syndrome and anaphylaxis. Red man syndrome has often been associated with rapid infusion of the first dose of the drug and was initially attributed to impurities found in vancomycin preparations. Even after improvement in vancomycin's purity, however, reports of the syndrome persist. The syndrome is a result of histamine release by mast cells. Although other anti-infective agents such as ciprofloxacin, amphotericin B, rifampicin and teicoplanin can also cause this syndrome, this problem is commonly associated with vancomycin. Discontinuation of the vancomycin infusion and administration of diphenhydramine can abort most of the reactions.

References: Davis RL, Smith AL, Koup JR. The 'red man's syndrome' and slow infusion of vancomycin [letter]. *Ann Intern Med*. 1986;104:285–286

Williams PD, Laska DA, Shetler TJ, McGrath JP, White SL, Hoover DM. Vancomycin-induced release of histamine from rat peritoneal mast cells and a rat basophil cell line (RBL-1). *Agents Actions*. 1991;32:217–223

341. Answer: C

Patients with ankylosing spondylitis undergoing total knee arthroplasty are likely to experience which of the following complications:

- A) Infection
- B) Instability
- C) Heterotypic ossification
- D) Periprosthetic fracture
- E) Patellar loosening

Discussion: Patients with ankylosing spondylitis are likely to have achieved significant pain relief and improvement in function following total knee arthroplasty. These patients, however, are also likely to experience a higher incidence of complications particularly stiffness and heterotopic ossification. In one series the incidence of HO following TKA in patients with AS was 20 percent.

References: Parvizi J, Duffy GP, Trousdale RT: Total Knee Arthroplasty in Patients with Ankylosing Spondylitis. *J. Bone Joint Surg*. 83 (A): 1312-1316, 2001

Fintersbush, A.; Amir, D.; Vatahki, E.; and Hussein, N.: Joint surgery in severe ankylosing spondylitis. *Acta Orthop Scand* 59: 491-496, 198

342. Answer: A

Hip arthroscopy mobility is limited due to a deep soft tissue envelope and dense capsule, as well as constrained bony anatomy. The areas hardest to see is:

- A) The PosteroInferior Femoral Head
- B) The Lateral Femoral Head
- C) The Posterior Acetabulum
- D) The Anterior Acetabulum
- E) The Ligamentum Teres

Discussion: The posteroinferior femoral head is the most difficult area to see arthroscopically

Reference: Bond JL, Knutson ZA, Ebert A, Guancho CA: The 23-point Arthroscopic Examination of the Hip: Basic Setup, Portal Placement, and Surgical Technique. *Arthroscopy* 25(4): 416 – 429, 2009

343. Answer: D

The structure that serves as an arthroscopic reference landmark in the peripheral compartment of the hip is the:

- A) Transverse Ligament
- B) Lesser Trochanter
- C) Intertrochanteric Line
- D) Medial Synovial Fold
- E) Ischiofemoral Ligament

Discussion: The medial synovial fold serves the reference landmark for the peripheral compartment of the hip.

Reference: Dienst M, Godde S, Seil R, Hammer D, Kohn D. Hip arthroscopy without traction: In vivo anatomy of the peripheral hip joint cavity. *Arthroscopy* 17: 924-931, 2001.

344. Answer: E

The best way to access the peripheral compartment of the hip for hip arthroscopy is:

- A) Hip Abduction
- B) Traction of 50 lbs
- C) Hip Adduction
- D) Hip External Rotation
- E) Hip Flexion

Discussion: Hip flexion relaxes the anterior capsule to allow access to the peripheral compartment. This is done with traction off.

References: Dienst M, Gödde S, Seil R, Hammer D, Kohn D. Hip arthroscopy without traction: In vivo anatomy of the peripheral hip joint cavity. *Arthroscopy* 17:924-931, 2001.

Dienst M. Hip arthroscopy: Technique and anatomy. *OperTech Sports Med*13:13-23, 2005

345. Answer: E

Causes of Pincer Impingement include all of the following except:

- A) CoxaProtrusio
- B) Relative Cranial Retroversion
- C) Retroversion of the Acetabulum
- D) CoxaProfunda
- E) Loss of Femoral Head Neck Offset

Discussion: Pincer impingement is acetabular based impingement. Causes include over coverage of the femoral head by the acetabulum – either globally, such as protrusion or profunda, or focally, such as cranial retroversion. Retroversion also causes anterior over coverage. Loss of femoral head neck offset is cam impingement

Reference: Beck M, Kalhor M, Leunig M, Ganz R: Hip Morphology Influences The Pattern of Damage to the Acetabular Cartilage: Femoroacetabular Impingement As A Cause of Early Arthritis of the Hip. J Bone Joint Surg 87(B): 1012 – 1018, 2005

346. Answer: C

Causes of Cam impingement include all of the following except:

- A) Loss of femoral head-neck offset
- B) Residuals of slipped capital femoral epiphysis (SCFE)
- C) Valgus femoral neck
- D) Short femoral neck
- E) Varus Femoral neck
- F) Residuals of Legg Calve Perthes

Discussion: Cam impingement is the result of loss of femoral head neck offset, that may be the result of slipped capital femoral epiphysis, or coxa magna, varus femoral neck or short femoral neck. Valgus femoral neck does not result in cam impingement.

Reference: Beck M, Kalhor M, Leunig M, Ganz R: Hip Morphology Influences The Pattern of Damage to the Acetabular Cartilage: Femoroacetabular Impingement As A Cause of Early Arthritis of the Hip. J Bone Joint Surg 87(B): 1012 – 1018, 2005

347. Answer: C

In a 17 year old high school football player, which of the following grafts has the highest rate of early re-rupture?

- A) Hamstring autograft
- B) Patella tendon autograft
- C) Tibialis allograft
- D) Quadriceps tendon autograft
- E) All have an equal chance of re-rupture

Discussion: In one study the authors concluded that young, active individuals having undergone an allograft ACL reconstruction were significantly more likely to experience clinical failure requiring revision reconstruction compared with those who underwent autologous graft reconstruction. Another study found that a high activity allograft group was 2.6 to 4.2 times more likely to fail when compared with low-activity allografts and low- and high-activity autografts. Thus, allografts have a higher failure rate when used in younger patients.

References: Pallis M, Svoboda SJ, Cameron KL, Owens BD: Survival comparison of allograft and autograft anterior cruciate ligament reconstruction at the United States Military Academy. Am J Sports Med. 2012 Jun;40(6):1242-6. PMID: 22534281

Barrett GR, Lubert K, Replogle WH, Manley JL: Allograft anterior cruciate ligament reconstruction in the young, active patient: Tegner activity level and failure rate. Arthroscopy. 2010 Dec;26(12):1593-601. PMID:20952145

348. Answer: B

Double bundle ACL reconstruction results in slightly less anterior knee laxity near full knee extension but also results in:

- A) Higher graft forces with knee flexion
- B) Higher graft forces with knee extension
- C) Lower graft forces with knee flexion
- D) Lower graft forces with knee extension
- E) No change in graft in graft forces

Discussion: The mean laxities for single-bundle reconstructions were within 1.1 mm of those of the intact knee between 0 degrees and 90 degrees. The single-bundle reconstruction produced graft forces, knee laxities, and coupled tibial rotations that were closest to normal. Double bundle ACL reconstruction tended to reduce laxities, but the reductions were accompanied by markedly higher forces in the posterolateral graft near 0 degrees.

Reference: Markolf KL, Park S, Jackson SR, McAllister DR: Anterior-posterior and rotatory stability of single and double-bundle anterior cruciate ligament reconstructions. J Bone Joint Surg Am. 2009 Jan;91(1):107-18. PMID: 19122085

349. Answer: E

PCL Injuries in athletes occur most frequently with which of the following injury mechanisms?

- A) Fall on flexed knee with foot plantarflexed
- B) Hyperflexion
- C) Hyperextension
- D) Posteriorly directed force applied to proximal tibia with the knee flexed (“dashboard injury”)
- E) Varus stress

Discussion: The most common mechanism of PCL injury in athletes is a posterior-directed blow to the proximal tibia with the knee in flexion and the foot plantar flexed. However, hyperflexion or hyperextension in the presence or absence of a posterior-directed tibial force have also been implicated as injury mechanisms.

Reference: F. Petrigliano, D. McAllister: Isolated posterior cruciate ligament injuries of the knee. Sports Med Arthrosc. 2006 Dec;14(4):206-12. PMID: 17135970

350. Answer: B

What is the best physical examination maneuver to make the diagnosis of an isolated PCL injury?

- A) Anterior drawer test
- B) Posterior drawer test
- C) Pivot shift test
- D) Jerk test
- E) McMurray’s test

Discussion: The most accurate test for assessing PCL integrity is the posterior drawer test. The posterior drawer test is performed with the patient supine with the hip flexed to 45 degrees, the knee flexed to 90 degrees, and the foot in neutral position. Both hands are placed behind the subject’s proximal tibia and a posterior-directed force is applied to the tibia, assessing the position of the medial tibial plateau relative to the medial femoral condyle. It is important to realize that the tibial plateau will sublux posteriorly in this position with a PCL injury. Thus, the examiner must first reduce the tibia by pulling anteriorly. This is followed by applying a posteriorly directed force. The magnitude of posterior translation is assessed and this measurement is utilized to grade the degree of laxity. Posterior displacement of 0-5 mm is designated a Grade I injury, 5-10 mm a Grade II injury, and greater than 10 mm a Grade III injury.

References: Petrigliano, D. McAllister: Isolated posterior cruciate ligament injuries of the knee. Sports Med Arthrosc. 2006 Dec;14(4):206-12. PMID: 17135970

D. McAllister, F. Petrigliano: Diagnosis and treatment of posterior cruciate ligament injuries. Curr Sports Med Rep. 2007 Oct;6(5):293-9. PMID: 17883964

351. Answer: C

In comparison to patients with normal patellar height ratio, patients with patella alta exhibit which of the following findings on MR imaging in knee extension?

- A) The patella is located in a more medial position relative to the center of the trochlear groove.
- B) (Lateral) patellar tilt is not significantly different
- C) Contact area between patellar and trochlear cartilage surfaces is reduced
- D) The patella is more flexed with respect to the femur

Reference: (Ward, Terk et al. 2007)

352. Answer: D

Which of the following statements regarding infrapatellar contracture syndrome is false?

- A) It is associated with patella infera
- B) It is associated with loss of knee extension torque
- C) It is associated with loss of knee flexion
- D) Its mechanical effects can be replicated simply by surgical distalization of the tibial tuberosity

Discussion: Infrapatellar contracture syndrome is a complex deformity of the infrapatellar and retropatellar tissues. Laboratory models involving simple shortening or lowering of the patellar tendon do not re-create its mechanical effects.

Reference: (Paulos, Wnorowski et al. 1994; Meyer, Brown et al. 1997; Ahmad, Kwak et al. 1998; Upadhyay, Vollans et al. 2005)

353. Answer: E

A 15 year old girl presents with a patellar dislocation after twisting her knee in a soccer game. In counseling her and her family about management, which of the following has the greatest impact on future risk of patellar dislocation:

- A) Examination reveals a tight lateral retinaculum
- B) Lateral xrays show Type B trochlear dysplasia
- C) Lateral xrays show patella alta
- D) There is a positive family history of patellar problems
- E) The patient reports a prior history of patellar dislocation

Discussion: Prior history of patellar dislocation is associated with a 50% risk of subsequent patellar instability, more than twice the risk for patients with no prior history of patellar instability.

Reference: Fithian, Paxton et al. 2004)

354. Answer: A

A 17 year old male basketball player is considering patellar stabilization for recurrent disabling patellar instability including multiple dislocations. Which of the following surgical interventions is NOT indicated for treatment of patellar instability?

- A) Isolated lateral release
- B) MPFL reconstruction
- C) Elmslie-Trillat distal realignment
- D) MPFL repair and distal realignment

Discussion: Isolated lateral release is rarely indicated and is not recommended by experts in a published survey (Fithian, Paxton et al. 2004). Outcomes of lateral release for instability have been disappointing (Fabbriani, Panni et al. 1992; Panni, Tartarone et al. 2005).

References: Ahmad, C. S., S. D. Kwak, et al. (1998). "Effects of patellar tendon adhesion to the anterior tibia on knee mechanics." *Am J Sports Med* 26(5): 715-724.

The effects of patellar tendon adhesion on the knee extensor mechanism and on the kinematics and contact areas for both the patellofemoral and tibiofemoral joints were determined for five cadaveric knees in an open kinetic chain testing configuration. Patellar tendon adhesion decreased the distance from the inferior patellar pole to the tibial tuberosity, effectively creating patella infera. When compared with the controls, knees with adhesion had medial and distal translation of the patella, as well as increased patellar flexion. Although the patellar articular

contact location shifted distally, the overall contact area did not change significantly. For the tibia, adhesion resulted in significant medial, proximal, and anterior translation, and internal rotation. Adhesion also resulted in a posterior shift of the tibial contact location. For the extensor mechanism, adhesion decreased the knee extension force created by the quadriceps muscle on the tibia, indicating a decrease in the effective moment arm of the extensor mechanism. Furthermore, as a result of patellar tendon adhesion, the angle formed by the quadriceps and patellar tendons decreased, suggesting an increase in patellofemoral joint reaction force with adhesion. The increased patellofemoral joint reaction force and the altered contact location may be related to anterior knee pain after knee trauma and knee surgery. Therefore, patients should be observed for subtle patella infera, which may indicate patellar tendon adhesion.

Fabbriciani, C., A. S. Panni, et al. (1992). "Role of arthroscopic lateral release in the treatment of patellofemoral disorders." Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association8(4): 531-536. The results of 50 arthroscopic lateral releases are reported. The average follow-up period was 36 months with a range of 18-52 months. Satisfactory results were achieved in 71% of 21 patients with patellar pain alone and in 76% of those (Betz RR, Lonergan R, Patterson R. The percutaneous lateral retinacular release *Orthopaedics* 1982;5:57-62) with instability. Patients with patellofemoral osteoarthritis or patellar dislocation were excluded from the series. Postoperative hemarthrosis occurred in 10%. Unsatisfactory results could be related to incomplete release, severe chondromalacia, or insufficient rehabilitation. Lateral release is capable of producing high rates of success with a low incidence of complication when used to treat patellar pain with tight retinaculum, patellar instability, and subluxation.

Fithian, D. C., E. W. Paxton, et al. (2004). "Lateral retinacular release: a survey of the International Patellofemoral Study Group." Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association20(5): 463-468. PURPOSE: The purpose of this investigation was to determine current views regarding lateral release among experienced knee surgeons with a specific interest in the patellofemoral joint. TYPE OF STUDY: Scientific survey. METHODS: A questionnaire was developed and mailed to all members of an international group with a specific interest in disorders of the patellofemoral joint. Frequencies and percentages of responses were calculated for each question to determine surgeon consensus. We measured agreement among responses using the kappa statistic. This provided an indication of consistency for each question as well as correlation among the responses to different questions. RESULTS: The survey response rate was 60%. Isolated lateral release was estimated to account for only 1 to 5 surgical cases per respondent per year, or 2% of cases performed annually. In the setting of arthroscopy or exploration, 74% of respondents believed that lateral release calls for specific informed consent. Strong consensus was found that objective evidence is needed to justify lateral release, but agreement was poor as to what clinical evidence provides the most appropriate indication for the procedure. CONCLUSIONS: Even among experienced knee surgeons with a special interest in diseases of the patellofemoral articulation, isolated lateral release is rarely performed. Strong consensus was found that isolated lateral release should not be undertaken without prior planning in the form of objective clinical indications and preoperative informed consent. LEVEL OF EVIDENCE: Level V.

Fithian, D. C., E. W. Paxton, et al. (2004). "Epidemiology and natural history of acute patellar dislocation." Am J Sports Med32(5): 1114-1121. BACKGROUND: The goals of this study were to (1) define the epidemiology of acute patellar dislocation, (2) determine the risk of subsequent patellar instability episodes (subluxation and/or redislocation) during the study period, and (3) identify risk factors for subsequent instability episodes. STUDY DESIGN: Prospective cohort study. METHODS: The authors prospectively followed 189 patients for a period of 2 to 5 years. Historical data, injury mechanisms, and physical and radiographic measurements were recorded to identify potential risk factors for poor outcomes. RESULTS: Risk was highest among females 10 to 17 years old. Patients presenting with a prior history of instability were more likely to be female ($P < .05$) and were older than first-time dislocation patients ($P < .05$). Fewer first-time dislocators (17%) had episodes of instability during follow-up than patients with a previous history of instability (49%) ($P < .01$). After adjusting for demographics, patients with a prior history had 7 times higher odds of subsequent instability episodes during follow-up than first time

dislocators (adjusted odds ratio = 6.6, $P < .001$). CONCLUSIONS: Patellar dislocators who present with a history of patellofemoral instability are more likely to be female, are older, and have greater risk of subsequent patellar instability episodes than first-time patellar dislocators. Risk of recurrent patellar instability episodes in either knee is much higher in this group than in first-time dislocators.

Meyer, S. A., T. D. Brown, et al. (1997). "Retropatellar contact stress in simulated patella infera." *Am J Knee Surg*10(3): 129-138. Six fresh-frozen cadaver knee joints were used to study changes in retropatellar contact mechanics accompanying patella infera. The knees were tested on a servohydraulic testing machine under conditions simulating stair descent at 10 degrees, 30 degrees, 60 degrees, and 90 degrees of knee flexion. A slotted metallic block mechanism embedded in the region of the tibial tubercle allowed selective distal offset of the patellar tendon insertion so as to model conditions of 0, 6, 13, 19, and 25 mm of patella infera. Patellofemoral and quadriceps tendofemoral contact areas and contact stresses were recorded using Pressensor contact film and quantitated using digital image analysis. Patella infera significantly altered retropatellar contact mechanics. Contact areas migrated proximally on the patella and decreased in size with progressive severity of patella infera. However, the peak and spatial mean retropatellar contact stresses were not elevated correspondingly. Apparently, quadriceps tendofemoral contact was initiated at progressively lower angles of knee flexion as the patella infera progressed. Under conditions of extreme infera at high flexion angles, the magnitude of tendofemoral contact force approached that of retropatellar contact force. These data indicate that in patella infera, patellofemoral contact stresses are not elevated appreciably. Therefore, the disabling symptoms associated with patella infera may be due to factors other than local mechanical overload.

Panni, A. S., M. Tartarone, et al. (2005). "Long-term results of lateral retinacular release." *Arthroscopy: the journal of arthroscopic & related surgery: official publication of the Arthroscopy Association of North America and the International Arthroscopy Association*21(5): 526-531. PURPOSE: We evaluated the outcomes of lateral retinacular release (LRR) after a long-term follow-up period of 5 to 12 years. TYPE OF STUDY: Long-term retrospective clinical follow-up study. PATIENTS AND METHODS: Between 1986 and 1994, 120 LRRs were performed in the Orthopaedic Department of the Catholic University of Rome. A total of 100 patients were evaluated. We divided the patients into 2 groups: group I contained 50 patients with patellar pain and no signs of instability; the remaining 50 patients, with clear signs of patellar instability, made up group II. Standard weight-bearing radiographs, axial views of the knee at 45 degrees, and dynamic computed tomography scans were performed in all patients preoperatively and at follow-up evaluation. Chondral damage was classified at the time of lateral release according to the criteria of Outerbridge and Dunlop. We used the Lysholm II score, which was modified for patellofemoral pathology and a clinical grading system of Busch and de Haven, to evaluate clinical outcomes at follow-up evaluation. RESULTS: In group I (pain), 70% reported satisfactory outcomes at follow-up evaluation compared with 50% in group II ($P < .05$) (instability). Compared with a previously published analysis of 3-year outcomes in this same patient population, there was very little change in group I patients, whereas group II showed a significant decrease in good outcomes over time. The worst results were obtained in cases with serious cartilage damage and exposure of the subchondral bone at the time of lateral release. CONCLUSIONS: LRR is a procedure offering a good percentage of success in the management of a stable patella with excessive lateral pressure and elective location of pain on the lateral retinaculum. In patellar instability the results are less favorable in long-term follow-up evaluation. The presence of high-grade joint surface injury is a poor prognostic indicator for lateral release. LEVEL OF EVIDENCE: Level IV.

Paulos, L. E., D. C. Wnorowski, et al. (1994). "Infrapatellar contracture syndrome. Diagnosis, treatment, and long-term followup." *Am J Sports Med*22(4): 440-449. Infrapatellar contracture syndrome is an uncommon but recalcitrant cause of reduced range of motion after knee surgery or injury. The results and conclusions presented here are based on a retrospective clinical study evaluating the long-term outcome in 75 patients who developed infrapatellar contracture syndrome. These 75 patients (76 knees) were evaluated at an average followup of 53 months after the index (inciting) procedure or injury. Comparing subgroups within the study population, factors that correlated with poorer results or more severe infrapatellar contracture syndrome were found to be acute anterior cruciate ligament repair or reconstruction, the use of patellar tendon autograft for anterior cruciate ligament reconstruction, nonisometric graft placement, multiple surgical procedures, use of closed manipulation, and the development of patella infera. We concluded that appropriate procedures can substantially increase the

range of motion in patients with infrapatellar contracture syndrome. However, residual functional morbidity persists in many patients, and the outcome, as determined by subjective knee function scores, is only fair. The natural history of an anterior cruciate ligament-deficient knee appears to be more benign than the natural history of a knee that develops infrapatellar contracture syndrome.

Upadhyay, N., S. R. Vollans, et al. (2005). "Effect of patellar tendon shortening on tracking of the patella." The American journal of sports medicine33(10): 1565-1574. BACKGROUND: Although 10% postoperative patellar tendon shortening after bone-patellar tendon-bone autograft reconstruction of the anterior cruciate ligament has been reported, there are no published studies assessing the effect of shortening on patellofemoral joint biomechanics under physiological loading conditions. PURPOSE: To investigate the influence of patellar tendon shortening on patellofemoral joint biomechanics. STUDY DESIGN: Controlled laboratory study. METHODS: The authors evaluated the patellofemoral contact area, the location of contact, and the patellofemoral joint reaction force and contact stresses in 7 cadaveric knees before and after 10% patellar tendon shortening. Shortening was achieved using a specially designed device. Experimental conditions simulating those occurring during level walking were employed: physiological quadriceps loads and corresponding angles of tibial rotation were applied at 15 degrees, 30 degrees, and 60 degrees flexion of the knee. Patellofemoral joint contact areas were measured before and after shortening using the silicone oil-carbon black powder suspension squeeze technique. RESULTS: After patellar tendon shortening, patellofemoral joint contact areas were displaced proximally on the patellar surface and distally on the femoral surface. Although the contact area increased by 18% at 15 degrees of knee flexion ($P = .04$), no significant change occurred at 30 degrees or 60 degrees of knee flexion ($P > .05$). Patellofemoral contact stress remained unchanged after patellar tendon shortening ($P > .05$) at each flexion angle. CONCLUSION: Our results suggest that a 10% shortening of the patellar tendon does not alter patellar contact stresses during locomotion. It is not clear whether apparent changes in contact location in all positions and contact area at 15 degrees would have clinical consequences.

Ward, S. R., M. R. Terk, et al. (2007). "Patella alta: association with patellofemoral alignment and changes in contact area during weight-bearing." J Bone Joint Surg Am89(8): 1749-1755. BACKGROUND: Patella alta is a condition which may predispose individuals to patellofemoral joint dysfunction. We compared patellofemoral joint alignment and contact area in subjects who had patella alta with subjects who had normal patellar position, to determine the effect of high vertical patellar positions on knee extensor mechanics. METHODS: Twelve subjects with patella alta and thirteen control subjects participated in the study. Lateral patellar displacement (subluxation), lateral tilt, and patellofemoral joint contact area were quantified from axial magnetic resonance images of the patellofemoral joint acquired at 0 degrees, 20 degrees, 40 degrees, and 60 degrees of knee flexion with the quadriceps contracted. RESULTS: With the knee at 0 degrees of flexion, the subjects with patella alta demonstrated significant differences compared with the control group, with greater lateral displacement (mean [and standard error], 85.4% +/- 3.6% and 71.3% +/- 3.0%, respectively, of patellar width lateral to the deepest point in the trochlear groove; $p = 0.007$), greater lateral tilt (mean, 21.6 degrees +/- 1.9 degrees and 15.5 degrees +/- 1.8 degrees; $p = 0.028$), and less contact area (157.6 +/- 13.7 mm² and 198.8 +/- 14.3 mm²; $p = 0.040$). Differences in displacement and tilt were not observed at greater knee flexion angles; however, contact area differences were observed at all angles evaluated. When data from both groups were combined, the vertical position of the patella was positively associated with lateral displacement and lateral tilt at 0 degrees of flexion and was negatively associated with contact area at all knee flexion angles. CONCLUSIONS: These data indicate that the vertical position of the patella is an important structural variable that is associated with patellofemoral malalignment and reduced contact area in patients with patella alta.

355. Answer: B

Which of the following indications has the best overall outcome for RTSA?

- A) 4-part proximal humerus fracture
- B) Cuff tear arthropathy
- C) Revision for failed TSA
- D) Primary OA
- E) Chronic shoulder instability

Discussion: When comparing the outcomes of reverse total shoulder arthroplasty, patients with a primary diagnosis of cuff tear arthropathy have the best overall outcomes when evaluating pain scores, range of motion, and functional outcome scores.

References: Kelly JD 2nd, Zhao JX, Hobgood ER, Norris TR. Clinical results of revision shoulder arthroplasty using the reverse prosthesis. *J Shoulder Elbow Surg.* 2012 Nov;21(11):1516-25.

Boyle MJ, Youn SM, Frampton CM, Ball CM. Functional outcomes of RTSA vs hemiarthroplasty for acute proximal humeral fractures. *JSES* 2013. Jan; 22(1)32-.7.

356. Answer: A

When comparing knotless constructs to suture anchors for arthroscopic shoulder labral stabilization, which of the following is true?

- A) The knotless devices have a lower single load to displace 2 mm
- B) There is no biomechanical difference between the knotless construct and the suture anchors
- C) Clinical studies show improved redislocation rates with knotless devices
- D) The knotless device has a higher load to failure than the standard suture anchor with cyclic loading
- E) Operative time is significantly less with knotless anchors

Discussion: Provencher et al, evaluated the stability of knotless devices compared to standard suture anchors in a biomechanical study. They found that the knotless devices had a lower single load to 2 mm displacement compared to standard suture anchors. However, no clinical differences have been noted at this time.

Reference: [A biomechanical analysis of anterior Bankart repair using suture anchors.](#) Nho SJ, Frank RM, Van Thiel GS, Wang FC, Wang VM, Provencher MT, Verma NN.

Am J Sports Med. 2010 Jul;38(7):1405-12. doi: 10.1177/0363546509359069. Epub 2010 Apr 1.

357. Answer: B

Which of the following regarding rotator cuff tears is true?

- A) Double row and transosseous equivalent repairs have a lower re-tear rate for all tears
- B) Transosseous repairs have an improved footprint restoration when compared to other repair constructs
- C) Muscle atrophy and fatty infiltration are reversible after repair of massive rotator cuff tears
- D) MRI has a high sensitivity and specificity for subscapularis tears
- E) A high acromio-humeral index (>7 mm) suggests a chronic retracted rotator cuff tear

Discussion: Nassos et al demonstrated that the transosseous repairs had improved footprint restoration with a watertight construct compared to traditional single row and double row repairs. MRI is relatively low sensitivity and specificity for subscapularis tears, especially compared to supraspinatus tears. Many studies have shown that atrophy and fatty infiltration are not reversible after massive cuff repair. A low (not how) AHI suggests a chronic retracted cuff tear.

Reference: Nassos JT, Elattrache NS, Angel MJ, Tibone JE, Limpisvasiti O, Lee TQ. A watertight construct in arthroscopic rotator cuff repair. *JSES* 2012.

358. Answer: B

When considering outcomes of reverse shoulder arthroplasty in younger (less than 60) patients, which of the following is true?

- A) ASES scores were significantly lower in younger patients than older patients
- B) Complication rates were higher in younger patients than older patients
- C) Humeral component loosening is more common in younger patients
- D) Notching was more common in younger patients
- E) Range of motion was lower in younger patients than older patients

Discussion: Ek et al examined 41 patients under the age of 65 following reverse shoulder arthroplasty. They found that motion and outcome scores were equivalent compared to older cohorts, but complication rates were significantly higher with a higher revision rate.

Reference: Ek ET, Neukom L, Catanzaro S, Gerber S. Reverse total shoulder arthroplasty for massive irreparable rotator cuff tears in patients younger than 65 years old: results after five to fifteen years. JSES 2013 Feb 2

359. Answer: C

The structure most at risk with an anterior portal for hip arthroscopy is:

- A) The Femoral Artery
- B) The Femoral Nerve
- C) The Lateral Femoral Cutaneous Nerve
- D) The Lateral Femoral Circumflex Artery
- E) The Medial Femoral Circumflex Artery

Discussion: The lateral femoral cutaneous nerve

Reference: Byrd JW, Pappas JN, Pedley MJ. Hip arthroscopy: An anatomic study of portal placement and relationship to the extraarticular structures. Arthroscopy 11:418-423, 1995.

360. Answer: E

Literature has shown the best approach for management of combined type of femoroacetabular impingement in a young athletic male with Tonnis 0 radiographic changes is

- A) Open surgical dislocation
- B) Mini-open approach combined with arthroscopy
- C) Arthroscopy
- D) Peri-acetabular osteotomy
- E) No single approach has been shown to be superior

Discussion: Current meta-analyses have not demonstrated superiority of one approach (open surgical dislocation, mini-open and arthroscopy) over another at this time. Tonnis 0 is a rating for no arthritis. Peri-acetabular osteotomy is performed for hip dysplasia.

Reference: Matsuda DK, Carlisle JC, Arthurs SC, Wierks CH, Philippon MJ: Comparative Systematic Review of the Open Dislocation, Mini-Open and Arthroscopic Surgeries for Femoroacetabular Impingement. Arthroscopy 27(2): 252-269, 2011

Botser IB, Smith TW Jr, Nasser R, Domb BG: Open Surgical Dislocation versus Arthroscopy for Femoral Acetabular Impingement. A Comparison of Clinical Outcomes. Arthroscopy 27(2): 270 – 278, 2011

Ng VY, Arora N, Best TM, Pan X, Ellis TJ: Efficacy of Surgery for Femoroacetabular Impingement. American Journal of Sports Medicine, 38(11): 2337 – 2345, 2010

361. Answer: E 2020

The most common cause of graft failure following ACL reconstruction is:

- A) Re-injury
- B) Loss of fixation
- C) Tunnels place improperly
- D) Graft fails to incorporate
- E) Combination of factors

Discussion: Mode of failure as deemed by the revising surgeon was traumatic (32%), technical (24%), biologic (7%), combination (37%), and infection (<1%). Thus, traumatic reinjury was deemed by surgeons to be the most common single mode of failure, but a combination of factors represents the most common mode of failure.

Reference: Wright RW, et al: Descriptive epidemiology of the Multicenter ACL Revision Study (MARS) cohort. Am J Sports Med. 2010 Oct;38(10):1979-86.PMID: 20889962

362. Answer: A

A 75-year-old man presents with worsening low back and bilateral leg pain. The pain worsens with ambulation and improves with sitting. On exam, he has strong DP and PT pulses. Straight leg raise is negative. A MRI of the lumbar spine is performed and is pictured in Figure A. On further questioning, which of the following is the patient also likely to report?

- A) Increased pain walking down stairs
- B) Increased pain while using a stationary bike
- C) Increased pain with coughing or sneezing
- D) Increased pain after driving a car for a long distance
- E) Pain that is worst first thing in the morning and gradually improves as the day goes on

Figure A**Figure B**

Discussion: The patient has lumbar spinal stenosis with neurogenic claudication and therefore is likely to experience worsening pain with activities that result in lumbar extension, such as walking down stairs.

Lumbar spinal stenosis often results from degenerative changes of the intervertebral disc and facet joints which ultimately narrows the space available for the thecal sac and exiting nerve roots. Patients can present with neurogenic claudication, reported as worsening leg and/or back pain with ambulation and diminished walking capacity. MRI may demonstrate disc degeneration/bulging, hypertrophy of the

ligamentum flavum and facet capsule, and narrowing of the central canal. Nonoperative management includes NSAIDs, PT and epidural steroid injections (ESI). Surgery is reserved for patients who have failed nonoperative measures and includes decompressive laminectomy with or without fusion depending on presence of instability.

Issack et al reviewed degenerative lumbar spinal stenosis. Unlike patients with vascular claudication, patients with neurogenic claudication are able to improve walking tolerance with postural changes, specifically with flexed-forward posture (such as leaning forward on a shopping cart). They are unable to improve their symptoms simply by cessation of walking. Patients with neurogenic claudication tend to lack the trophic changes of the skin on the legs/feet as well as diminished pulses characteristic of vascular disease.

Young et al reviewed the utilization of lumbar ESI for low back and leg pain. The authors concluded that lumbar ESI are a reasonable nonsurgical option to provide temporary symptomatic relief. Fluoroscopic guidance facilitates accurate placement of the injection into the epidural space, while its nonuse may lead to higher percentage of technical failures. Lastly, the transforaminal approach is more selective than the interlaminar approach and can provide diagnostic information as well as symptom relief.

Figures A and B are T1 sagittal and T2 axial MR images, respectively, of the lumbar spine demonstrating significant central canal stenosis most notable at L4-L5 with broad disc protrusion, facet degeneration and infolding of the ligamentum flavum.

Reference: Degenerative lumbar spinal stenosis: evaluation and management. By: Issack PS, Cunningham ME, Pumberger M, Hughes AP, Cammisa FP

The use of lumbar epidural/transforaminal steroids for managing spinal disease. By: Young, JAAOS 2007

363. Answer: C

When compared to infrapatellar tibial nailing, suprapatellar tibial nailing has been shown to result in which of the following:

- A) higher incidence of knee pain
- B) higher incidence of non-union
- C) higher incidence of knee sepsis
- D) lower incidence of distal third fracture malunions
- E) lower incidence of prominent hardware

Discussion: Although the incidence of knee pain and fracture union/malunion has not been shown to be statistically different between the two procedures, there have been more documented cases (although NOT statistically significant) of knee septic arthritis with SP nailing when comparing the two procedures

Reference: Orthobullets Team

364. Answer: E 2020

A 12-year-old female sustained a right knee injury during a high-level gymnastic competition. Physical examination revealed a significant effusion, positive anterior drawer, and 3+ Lachman. She is a Tanner 3 on the scale of physical development. When considering transphyseal reconstruction techniques, which of the following factors has the greatest potential to cause physeal injury in the tibia?

- A) Vertical transphyseal tunnel position
- B) Slow transphyseal tunnel reaming
- C) Hamstring autograft
- D) Small transphyseal tunnel diameter
- E) Horizontal and oblique transphyseal tunnel position

Discussion: When considering transphyseal ACL reconstruction techniques in skeletally immature patients, a horizontally oriented tunnel and interference screw has the greatest potential to cause tibial physeal injury.

Transphyseal reconstruction techniques have traditionally been approached with caution due to the possibility of growth disturbance. The likelihood of growth disturbance has been shown to be associated with the percentage of cross-sectional area of physis injured during surgical reconstruction. Different models have shown that 7% to 9% of the cross-sectional area of physis is enough to cause significant disturbance. Factors found to increase volumetric injury include: oblique tunnel position, high-speed tunnel reaming, and increasing tunnel diameter (>8mm).

Frosch et al. evaluated the clinical outcomes and risks of anterior cruciate ligament (ACL) surgery in children and adolescents. They found that the overall rate of leg-length difference was significantly less with transphyseal reconstruction techniques than physeal-sparing.

Kumar et al. looked at a series of 32 skeletally immature patients with Tanner scores between 1-3 that were treated with transphyseal reconstruction techniques. They showed that there were no leg limb discrepancies in all patients followed up to the age of 16 years old.

Kocher et al. retrospectively reviewed sixty-one knees in fifty-nine skeletally immature pubescent adolescents who underwent transphyseal reconstruction of the anterior cruciate ligament. No lower- extremity length discrepancies were detected clinically with this procedure. Three cases of arthrofibrosis required manipulation with the patient under anesthesia were required.

Illustration A shows a sagittal view, of a subacute ACL tear. There is complete ligament discontinuity. Only a small part of the distal ACL (white arrow) is seen inferiorly.

Reference: Outcomes and risks of operative treatment of rupture of the anterior cruciate ligament in children and adolescents. Frosch, ASCOPY 2010

Transphyseal anterior cruciate ligament reconstruction in the skeletally immature: follow-up to a minimum of sixteen years of age. Kumar, JBJS 2013

Transphyseal anterior cruciate ligament reconstruction in skeletally immature pubescent adolescents. Kocher, JBJS 2007



365. Answer: B

Cell count is used in the diagnostic definition of prosthetic joint infections. The generally accepted cutoff is synovial fluid white cell count of greater than 3000 cells/ μ L and polymorphonuclear percentage of greater than 80%. However, there is recent evidence that the threshold should be different between hip and knee PJI, where the threshold for cell count should be lowered:

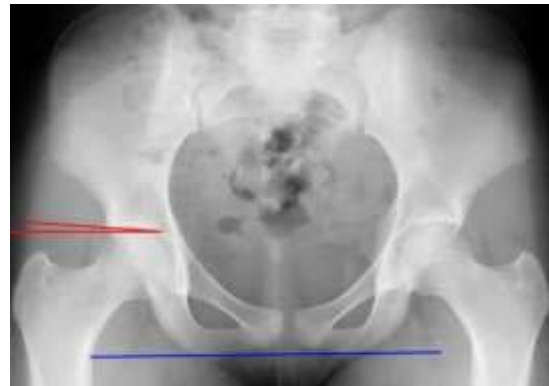
- A) For hip infections
- B) For knee infections
- C) For both hip and knee infections
- D) For neither hip or knee infections
- E) Depending on other inflammatory markers

Discussion: Cell count and PMN% are sensitive in detecting PJI. Receiver-operator-curve analysis suggests that the synovial aspirate cell count cutoff for total hip arthroplasty PJI be at 3000 cells/ μ L, but that the number for total knee arthroplasty infection be set at 1600 cells/ μ L. Additionally, there is evidence to lower PMN% to 60% and 66% in knee and hip PJI, respectively.

Reference: Team Orthobullets (D) MD

366. Answer: A

A 19-year-old hockey goalie presents with longstanding activity-related right hip pain. On physical examination, he has limited hip internal rotation. He also has pain with flexion, adduction, and internal rotation of his hip. Which of the following radiographic measurements or signs are commonly used to confirm this patient's most likely diagnosis?

**Figure A****Figure B****Figure C****Figure D****Figure E**

- A) Figures A & E
- B) Figures C & D
- C) Figures A, C, & D
- D) Figures B & E
- E) Figures C, D, & E

Discussion: This patient likely has femoroacetabular impingement (FAI). Figures A & E demonstrate the alpha angle and the crossover sign which are both used in the diagnosis of FAI.

The alpha angle is a measurement for quantifying the head-neck junction deformity. On the frog-leg lateral, it is formed by a line drawn from the center of the femoral head, through the center of the femoral neck. A second line

is drawn from the center of the femoral head to the point on the anterolateral head-neck junction where the radius of the femoral head begins to increase beyond the radius found more centrally in the acetabulum where the head is more spherical. The intersection of these two lines forms the alpha angle, and values of $>60^\circ$ are suggestive of a head-neck offset deformity. The crossover sign is a sensitive and specific indicator of native acetabular version. It is seen on AP radiograph of the hip or pelvis. Normally, the anterior and posterior wall shadows should meet superiorly and laterally. In cases of acetabular retroversion, the crossover of the shadows occurs more distally. If the crossover sign is present it signifies acetabular retroversion and possible pincer impingement.

Clohisy et al. performed a systematic approach to the plain radiographic evaluation of the adult hip. They report that many radiographic measurements have been described as indicators of structural disease. They report that the lateral center-edge angle, the anterior center-edge angle, the acetabular index of depth to width, the femoral head extrusion index, and the Tönnis angle have all been used in the diagnosis of acetabular dysplasia. Measurements of acetabular version, the head-neck offset, and the alpha angle have been used in the diagnosis of FAI.

Nötzli et al. developed a method to describe concavity at the femoral head-neck junction. MRI scans of 39 patients with groin pain and positive impingement tests were compared to asymptomatic controls. They found an alpha angle of 74.0 degrees for symptomatic patients and 42.0 degrees for the control group. They conclude that using MRI symptomatic hips of patients who have impingement have significantly less concavity at the femoral head-neck junction than normal hips.

Figure A is a lateral of the hip demonstrating the calculation of the alpha angle. Figure B is an AP pelvis radiograph demonstrating the Tönnis angle. Acetabula having a Tönnis angle of 0° to 10° are considered normal, whereas those having an angle of $>10^\circ$ or $<0^\circ$ are considered to have increased and decreased inclination, respectively. Figure C is an AP radiograph of the hip demonstrating the lateral center-edge angle. Values of $<25^\circ$ may indicate inadequate coverage of the femoral head. Figure D is a false-profile radiographic view of the hip demonstrating the anterior center-edge angle. Values of $<20^\circ$ can be indicative of structural instability. Figure E is an AP radiograph of the hip demonstrating the crossover sign.

References: A systematic approach to the plain radiographic evaluation of the young adult hip. Clohisy, JBJS 2008
The contour of the femoral head-neck junction as a predictor for the risk of anterior impingement. Nötzli, BJJ 2002

367. Answer: C 2020

In a 17-year-old high school football player, which of the following grafts has the highest rate of early re-rupture?

- A) Hamstring autograft
- B) Patella tendon autograft
- C) Tibialis allograft
- D) Quadriceps tendon autograft
- E) All have an equal chance of re-rupture

Discussion: In one study the authors concluded that young, active individuals having undergone an allograft ACL reconstruction were significantly more likely to experience clinical failure requiring revision reconstruction compared with those who underwent autologous graft reconstruction. Another study found that a high activity allograft group was 2.6 to 4.2 times more likely to fail when compared with low-activity allografts and low- and high-activity autografts. Thus, allografts have a higher failure rate when used in younger patients.

References: Team Orthobullets (D) MD

368. Answer: B

Many hip arthroscopists perform hip arthroscopy with just 2 portals – the Anterior and the Anterolateral portals. To allow for maneuverability, most surgeons also connect the two portals. Connecting these two portals results in cutting what structures:

- A) The Zona Orbicularis
- B) The Iliofemoral Ligament
- C) The Ischiofemoral Ligament
- D) The Pubofemoral Ligament
- E) The Ligamentum Teres

Discussion: The Iliofemoral Ligament is the capsuloligamentous structure that is cut when connecting the anterior and anterolateral portals.

Reference: Team Orthobullets (D) MD

369. Answer: A

The 2018 definition of periprosthetic hip and knee infection emerged from the original Musculoskeletal Infection Society (MSIS) criteria introduced in 2011. This revision resulted in higher sensitivity (98% compared to 79%). Which of the following findings would indicate infection?

- A) Presence of sinus tract to the joint
- B) Elevated serum ESR and CRP
- C) Elevated synovial WBC
- D) Positive alpha-defensin
- E) Elevated synovial PMN (%)

Discussion: The diagnosis of PJI relies on a scoring-based definition. Presence of major criteria (two positive cultures or presence of a sinus tract communicating with the joint) is diagnostic of infection. Minor criteria are given a weighted scoring system: elevated serum CRP (2 points) and serum ESR (1), and elevated synovial WBC (3), positive alpha-defensin (3), elevated synovial PMN % (2), and elevated synovial CRP (1). For the minor criteria, six points are necessary to definitively diagnose PJI. **Reference:** Team Orthobullets (D) MD

370. Answer: E

What is the best treatment option for an 18-year-old soccer player with an acute isolated grade 1 PCL injury?

- A) Open reduction, internal fixation
- B) Single bundle PCL reconstruction
- C) ACL reconstruction
- D) Double bundle PCL reconstruction
- E) Physical therapy

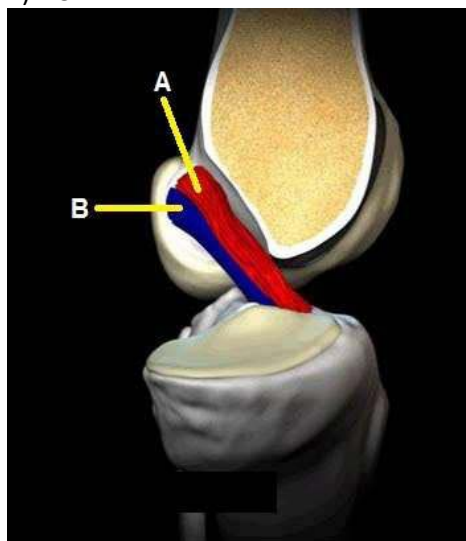
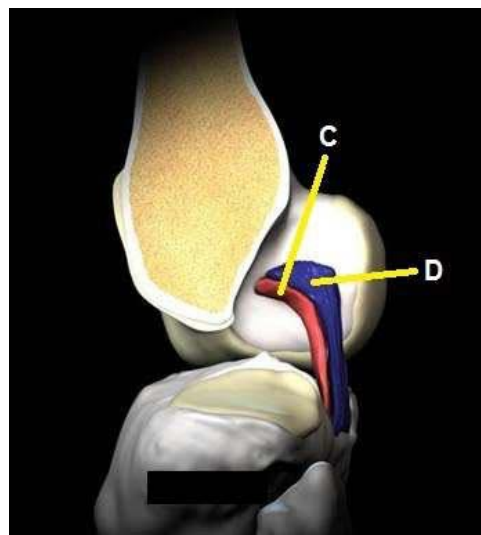
Discussion: Currently, there is no clinical data to suggest that contemporary reconstruction techniques can improve knee stability in low-grade (I/II) PCL injury or improve outcomes in this cohort of patients. As such, isolated, low-grade PCL injuries are often treated non-operatively with a regimen that includes protected weightbearing in the acute stage followed by structured rehabilitation focused on improving quadriceps strength. Collectively, the current literature suggests that most of these patients will return to sport.

Reference: Team Orthobullets (D) MD

371. Answer: B

Figures A and B are sagittal illustrations of the knee in extension with a portion of the femur removed to visualize central structures. Which of the following ligamentous structure(s) is/are primarily responsible for rotational stability of the knee?

- A) A
- B) B
- C) A + B
- D) C
- E) C + D

**Figure A****Figure B**

Discussion: The posterolateral bundle of the anterior cruciate ligament (ACL), labelled B, is primarily responsible for rotational stability of the knee.

The ACL is organized into two primary components: the anteromedial bundle (AMB) and the posterolateral bundle (PLB), named for their tibial insertions. The AMB is the main restraint to anterior tibial translation, particularly at knee flexion when the PLB is slack. The PLB provides rotational stability, particularly at knee extension when it is most taut, and is examined by the pivot shift test. A positive pivot shift test post-operatively indicates persistent rotatory instability and has been associated with functional instability with cutting activities.

Amis et al. reviewed the functional anatomy of the ACL. Biomechanical studies conclude that the two bundles exhibit different patterns of length changes and tension variations during knee motion. The AMB remains taut throughout the flexion-extension arc with a mild increase in length and tension at knee flexion. The PLB progresses from taut in extension, slack in mid-flexion and tensions again beyond 90 degrees of knee flexion with greater length change than the AMB. This leads to different roles in controlling knee laxity, with the PLB having a more clear role near extension and the AMB more dominant in flexion.

Duthon et al. authored a review article detailing the micro- and macro-anatomy of the ACL. The ACL is primarily composed of type I collagen, is innervated by the posterior articular branches of the tibial nerve and receives vascular supply from the middle geniculate artery. Of the two bundles, the PLB is larger and has shorter fibers compared to the AMB. In knee extension, the bundles run in a parallel fashion. As the knee flexed, there is lateral rotation of the ACL as a whole around its longitudinal axis and the AMB spirals around the PLB (see Illustration A).

Figure A is an illustration of the ACL in an extended knee, composed of the AMB (A) and PLB (B). Figure B is an illustration of the PCL in an extended knee, composed of the ALB (C) and PMB (D). Illustration A is a cadaveric picture from Duthon et al. demonstrating the change in ACL bundle orientation as the knee progresses from extension to flexion.

Reference: The functions of the fibre bundles of the anterior cruciate ligament in anterior drawer, rotational laxity and the pivot shift. Amis, KSSTA 2012

Anatomy of the anterior cruciate ligament. Duthon, KSSTA 2006

372. Answer: C

A 42-year-old man is seen in the emergency room after a fall from a ladder with a displaced tibial shaft fracture seen in Figures A and B. What is the appropriate starting point of an intramedullary nail when surgically treating this fracture?

- A) Centered between medial and lateral eminence
- B) Medial border of the medial tibial eminence
- C) Medial border of the lateral tibial eminence
- D) Lateral border of the medial tibial eminence
- E) Lateral border of the lateral tibial eminence



Figure A



Figure B

Discussion: The recommended starting point on the tibia for guide wire and intramedullary (IM) nail fixation is at the medial edge of the lateral tibial eminence.

Tibial shaft fractures are commonly treated with IM nail fixation to allow relative stability and immediate weight bearing. Particularly for proximal third shaft fractures, deforming forces on the tibia often result in an apex anterior (procurvatum), valgus malalignment after rod placement. The deforming forces on the proximal segment are extensor mechanism extending the proximal fragment (causing apex anterior) and insertion at pes anserine medially (causing valgus). An appropriate starting point, use of temporary plating, a semi-extended knee position, and/or blocking screws placed posteriorly and laterally may all be used to prevent this deformity.

McConnell et al. conducted an anatomic and radiographic cadaveric study on 20 knees to evaluate a "safe zone" for tibial nailing. They conclude that wire entry point at the medial aspect of the lateral tibial spine (on the anteroposterior view) and just at or anterior to the edge of the anterior articular surface (on the lateral view) is a safe site for nail entry minimizing risk of damage to intra-articular structures.

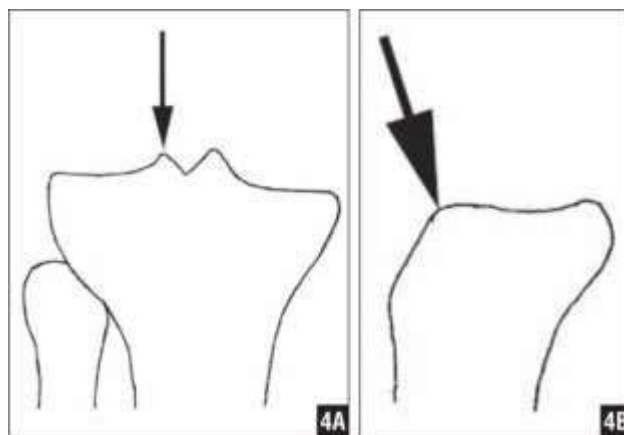
Hak reviews proximal third tibial shaft fractures and multiple techniques to achieve adequate reduction. He describes Poller blocking screws (posterior and lateral placement), retropatellar approach in semi-extended position, and appropriate starting point, even suggesting a slightly more lateral position (directly on the lateral tibial eminence) can be helpful in proximal third fractures.

Figures A and B show an AP and Lateral of a tibial shaft fracture in mild flexion and valgus deformity.

Illustration A is from the Hak reference demonstrating starting point for tibial IM Nail on AP and Lateral views.

Reference: Tibial portal placement: the radiographic correlate of the anatomic safe zone. McConnell, JOT 2001.

Intramedullary nailing of proximal third tibial fractures: techniques to improve reduction. Hak, ORTHO 2011



373. Answer: A

A 44-year-old male presents with pain in the posterior aspect of his left thigh after walking more than 20 feet. Figure A demonstrates an upright lateral lumbar spine radiograph. There is 3mm of translation on flexion and extension radiography. Figure B is a sagittal MRI image and Figure C is an axial image through L4/5. He has failed non-operative treatment and elects to undergo surgery. Assuming he undergoes the appropriate surgery, which of the following places him at the highest risk for adjacent segment disease requiring future surgery?

- A) Undergoing a laminectomy at the cranial adjacent level
- B) Undergoing a one level fusion
- C) Degenerative spondylolisthesis
- D) Obesity
- E) Circumferential fusion

Discussion: The patient has a degenerative spondylolisthesis with associated spinal stenosis at L4/5. The appropriate surgical treatment would involve an L4/5 decompression and fusion. A decompression (laminectomy) adjacent to a fusion increases the risk of developing adjacent segment disease.

The patient has a degenerative spondylolisthesis with associated spinal stenosis at L4/5. When spinal stenosis is associated with any type of instability, such as a spondylolisthesis, long-term results are improved if the patient undergoes a fusion. While a decompression and posterior fusion is an excellent option for this patient, patients who undergo a lumbar fusion with decompression are at risk of developing spinal stenosis at levels adjacent to the fusion.

Sears et al. reported risk factors for adjacent segment disease in over 900 patients. Risk factors identified were multi-level surgery, age > 60 years, and an adjacent level laminectomy. Overall, the average incidence of adjacent segment disease requiring surgery was 2.5% per year.

Cheh et al. reported on the incidence of adjacent segment disease after 188 lumbar fusion procedures, and they found similar risk factors such as age > 50 years and multi-level surgery. They also reported patients who required surgery ending at L1, L2 or L3 had an increased risk compared to fusions ending at L4 or L5.

Figure A and B are the radiographs demonstrating an L4/5 degenerative spondylolisthesis. Figures C and D are the sagittal and axial MRI demonstrating lateral recess stenosis.

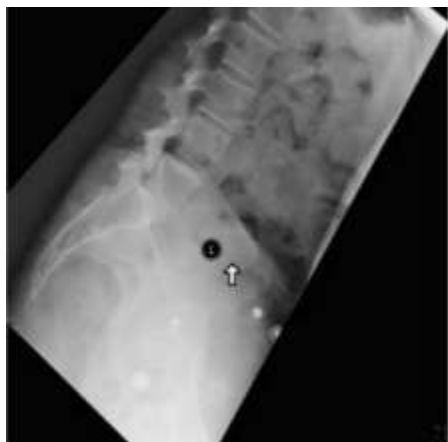


Figure A



Figure B

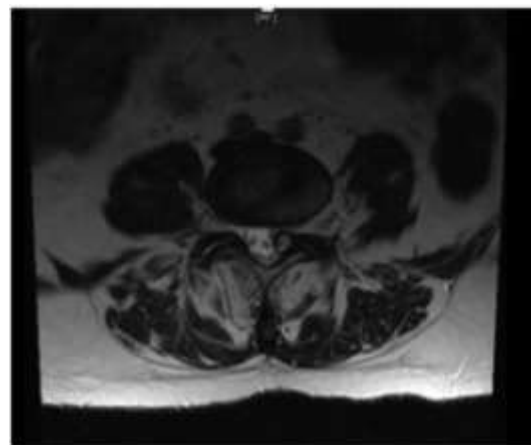


Figure C

Reference: Incidence and prevalence of surgery at segments adjacent to a previous posterior lumbar arthrodesis. Sears, SPINEJ 2011. Adjacent segment disease following lumbar/thoracolumbar fusion with pedicle screw instrumentation: a minimum 5-year follow-up. Cheh, SPINE 2007

374. Answer: B

According to recent literature, approximately what percentage of all ankle sprains in competitive football are high ankle sprains (syndesmosis injuries)?

- A) 5%
- B) 25%
- C) 50%
- D) 75%
- E) 90%

Discussion: According to a recent review of the NCAA injury surveillance system, about 24% of all ankle sprains in college football are syndesmosis injuries (i.e., high ankle sprains). In addition, it is estimated that about 15% of players participating in the NFL combine have a history of syndesmosis injuries.

Boytim (5) reported 18 of 98 (18%) acute syndesmotic injuries when looking at members of the Minnesota Vikings football team.

Reference: Team Orthobullets (D) MD

375. Answer: C

Figures A and B show radiographs of a 24-year-old female with a soccer injury. A physical examination reveals an isolated, closed injury with no clinical features of neurovascular injury or compartment syndrome. She has been consented to be treated with intramedullary nail fixation. A pre-operative note by the anaesthesiology team makes reference to the patient's fair skin and natural red-hair color. How will this information affect the post-operative management of this patient?

- A) Longer duration of anticoagulation due to increased risk of DVT
- B) Avoiding anticoagulation medications due to increased risk of bleeding
- C) Require higher dosages of post-operative analgesia
- D) Longer period of non-weight bearing on surgical limb
- E) Avoiding opioids due to higher risk of unrecognized allergies



Figure A



Figure B

Discussion: Female patients with natural red-hair may require higher dosages of post-operative analgesia compared to other hair types.

Melanocortin-1-receptor (MC1R) is one of the key proteins involved in hair color and skin tone. Mutations of the MC1R alleles can render this protein non-functional, which results in a phenotype of red-hair and fair skin. Mutations of the MC1R have shown to modulate the pain response and opioid efficacy in these patients. Women are more commonly affected and often require more anaesthetic and higher dosages of opioid to achieve comparable MAC level and pain-relief, respectively, as women with other hair types.

Liem et al. showed that a greater concentration of induction and maintenance agents (sevoflurane and desflurane, respectively) were required to sustain comparable MAC levels in red-haired patients as darkhaired patients.

Fillingim et al. reviewed the affect of gender, sex and pain. They concluded there is a biopsychosocialelement of pain that is perceived differently by men and women. In terms of postoperative and procedural pain, the outcome might be more severe in women than men.

Delaney et al. looked at the involvement of the melanocortin-1 receptor in acute pain in mice. They found that while the MC1R is better known as a gene involved in mammalian hair colour, it was shown to be involved in the pain pathway of inflammatory but not neuropathic origin. Mutations of MC1R showed increased tolerance to noxious pain stimulus in mice.

Figures A and B are AP and lateral radiographs of a left tibia. There is a low energy, distal third shaft fracture with no cortical apposition on the AP view.

Reference: Anesthetic requirement is increased in redheads. Liem EB 2004
Sex, gender, and pain: a review of recent clinical and experimental findings. Fillingim RB 2009
Involvement of the melanocortin-1 receptor in acute pain and pain of inflammatory but not neuropathic origin. Delaney, PLOS 2010

376. Answer: C

A 33-year-old male presents for initial evaluation of his right leg, which sustained a closed tibia fracture 24 weeks ago. Injury films are shown in Figure A, at which time he undergoes uncomplicated intra-medullary nailing of the tibia. He has persistent pain with weight-bearing. Updated radiographs show intact hardware, no malalignment, and no bony union. Inflammatory serologies are within laboratory reference ranges. His soft tissue envelope appears healthy and intact. Which of the following is likely to contribute to achieving osseous union?

- A) Removal of the nail and conversion to cast treatment
- B) Exchange nailing with a solid nail of equal diameter and length
- C) Osteotomy or partial osteotomy of the fibula
- D) Addition of bone morphogenetic protein (BMP)-3 to the nonunion site
- E) Induced membrane (Masquelet) technique

Discussion: This patient has a tibial non-union with an intact fibula. Fibular osteotomy or osteotomy can increase the amount of compression at the tibial non-union site that occurs with weight-bearing.

If a healed or intact fibula is effectively longer than a fractured and/or non-uniting tibia then the fibula may prevent tibial healing. A fibular fracture associated with a tibia fracture usually heals within 6 weeks, and therefore is often healed by the time delayed union of the tibia is diagnosed. If compression across a tibia fracture is to occur with an intact fibula, some force must be used to deform the fibula before tibial compression can occur, unless the fibula has healed in a shortened position. Fibular osteotomy or osteotomy can address this length mis-match and help achieve union.



Teitz et al. reviewed 550 patients with tibial fractures, 111 of which had intact fibulae treated with either a long cast, short cast, patellartendon bearing cast or external fixation. There was a 26% non-union rate in adult (age >20) patients with tibial shaft fractures with intact fibulae. They also found that, biomechanically, tibiofibular length discrepancy caused altered strain patterns for tibia, fibula and ankle. They concluded that in older patients, the intact fibula results in greater incidence and severity of complications.

DeLee et al. reviewed 67 patients with un-united tibia fractures at 20 weeks. 51 patients were treated with partial fibulectomy 20 to 24 weeks. The partial fibulectomy (2.5 cm of fibula) was performed remote from the tibial fracture and fibulectomy (rather than osteotomy) done to prevent fibular healing occurring before tibial union, and yet not to create gross instability. This resulted in union in 77% of cases. They concluded that early fibulectomy minimized morbidity and decreased the need for bone grafting, while leaving the tibial fracture site undisturbed, should future bone-grafting be necessary.

Figure A shows an isolated tibial fracture with intact fibula. Illustration A shows examples of partial fibulectomy for treatment of tibial non-union after casting (a), nailing (b and c) and external fixation treatment (d).

References: Problems associated with tibial fractures with intact fibulae. Teitz, JBJS 1980 Partial fibulectomy for ununited fractures of the tibia. DeLee, JBJS 1981

377. Answer: A

Complications from hip arthroscopy are most commonly related to which of the following?

- A) Use of traction
- B) Lateral positioning
- C) Supine positioning
- D) Deep venous thrombosis
- E) Heterotopic ossification

Discussion: Hip arthroscopy is currently effective for the treatment of loose bodies, labral tears, chondral injuries, AVN, synovial disease, ruptured ligamentum teres, impinging osteophytes, and unexplained mechanical symptoms. The set-up is typically supine or lateral, and traction is applied. The complications are rare but are associated with traction injuries, iatrogenic chondral injuries, and neurovascular injury due to aberrant portal placement. Transient neuropraxia of the groin (pudendal) or dorsum of the foot (peroneal) are most common as these are the points where the traction is applied. The Byrd is the first to describe 10 year follow-up of hip arthroscopy patients and only 2 complications were reported.

Reference: Prospective analysis of hip arthroscopy with 10-year followup. Byrd, CORR 2010

378. Answer: D

The structure injured in Figure A occurs most frequently in which of the following injury patterns depicted in figures B through F?

- A) B
- B) C
- C) D
- D) E
- E) F



Figure A

Figure B



Figure C



Figure D



Figure E



Figure F



Discussion: The ACL is most commonly injured in Schatzker IV and VI injury patterns; Type IV injuries are also associated with medial meniscus disruption, vascular injury, and compartment syndrome.

Tibial plateau fractures are the result of an axial load with a varus, valgus, or rotational moment. As such, several soft tissue and ligamentous injuries often result, with higher energy mechanisms associated with more soft tissue injuries. Injury to the ACL occurs most commonly in Type IV and VI injuries. Magnetic resonance imaging may be useful at identifying associated soft tissue injuries in tibial plateau fractures. However, the timing and treatment of associated soft tissue injuries in this setting remains a controversial topic. Gardner et al. evaluated the incidence of associated soft tissue injuries in tibial plateau fractures utilizing MRI in prospective cohort study of 103 patients. They found that the incidence of soft tissue injury was higher than previously reported; only 1 patient in their study lacked a soft tissue insult. They also found that 77% of patients sustained injury to 1 or more cruciate ligaments, 91% sustained lateral meniscus injury, 44% sustained medial meniscus injury, and 68% of patients injured 1 or more posterolateral corner structures. Abdel-Hamid et al. retrospectively evaluated soft tissue injuries in 98 tibial plateau fractures that were initially treated with arthroscopy-assisted surgical fixation. They found that

meniscal injuries and bony ACL avulsions were most commonly seen in their series. Additionally, they found a statistically significant association between ACL injuries in Type IV and VI injuries. Wang et al. studied the incidence of soft tissue injuries in tibial plateau fractures and the relationship of articular widening and depression with meniscal and ligamentous injuries in 54 patients. They found that the meniscus was the most commonly injured structure, occurring in 56% of the patients in their series. Finally, they found a correlation between articular widening and depression with a higher incidence of soft tissue injury. Figure A is a sagittal MRI depicting an ACL tear. Figures B through F are radiographs depicting Schatzker I, II, III, IV, and V injuries, respectively. Illustration A is a diagram showing the Schatzker classification.

References: The incidence of soft tissue injury in operative tibial plateau fractures: a magnetic resonance imaging analysis of 103 patients. Gardner, JOT 2005. Arthroscopic evaluation of soft tissue injuries in Abdel-Hamid, ASCOPY 2006 tibial plateau fractures: retrospective analysis of 98 cases. The distinct prediction standards for radiological assessments associated with soft tissue injuries in the acute tibial plateau fracture. Wang J 2015

379. Answer: B

A 29-year-old male who underwent right hip arthroscopy for femoroacetabular impingement (FAI) two years ago presents for initial evaluation. He reports significant improvement in symptoms since the time of surgery but has never had full relief and continues to have activity related groin pain and discomfort with deep hip flexion activities. Review of arthroscopic photos from his index procedure confirm intact cartilage surfaces at that time. He has done extensive physical therapy without further improvement.

Hip flexion, adduction and internal rotation reproduce his pain. Which of the following radiologic findings are indicative of the most likely reason for his persistent symptoms?

- A) Tönnis angle of 8°
- B) Alpha angle of 60°
- C) Lateral center edge angle of 25°
- D) Anterior center edge angle of 27°
- E) Medial aspect of the femoral head is 7 mm lateral to the ilioischial line



Figure A



Figure B



Figure C



Figure D

Discussion: This patient has symptoms consistent with persistent FAI despite surgical treatment. Alphaangles of greater than 42° are suggestive of femoral head-neck offset deformity, a contributor to FAI.

Various factors may contribute to development of persistence of pain after hip arthroscopy directed at FAI. Chondral issues, postoperative adhesions, labral lesions and instability all merit consideration but persistent structural deformity is the most common reason for failed FAI arthroscopy requiring revision.

Philippon et al. retrospectively reviewed 37 revision hip arthroscopies performed by the senior author. All were indicated for persistent pain and 36 of 37 had radiographic evidence of FAI at the time of revision.

Bogunovic et al. analyzed 60 hips with a history of failed hip arthroscopy. Residual FAI was identified as the etiology for failure in 68%. Revision procedures included both open and arthroscopic hip preservation as well as total hip arthroplasty procedures.

Illustration A shows measurement of the Tönnis angle. Illustration B shows measurement of the alpha angle on a frog lateral radiograph. Illustration C shows measurement of the lateral center edge angle of Wiberg. Illustration D shows measurement of the anterior center edge angle of Lequesne. Illustration E shows measurement of the position of the hip center.

Reference: Revision hip arthroscopy. Philippon, AJSM 2007 Why do hip arthroscopy procedures fail? Bogunovic, CORR 2013

380. Answer: E

A 21 year-old collegiate football player suffers an external rotation of his ankle. He has difficulty walking afterward. He has no fractures. Which of the following ankle ligaments is most likely to be the initial structure injured?

- A) Calcaneofibular ligament
- B) Anterior talofibular ligament
- C) Deep deltoid ligament
- D) Superficial deltoid ligament
- E) Anterior inferior tibiofibular ligament

Discussion: High ankle sprains are external rotation injuries of the ankle and syndesmosis. They often occur in skiers, hockey players, and running and cutting athletes, particularly in collision sports. The anterior inferior tibiofibular ligament is the initial ligament injured. External rotation of the foot on the leg causes the talus to press against the lateral malleolus. This rotational movement first affects the anterior inferior tibiofibular ligament of the



Figure E

syndesmosis. If external rotation continues, the interosseous membrane and then the posterior tibiofibular ligament will be injured. Clanton's study supports that the anterior inferior tibiofibular ligament is the most commonly injured ligament in ankle sprains where the mechanism of injury is external rotation. This occurs regardless of the position of the foot at the time of injury. Pure dorsiflexion causes the interosseous ligaments to tighten and abduction on a neutral ankle can cause interosseous injury when preceded by deltoid injury or medial malleolus fracture.

Reference: Team Orthobullets (D) MD

381. Answer: B

A 42-year-old male sustains the injury shown in Figure A. Iatrogenic shortening of the fibula during fixation would first result in which of the following?

- A) Need for open deltoid ligament repair
- B) Syndesmotic malreduction
- C) Fibular impingement
- D) Peroneal tendon tear
- E) Fibular nonunion

Discussion: Shortening of the fibula would lead to syndesmotic malreduction in this fracture pattern. To restore the syndesmotic relationship of the tibia and fibula, the fibula must be anatomically restored; this includes length, alignment, and rotation of the fibula.

Successful reduction of the fibula fracture is generally done in an open manner, and open reduction of the syndesmosis is also helpful to achieve anatomic reduction. Percutaneous or open clamping of the syndesmosis can be harmful if the vector of the clamp is off-axis of the joint.

Contralateral ankle radiographs are also a useful method to assess anatomic syndesmosis reduction.



Gardner et al. (2015) report that accurate reduction and stable fixation of the syndesmosis is critical to maximize patient outcomes. They also state that multiple types of malreduction can occur, including translational, rotational, and overcompression.

Gardner et al. (2006) reviewed patients undergoing ankle and syndesmotic fixation. They reported that 24% had evidence of radiographic postoperative diastasis while 52% had incongruity of the fibula within the incisura on CT scan. They concluded that many malreductions on CT scan went undetected by plain radiographs.

Miller et al. performed a cadaveric study that assessed clamp and screw placement and the relationship of malreductions with clamping at different angles to the ankle. They reported that clamps placed at 15° and 30° significantly displaced the fibula in external rotation and caused significant overcompression of the syndesmosis. Thirty-degree lateral screws caused significant anteromedial displacement, external rotation, and overcompression of the syndesmosis. The 15° posterolateral screws also caused significant external rotation and overcompression of the syndesmosis.

Figure A shows a bimalleolar ankle fracture with syndesmotic injury. Illustration A shows a shortened fibula with ankle joint incongruity.

Reference: Technical Considerations in the Treatment of Syndesmotic Injuries Associated With Ankle Fractures. Gardner, JAAOS 2015. Malreduction of the tibiofibular syndesmosis in ankle fractures. Gardner, FAI 2006 iatrogenic syndesmosis malreduction via clamp and screw placement. Miller, JOT 2013

382. Answer: C**2020**

A football player sustains a knee injury and is evaluated in your office. Examination is notable for a Lachman 2B and a positive pivot shift test. Representative MRI cuts are displayed in Figures A and B. You discuss surgical reconstruction options with the patient. Which of the following factors is associated with an increased risk of failure following reconstruction with hamstring autograft?

- A) Age > 20 years
- B) BMI > 30
- C) Graft size < 8mm
- D) Femoral tunnel transtibial drilling
- E) Tibial fixation with staple

Discussion: Graft size < 8mm and age < 20 years have been shown to increase the risk of failure following anterior cruciate ligament reconstruction (ACLR) with hamstring (HS) autograft.

The anterior cruciate ligament (ACL) is the most commonly reconstructed ligament of the knee. Revision rates of ACLR have been reported to be between 5-20%, the most common cause being improper femoral tunnel placement. Younger patients are at an increased risk for graft failure and are less tolerant of recurrent instability. ACL injuries can be reconstructed using a variety of autograft options, including bone-patellar tendon-bone (BTB), HS and quadriceps tendons, as well as several allograft options. The use of HS autograft has several benefits, including smaller incision and decreased risk of anterior knee pain, but does not always yield a graft of sufficient diameter, particularly in younger patients. This has raised concerns over potentially inadequate graft strength in a population that is already at risk for ACL re-rupture.

Magnussen et al. prospectively evaluated 296 patients that underwent ACLR with HS autograft for a 2- year period to determine factors that may predispose to failure of ACLR. Patient characteristics and intraoperative HS graft diameter were recorded. Patients with a HS graft diameter less than 8mm demonstrated a statistically greater risk of ACLR failure ($p = 0.043$). While height, weight, gender and participation in athletics were found to be significantly related to graft diameter size, those factors alone did not impact failure rate.

Park et al. performed a retrospective cohort study of 256 patients that underwent ACLR with HS autograft to determine risk factors associated with failure. Multiple logistical regression analysis showed age < 20 years (OR 18.97, $p = .005$) and decreased graft size (OR 2.2, $p = .05$) to be significantly associated with an increased risk of revision. No difference in revision rates were noted based on ratio of graft size to patient height, weight, or BMI, type of femoral tunnel drilling or type of tibial fixation.

Figure A and B are two sagittal MRIs, T1 and T2 respectively, demonstrating a complete ACL tear.



Figure A



Figure B

Reference: Graft size and patient age are predictors of early revision after anterior cruciate ligament reconstruction with hamstring autograft. Magnussen, ASCOPY 2012

Factors predicting hamstring tendon autograft diameters and resulting failure rates after anteriorcruciate ligament reconstruction. Park, KSSTA 2013

383. Answer: D

During hip arthroscopy, the sciatic nerve is most at risk with which of the following portal techniques?

- A) Anterior peritrochanteric portal with limb in internal rotation
- B) Anterior peritrochanteric portal with limb in flexion
- C) Posterior peritrochanteric portal with limb in internal rotation
- D) Posterior peritrochanteric portal with limb in external rotation
- E) Distal lateral portal with limb in neutral rotation

Discussion: The posterolateral portal is made 2-3cm posterior to the tip of the greater trochanter. The hip should never be externally rotated during this portal entry as this brings the sciatic nerve closer to the portal. Internal rotation would move the portal farther away from the sciatic nerve- this concept is similar to internally rotating during a posterior approach to the hip for a total hip arthroplasty. McCarthy presents a review of hip arthroscopy basic principles.

Reference: Hip Arthroscopy: Applications and Technique. McCarthy, JAAOS 1995 Hip arthroscopy: indications, outcomes, and complications. McCarthy JC 2006

384. Answer: E

In the radiographic evaluation of femoroacetabular impingement (FAI), which of the following views is obtained with a standing radiograph and an angle of 65 degrees between the pelvis and the film?

- A) AP pelvis
- B) Inlet
- C) Outlet
- D) Frog lateral
- E) False profile

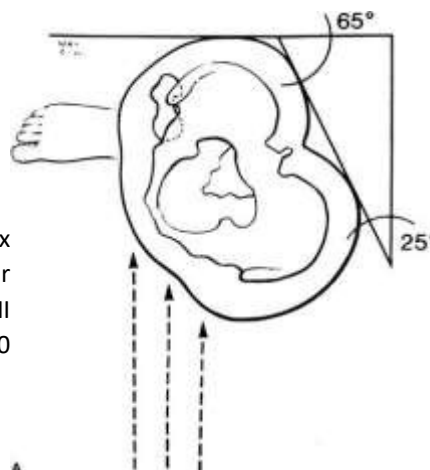
Discussion: The False profile view (also known as Faux profil) is performed with the patient standing with the affected hip on the cassette, the ipsilateral foot parallel to the cassette and the pelvis rotated 65° from the plane of the cassette. It can be used to assess anterior coverage of the femoral head for patients with hip dysplasia (DDH) and FAI.

Chosa et al developed the anterior acetabular head index (AAHI) on false profile radiographs to assess anterior acetabular coverage and found a correlation between AAHI and vertical-center-anterior (VCA) angle when reviewing 250 patients.

Sakai et al used three-dimensional (3-D) computed tomography (CT) to evaluate the vertical-center angle in 100 hips without osteoarthritic changes. They found that the anterior point of the VCA angle accurately defined the foremost aspect of the acetabulum in normal hips, but questioned the accuracy of its use in hips with dysplasia.

Illustration A demonstrates the technique for obtaining a false profile view and a representative radiograph.

References: Anterior acetabular head index of the hip on false-profile views. New index of anterior acetabular cover. Chosa, BJJ 2003. Is vertical-center-anterior angle equivalent to anterior coverage of the hip? Sakai, CORR 2009



385. Answer: B

A 43-year-old male sustains the injury shown in Figure A. He has an overlying 3 centimeter wound with exposed bone. Which of the following antibiotics is indicated for initial prophylaxis?

- A) Ciprofloxacin
- B) Vancomycin
- C) Penicillin
- D) Gentamycin
- E) Cefazolin

Discussion: The scenario described above is of a type II open fracture, and current initial recommendations for these injuries include tetanus prophylaxis/update and a first-generation cephalosporin (if no allergies). Hauser et al review the literature on antibiotics and open fractures. They note that use of first-generation cephalosporins, along with appropriate fracture care, minimize risk of infection. They also state that current treatment is often rooted in old (>30 years) low-level data. Saveli et al report that although methicillin-resistant *Staphylococcus aureus* (MRSA) is increasingly common, no evidence exists to recommend for use of MRSA prophylaxis. They recommend selecting antibiotics against MRSA for these open fractures only if significant prevalence of MRSA carriers is seen or other risk factors are present. Zalavras et al review open fracture treatment protocols and state that although controversy exists regarding optimal treatment of open fractures, immediate intravenous antibiotic administration should be done in order to minimize infection. They also report that the goals of treatment of these injuries are the prevention of infection, union of the fracture, and restoration of function.

Reference: Surgical Infection Society guideline: prophylactic antibiotic use in open fractures: a evidence-based guideline. By: Hauser CJ Adams CA Jr Eachempati SR. The role of prophylactic antibiotics in open fractures in an era of community-acquired methicillin-resistant *Staphylococcus aureus*. By Saveli CC, Belknap RW, Morgan SJ, Price CS. Open fractures: evaluation and management. By: Zalavras CG, Patzakis MJ.



386. Answer: D

At what point of glenoid retroversion is there risk for component perforation of the glenoid vault with traditional high side reaming and standard component implantation?

- A) 5 degrees
- B) 10 degrees
- C) 15 degrees
- D) 20 degrees

Discussion: Posterior glenoid wear results in increased retroversion and erosion of the bony vault, which can compromise component fixation. Iannotti and associates reported on 13 patients with varying degrees of glenoid deformity. At 20 degrees of retroversion, optimal glenoid component placement after eccentric reaming was associated with glenoid vault perforation.

Reference: Orthobullets Team

Trauma

387. Answer: B 2017

Anterior iliac crest bone graft (AICBG) and the reamer-irrigator-aspirator (RIA) system can be used for harvesting of autogenous bone graft. Which of the following is true, regarding their use:

- A) RIA provides less volume of autogenous graft than AICBG.
- B) RIA creates more blood loss than AICBG
- C) RIA can be used at an individual donor site once
- D) RIA has less osteogenic potential than AICBG

Discussion: In the series by Marchand et al, the average hematocrit drop following RIA harvest was 13.7, compared to 7.36 in the AICBG cohort. RIA procedures collected an average of 53 cc of bone graft, compared to 27 cc with AICBG.

Reference: Marchand LS, Rothberg DL, Kubiak EN, Higgins TF. Is this autograft worth it?: The blood loss and transfusion rates associated with RIA bone graft harvest. Journal of Orthopaedic Trauma, Publish Ahead of Print. 2017.

388. Answer: D 2017/2020

Complications associated with use of the reamer-irrigator-aspirator (RIA) for bone graft harvest include all of the following, except:

- A) Hypotension
- B) Hematoma
- C) Intra-operative or post-operative fracture
- D) High rates of donor site pain

Discussion: Hypotension (secondary to intra-operative blood loss), post-operative hematoma, and fracture (intra-operatively or post-operatively), are all described complications associated with use of RIA. However, donor site morbidity and pain remain quite low with its use. In the study by Han et al, they report that no patients had any persistent donor pain at follow up.

Reference: Han F, Peter L, et al. Reamer Irrigator Aspirator bone graft harvesting: Complications and outcomes in an Asian population

389. Answer: C 2017/2020

Anterior iliac crest bone graft harvest (AICBG) can be used as a source of autologous bone graft. Which of the following is NOT a known complication associated with AICBG harvest:

- A) Deep infection.
- B) Thigh or buttock paresthesias.
- C) 15% rate of persistent donor site pain.
- D) Hematoma.

Discussion: With good soft tissue handling and current techniques for bony harvest, substantial, persistent pain at the iliac crest donor site occurs in 0-2% of patients.

Reference: Loeffler BJ, Kellam JF, Sims SH, Bosse MJ. Prospective Observational Study of Donor-Site Morbidity Following Anterior Iliac Crest Bone-Grafting in Orthopaedic Trauma Reconstruction Patients. JBJS 2012;94:1649-54. Shin SR, Tornetta P. Donor Site Morbidity After Anterior Iliac Crest Bone Graft Harvesting. J Orthop Traum. Volume 30, Number 6, June 2016.

390. Answer: C 2017

22-year-old injures knee during motorcycle crash. He has moderate swelling of his knee, and his calf is soft and his pulses are intact and symmetric with uninjured side. Due to his shortening and subluxation, you place him in knee spanning external fixation and await soft tissue recovery.

Definitive surgical stabilization of this fracture should include:

- A) Knee spanning external fixation
- B) Medial buttress plating for medial fracture
- C) Medial buttress plating and lateral joint reconstruction
- D) Lateral locking plate
- E) Ring fixator

Discussion: This patient has a medial fracture dislocation variant. This will require definitive internal fixation for joint reconstruction. While it does represent a medial condylar fracture, the fracture crosses the midline and enters the lateral joint, creating characteristic centrolateral joint injury. Buttress plating alone does not restore joint congruity and lateral joint reconstruction via separate technique is required. A lateral locking plate does not adequately stabilize the condylar fracture or address the joint disruption.

Reference: Moore, Tillman M. "Fracture-Dislocation of the Knee." *Clinical Orthopaedics and Related Research*. Print.
Potocnik, Primoz, Yves P. Acklin, and Christoph Sommer. "Operative Strategy in Postero-medial Fracture-dislocation of the Proximal Tibia." *Injury*: 1060-065. Print.

**391. Answer: D**

A 66-year-old female teacher slips and falls running after a 6 year old student. A radiograph of her right hip is shown below. She is an avid bird watcher and cares for her elderly parents. Her past medical history includes a history of breast cancer 11 years ago and migraine headaches. Which treatment would give her the best outcome and the lowest probability of reoperation?

- A) Closed reduction and cannulated screw fixation
- B) Open reduction and cannulated screw fixation
- C) Cemented hip hemi-arthroplasty
- D) Total hip arthroplasty
- E) Uncemented hip hemi-arthroplasty

Discussion: Radiograph shows a displaced right femoral neck fracture. The patient is healthy woman who is high functioning professionally and personally. A total hip arthroplasty will give her the best outcome and the lowest probability of re-operation rates compared to both internal fixation and hemi-arthroplasty.



Femoral head AVN are between 30-50% with displaced femoral neck fractures (Garden III-IV). Large studies support treatment of these fractures with an arthroplasty rather than with internal fixation. Type of arthroplasty has also been studied: total hip arthroplasty have better functional outcome especially in the mid to long term, and a lower reoperation rate. Dislocation rate is however higher with a total hip arthroplasty. A hemi-arthroplasty remains a valuable option in older dependent patients with significant medical comorbidities where the goal of the surgery is pain relief as much as mobility.

Hedbeck et al. performed a randomized controlled trial involving 120 elderly patients with acutely displaced femoral neck fractures that were treated with either bipolar hemiarthroplasty or THA. They showed Harris hip scores and EQ-5D scores in favour of THA. They suggested treatment with THA in elderly, lucid patients with displaced femoral neck fractures.

Hopley et al performed a metaanalysis of 15 papers (four randomised controlled trials, three quasirandomised trials, and eight retrospective cohort studies, totaling 1890 patients). They showed a lower risk of reoperation (relative risk 0.57, 95% confidence interval 0.34 to 0.96, risk difference 4.4%, 95% confidence interval 0.2% to 8.5%). Total hip arthroplasty consistently showed better ratings in the Harris hip score (three studies, 246 patients, weighted mean difference 5.4, 95% confidence interval 2.7 to 8.2) after follow-up periods of 12 to 48 months. The standardised mean difference of different scores from five studies was 0.42 (95% confidence interval 0.24 to 0.61), indicating a medium functional advantage of total hip arthroplasty over hemiarthroplasty. Total hip arthroplasty was associated with a slightly higher risk of dislocation (relative risk 1.48, 95% confidence interval 0.89 to 2.46) and general complications (1.14, 0.87 to 1.48).

References:-Comparison of bipolar hemiarthroplasty with total hip arthroplasty for displaced femoral neck fractures: a concise four-year follow-up of a randomized trial. Hedbeck CJ, Enocson A, Lapidus G, Blomfeldt R, Törnkvist H, Ponzer S, Tidermark J Bone Joint Surg Am. 2011 Mar 2;93(5):445-50

Primary total hip arthroplasty versus hemiarthroplasty for displaced intracapsular hip fractures in older patients: systematic review. **Hopley C, Stengel D, Ekkernkamp A, Wich M BMJ 2010;340:c2332**

392. Answer: C 2020

A 76 year old retired healthy neurologist falls on concrete (6 feet) putting on holiday lights on his porch. He sustains a completely displaced femoral neck fracture. A lively discussion takes place between you and the patient regarding his treatment (hemi versus total hip arthroplasty). Which of the following statement is true?

- A) Risk of deep venous thrombosis is lower with a hemi-arthroplasty
- B) Higher risk of reoperation with a total hip arthroplasty
- C) Lower risk of dislocation with a hemi-arthroplasty
- D) Higher risk of peri-prosthetic fracture with a hemi-arthroplasty
- E) Lower blood loss with a total hip arthroplasty

Discussion: The patient is a 76 year old healthy active male who has an average life expectancy of 10.34 years (2016 Social Security actuarial table). His life expectancy is likely higher than 10 years because of his level of education and his socioeconomic circumstances. His risk of reoperation after a hemiarthroplasty would be significant and his hip function would deteriorate fast. A drawback of a total hip arthroplasty compared to a hemi arthroplasty is the higher risk of the dislocation with the former.

References:-Comparison of bipolar hemiarthroplasty with total hip arthroplasty for displaced femoral neck fractures: a concise four-year follow-up of a randomized trial. Hedbeck CJ, Enocson A, Lapidus G, Blomfeldt R, Törnkvist H, Ponzer S, Tidermark J Bone Joint Surg Am. 2011 Mar 2;93(5):445-50

Primary total hip arthroplasty versus hemiarthroplasty for displaced intracapsular hip fractures in older patients: systematic review. **Hopley C, Stengel D, Ekkernkamp A, Wich M BMJ 2010;340:c2332**

393. Answer D 2020

Your patient would like to delay the surgery by 7 days until he is evaluated by his personal internist. Which one of the following statements is true regarding the timing of his surgery?

- A) Presence of acute medical comorbidities does not affect peri-operative mortality
- B) Timing of surgery does not affect peri-operative mortality
- C) 30 day mortality is not affected by delaying up to 10 days
- D) 1 year mortality is increased if surgery is delayed by more than 4 days
- E) 90 day mortality rate is decreased if it is to wait for an evaluation by a physician familiar with the patient

Discussion: Moran et al studied 2660 elderly hip fracture patients to determine whether a delay in surgery affects postoperative mortality. The 30-day mortality for patients for whom the surgery had been delayed for more than 4 days was 10.7%, compared to 7.3% in those delayed 1-4 days. The group delayed >4 days also had significantly increased mortality at 90 days and 1 year. Patients who had been admitted with an acute medical comorbidity that required treatment prior to the surgery had a 30-day mortality of 17%, which was nearly 2.5 times greater than that for patients without an acute comorbidity. The study concluded that patients with medical comorbidities that delayed surgery had 2.5 times the risk of death within 30 days after the surgery compared with patients without comorbidities. Mortality was not increased when the surgery was delayed up to four days for patients who were otherwise fit for hip fracture surgery, however, a delay of more than four days significantly increased mortality.

Reference: Early mortality after hip fracture: is delay before surgery important?
Moran CG, Wenn RT, Sikand M, Taylor AM. *J Bone Joint Surg Am.* 2005 Mar;87(3):483-9.

394. Answer: C

The patient decides to go ahead with a total hip arthroplasty the day after hearing your cogent arguments. His family, however, wants to discuss the pros and cons of cementing or not cementing the femoral stem. Which one of the following statements is true regarding this controversial topic?

- A) Intraoperative mortality is higher with uncemented femoral implants
- B) Bone shape and quality do not affect femoral stem fixation
- C) Intraoperative proximal femur fractures are more common with uncemented femoral implant
- D) Cemented implants should be avoided in patients with latex allergy
- E) Antibiotic cement does not lower infection rate

Discussion: Intraoperative proximal femur fractures are a known complication of uncemented femoral stem in older patients because of osteoporosis (density and brittleness) (Inngul et al). The anatomy of the proximal femur changes (so called stove pipe appearance); most uncemented femoral stems are not designed for those femurs (Langslet et al). The short and longer term functional outcomes for cemented stems seem to be superior (Viberg et al).

References: Cemented *versus* uncemented arthroplasty in patients with a displaced fracture of the femoral neck. A randomized clinical trial. C. Inngul, R. Blomfeldt, S. Ponzer, A. Enocson

The Bone & Joint Journal. 2015 Nov; 97B (11):1475-80.

Cemented versus uncemented hemiarthroplasty for displaced femoral neck fractures: 5-year followup of a randomized trial. Langslet E¹, Frihagen F, Opland V, Madsen JE, Nordsletten L, Figved W. *Clin Orthop Relat Res.* 2014 Apr;472(4):1291-9.

Lower reoperation rate for cemented hemiarthroplasty than for uncemented hemiarthroplasty and internal fixation following femoral neck fracture 12- to 19-year follow-up of patients aged 75 years or more Bjarke Viberg, Søren Overgaard, Jens Lauritsen, and Ole Ovesen *Acta Orthopaedica* 2013; 84 (3): 254–259

395. Answer: B

The mechanism of action bisphosphonate drugs (Fosamax, Boniva, Actonel. etc.) is:

- A) Inhibit osteoblast function
- B) Inhibit osteoclast
- C) Block the Renal excretion of calcium
- D) Increase phosphate absorption in the out

Discussion: The Mechanism of Action of bisphosphonate therapy is to inhibit osteoclast function by interfering with protein prenylation & inhibiting the mevalonate pathway of cholesterol synthesis.

Reference: Balach T, Baldwin PC, Intravia J, Atypical Femur Fractures Associated With Diphosphonate Use. *J Am Acad Orthop Surg* 2015; 23: 550-557

396. Answer: D

Randomized controlled trial of bisphosphonate medication and placebo of calcium alone have shown:

- A) No statistically significant differences between the treatment groups
- B) Alteration in liver function tests when used for more than 3 Years
- C) A 22.5% incidence of atypical femur fractures
- D) Them to Be effective in increasing BMD & reducing the incidence of a second fracture

Discussion: The Fracture Intervention Trial (FIT), the Fracture Intervention Trial Long Term Extension (FLEX), and the Health Outcome Reduced Incidence Zoledronic Acid Pivotal Fracture Trial (HORIZON) demonstrated the benefits of bisphosphonate therapy

References: Saleh A, Hegde VV, Potty AP, & Lane JM. Bisphosphonate Therapy and Atypical Fractures. Orthop Clin N Am 44 2013: 137-151

397. Answer: D 2020

A 76 Year Old Asian female has been on Fosamax Therapy for 7 Years. She Presents To Your Office With A 3 Month History Of Hip & Thigh Pain, & Difficulty Bearing Weight. Radiographs Of Her Femur Reveal Thickening Of The Lateral Cortex With Beaking, & A Small Uni-Cortical Lucent Line in The Proximal Third Of Her Femur. Your Treatment Recommendation Would Be:

- A) Increase The Dose Of Her Fosamax And Add Supplemental Calcium
- B) Decrease The Dose Of Her Fosamax And Add Vitamin D
- C) Prescribe Crutches Or A Walker With A 12 Week Period Of Protected Weight Bearing
- D) Schedule A Prophylactic Femoral Nailing

Discussion: This patient has a Stage 2 Bisphosphonate Lesion with an incomplete stress fracture. She is at high risk for a sudden atraumatic fracture & is best treated by Prophylactic Nailing.

Reference: Einhorn TA, Bogdan Y, Tornetta P. Bisphosphonate-Associated Fractures of the Femur: Pathophysiology and Treatment. J Orthop Trauma 2013: 433-438

398. Answer: A

Following internal fixation of an atypical femur fracture you should advise your patient that:

- A) Delayed union & nonunion occur in 10%-25% of cases
- B) plate Fixation leads to better rates of healing than IM nailing
- C) Outcomes are closely related to BMI & smoking status
- D) The contralateral femur should be prophylactically nailed

Discussion: Tornetta & others have shown in a multi-center study that there is a high incidence of delayed union & nonunion of atypical fractures despite good initial treatment.

Reference: Teo BJX, Koh JSB, Goh AK, et al. Post-Operative Outcomes of Atypical Femoral Subtrochanteric Fracture In Patients On Bisphosphonate Therapy. Bone Joint J. 2014: 658-564

399. Answer: D

28 year old involved in soccer match injury and has leg pain and deformity. His skin is intact and you choose intramedullary nailing as your treatment of choice. Your management of this patient now should now include:

- A) MRI knee to r/o internal derangement
- B) MRI ankle to r/o internal derangement
- C) CT knee to rule out proximal fractures
- D) CT ankle to rule out distal fractures
- E) Full length contralateral radiograph for templating

Discussion: This patient has a torsional mechanism of injury. There is a high rate of occult posterior malleolus fractures with this injury. Proximal ligament injuries are possible but atypical. Preliminary or definitive stabilization of that injury should occur prior to nail placement. Postoperative weight bearing might also be restricted due to this injury.

Reference: Boraiah, Sreevathsa et al. "High Association of Posterior Malleolus Fractures with Spiral Distal Tibial Fractures." *Clinical Orthopaedics and Related Research* 466.7 (2008): 1692–1698. *PMC*. Web. 7 Mar. 2016.



400. Answer: C

22 year old injures knee during motorcycle crash. He has moderate swelling of his knee but lateral abrasions.

What techniques can help avoid deformity if an intramedullary nail is the selected treatment?

- A) Placement of screws that block a posteriorly directed nail path and doing nail with leg in near full extension
- B) Doing nail with leg in near full extension and percutaneous pointed clamp application
- C) Placement of screws that block a posteriorly directed nail path, doing nail with leg in near full extension, and percutaneous pointed clamp application

Discussion: Proximal third tibial shaft fractures are challenging to manage with intramedullary fixation with classic apex anterior and valgus deformations. Adjuncts other than just nail insertion are usually required to prevent deformity.

Reference: Nork SE1, Barei DP, Schildhauer TA, Agel J, Holt SK, Schrick JL, Sangeorzan BJ. Intramedullary nailing of proximal quarter tibial fractures. *J Orthop Trauma*. 2006 Sep;20(8):523-8.



401. Answer: D 2017

A 95 year old patient sustains a fall and has this closed distal femur fracture. Which of the following statements is true?

- A) Plate fixation of this fracture has a union rate between 95-100%
- B) Posterior condylar fractures are not seen with this fracture pattern
- C) CT is not required to rule out articular extension
- D) Newest retrograde nail designs have superior stability versus plates

Discussion: The nonunion rate for distal femur fractures is high than appreciated, possible up to 30%. Posterior shearing condylar fractures are seen with these fractures frequently. CT is



required to rule out articular extension and posterior condylar fractures. The newest retrograde nails with screws that engage the rod and multiple distal interlock options are as good as or more stable than many locking plate designs.

Reference: Pekmezci M1, McDonald E, Buckley J, Kandemir U. Retrograde intramedullary nails with distal screws locked to the nail have higher fatigue strength than locking plates in the treatment of supracondylar femoral fractures: A cadaver-based laboratory investigation. *Bone Joint J.* 2014 Jan;96-B(1):114-21.

402. Answer: B

A 26 year old patient was involved in a motorcycle accident and sustained a closed tibia fracture. You would like to perform tibial nailing but the fracture extends laterally to the ankle mortise. Good options for fixation include:

- A) ORIF with direct fracture reduction and plate application
- B) Intramedullary nailing with use of angular stable locking screws
- C) Ankle spanning external fixation
- D) Cast then cast brace treatment
- E) Fine wire circular external fixation

Discussion: This is a comminuted distal extra-articular fracture. Open approaches are risky at this location due to concerns for stripping and exposure necessary to achieve stability and reduction. External fixation schemes and casting are challenging because of prolonged treatment times and proximity to joint. Intramedullary nailing is feasible with or without angle stable locking screws to account for lack of lateral cortex

Reference: Boyer et al. Results of angular-stable locked intramedullary nails in the treatment of distal tibia fractures. *Orthop Traumatol Surg Res.* 2014 Dec;100(8):901-5.



403. Answer: D

Reduction of the unstable distal tibio-fibular syndesmosis can be aided by each of the following EXCEPT:

- A) Open reduction and direct visualization of the syndesmosis
- B) Fixation of the posterior malleolus
- C) Application of a clamp oriented along the neutral anatomic axis
- D) Application of a clamp oriented oblique to the neural anatomic axis
- E) Use of intra-operative computed tomography

Discussion: Clamp induced malreduction of the syndesmosis has been shown to occur with instrument placement oblique to the anatomic axis of the syndesmosis. Each of the other interventions has been shown to improve or aid in reduction.

Reference: Phisitkul P, Ebinger T, Goetz J, Vaseenon T, Marsh JL. Forceps reduction of the syndesmosis in rotational ankle fractures: a cadaveric study. *J Bone Joint Surg Am.* 2012 Dec 19;94(24):2256-61.

404. Answer: 2020

Malreduction of the syndesmosis:

- A) Has been shown to occur in up to 15% of cases even when a direct open reduction is performed
- B) Is not affected by the morphology of the distal tibial incisura
- C) Has little effect on patient reported functional outcomes
- D) Is evaluated by the modified Cotton or external rotation stress test
- E) Is unaffected by fibular reduction

Discussion: The study by Miller et al. identified syndesmotic mal-reduction (as determined by postoperative computed tomography) in 16% of cases where a formal open reduction was performed.

Reference: Miller AN, Carroll EA, Parker RJ, Boraiah S, Helfet DL, Lorch DG. Direct visualization for syndesmotic stabilization of ankle fractures. *Foot Ankle Int.* 2009 May;30(5):419-26.

405. Answer: E 2020

Screw stabilization of the distal tibio-fibular syndesmosis is ideally performed:

- A) With a single 3.5mm fully threaded tricortical screw
- B) With a single 4.5mm fully threaded tricortical screw
- C) With a single 3.5mm fully threaded quadricortical screw
- D) With two 3.5mm fully threaded tricortical screws
- E) Current literature has not demonstrated superiority of one fixation strategy over another

Discussion: Multiple biomechanical and clinical studies have evaluated fixation strategies for the distal tibio-fibular syndesmosis and one strategy (screw size and number of cortices) has not been identified as superior to another.

Reference: Van Heest TJ, Lafferty PM. Injuries to the ankle syndesmosis. *J Bone Joint Surg Am.* 2014 Apr 2;96(7):603-13.

406. Answer: C

A recent randomized controlled trial comparing static versus dynamic fixation of the ankle syndesmosis showed:

- A) Improved syndesmotic reduction with the dynamic fixation device
- B) Statistically significant improved functional outcome scores at all recorded time points with the dynamic fixation device
- C) Lower rates of reoperation with the dynamic fixation device
- D) Statistically significant rate in return to work and sports with the dynamic fixation device
- E) Statistically significant increase in range of ankle dorsiflexion and plantarflexion with the dynamic fixation device

Discussion: Rates of reoperation for all reasons (implant failure, bother, loss of reduction) was greater in the group with syndesmotic screw stabilization. Reduction, functional outcome scores (at all time points), return to work/school and range of motion (both dorsi- and plantarflexion) were not found to be statistically different.

Reference: Laflamme M, Belzile EL, Bédard L, van den Bekerom MP, Glazebrook M, Pelet S. A prospective randomized multicenter trial comparing clinical outcomes of patients treated surgically with a static or dynamic implant for acute ankle syndesmosis rupture. *J Orthop Trauma.* 2015 May;29(5):216-23.

407. Answer: E 2017

A 77-year-old lady presents after falling and sustaining an injury to her knee. Her medical history is significant only for osteoporosis and diabetes. Radiographs and representative CT scan images are shown in Figures A and B. What is the most appropriate treatment method for this patient's injury?

- A) Traction and splinting
- B) Lateral on-locking buttress plate application
- C) Retrograde supracondylar nail fixation
- D) Knee spanning External fixation
- E) Lateral locking plate application



Discussion: The injury shown in Figures A and B represents a low comminuted metaphyseal extraarticular distal femur fracture in osteoporotic bone. Because of the poor bone quality and distal extent of this injury, the best fixation construct for treatment of this fracture in this patient is lateral locking plate application. Intramedullary nailing may be possible but the low extent of the fracture makes it difficult to maintain stability with most current implants. Knee spanning is typically temporary treatment and does not allow for early mobilization.

References: Egol KA, Kubiak EN, Fulkerson E, Kummer FJ, Koval KJ. Biomechanics of locked plates and screws. J Orthop Trauma. 2004 Sep;18(8):488-93.

Weight M, Collinge C. Early results of the less invasive stabilization system for mechanically unstable fractures of the distal femur (AO/OTA types A2, A3, C2, and C3). J Orthop Trauma. 2004 Sep;18(8):503-8.

408. Answer: D 2017

A 25-year-old man sustains a femur fracture in a motorcycle accident. AP radiograph is shown below. Prior to surgery, a CT scan of the knee is ordered for preoperative planning. Which of the following additional findings is most likely to be discovered?

- A) Tibial spine fracture
- B) Impaction fracture of medial femoral condyle
- C) Femoral neck fracture
- D) Coronal plane fracture (Hoffa Fracture) of lateral condyle
- E) Avulsion fracture of lateral tibial plateau (Segond Fracture)



Discussion: The "Hoffa fracture" is a coronal plane fracture of the femoral condyle that is often missed on plain radiographs of supracondylar and intercondylar femur fractures. It involves the lateral condyle more frequently than the medial. Identification is important as it may impact operative planning and likely require screw fixation in the anteroposterior plane. Nork et al. reviewed 202 supracondylar-intercondylar distal femoral fractures and found a 38% prevalence of associated coronal plane fractures. Impaction fractures and femoral neck fractures have no well defined association with distal femur fractures. Segond fractures suggest ACL disruption.

Reference: Nork SE, Segina DN, Aflatoon K, Barei DP, Henley MB, Holt S, Benirschke SK. The association between supracondylar-intercondylar distal femoral fractures and corona

409. Answer: C 2017

Nonunions and delayed unions of the distal femur have been attributed to all of the following EXCEPT:

- A) Infection
- B) Bone loss
- C) Locking internal fixation with too little flexibility
- D) Locking internal fixation with too much flexibility
- E) Use of nonlocking plates with highly comminuted metaphyseal fractures

Discussion: Infection and bone loss are too common etiologies for delayed or nonunion after high energy trauma. Locked plates rely on the plate/screw interface, and each provides not only axial stability but also angular stability. Nonlocking plates cannot provide adequate stability in the setting of comminuted metaphyseal fractures.

New literatures suggest that there may be a higher than appreciated rate of nonunion in distal femur fractures fixed with locking plates, and that this may be related to locking constructs that create too stiff of a biomechanical environment. This stiffness may inhibit normal patterns of fracture healing.

References: Gardner MJ, Helfet DL, Lorich DG. Has locked plating completely replaced conventional plating? *Am J Orthop* (Belle Mead NJ). 2004 Sep;33(9):439-46. PMID:15509108 (Link to Abstract)

Lujan TJ, Henderson CE, Madey SM, Fitzpatrick DC, Marsh JL, Bottlang M. Locked plating of distal femur fractures leads to inconsistent and asymmetric callus formation. *J Orthop Trauma*. 2010 Mar;24(3):156-62. doi: 10.1097/BOT.0b013e3181be6720.

Henderson CE, Lujan TJ, Kuhl LL, Bottlang M, Fitzpatrick DC, Marsh JL. 2010 mid-America Orthopaedic Association Physician in Training Award: healing complications are common after locked plating for distal femur fractures. *Clin Orthop Relat Res*. 2011 Jun;469(6):1757-65. doi: 10.1007/s11999-011-1870-6. Epub 2011 Mar 22.

410. Answer: E 2017

Which of the following substances is consistently osteoinductive?

- A) Freeze dried allograft
- B) Demineralized bone matrix
- C) Calcium Phosphate
- D) Fresh cancellous allograft
- E) Autogenous iliac crest cancellous graft

Discussion: Prepared cancellous allografts provide scaffolding for osteoconduction but do not provide progenitor cells and growth factors for osteoinduction. Demineralized bone matrix may have active inductive proteins, but there is significant variability based on donor profile and preparation technique. Calcium phosphate provides structural support but has no inherent biologic activity. Autogenous bone graft contains osteoblasts, endosteal osteoprogenitor cells capable of forming new bone, and a structural matrix that acts as a scaffold, making it the gold standard for bone grafting.

References: Bone-graft substitutes: facts, fictions, and applications. Greenwald AS, Boden SD, Goldberg VM, Khan Y, Laurencin CT, Rosier RN; American Academy of Orthopaedic Surgeons. The Committee on Biological Implants. *J Bone Joint Surg Am*. 2001; 83-A Suppl 2 Pt 2:98-103. PMID: 11712842

Buckwalter JA, Glimcher MJ, Cooper RR, Recker R: Bone biology part I. *J Bone Joint Surg Am* 1995;77:1256-1275. PMID:8727757

411. Answer: D

Which of the following statements about autogenous iliac crest bone harvest in trauma patients is false?

- A) Hematoma, infection, and sensory disturbances are reported complications of ICBG harvest
- B) There are differences in complication rates between anterior and posterior ICBG harvest
- C) ICBG provides osteoprogenitor cells, scaffold, and signaling proteins.
- D) Substantial, persistent donor site pain is seen in greater than 15% of patients after ICBG
- E) Intramedullary bone harvest may provide viable alternative to ICBG

Discussion: Local procedural complications of ICBG harvest are well reported. Posterior iliac crest bone harvest may have a lower overall complication rate. ICBG remains the gold standard for autogenous grafting because of the important components for bone formation that are available in this graft. Intramedullary harvest is using a reamer aspirator system may provide a viable alternative to crest grafting. Donor site pain and long term disability are likely much lower than perceived for contemporary grafting procedures.

References: Meingerg E, Marcucio R, Miclau T. Fracture repair and bone grafting. In: Flynn JM, ed. Orthopaedic Knowledge Update 10. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2011:11-21.

Ahlmann E, Patzakis M, Roidis N, Shepherd L, Holtom P. Comparison of anterior and posterior iliac crest bone grafts in terms of harvest-site morbidity and functional outcomes. *J Bone Joint Surg Am.* 2002 May;84-A(5):716-20.

Loeffler BJ, Kellam JF, Sims SH, Bosse MJ. Prospective observational study of donor-site morbidity following anterior iliac crest bone-grafting in orthopaedic trauma reconstruction patients. *J Bone Joint Surg Am.* 2012 Sep 19;94(18):1649-54.

412. Answer: C

Advantages to performing a hemiarthroplasty instead of a total hip arthroplasty for a displaced femoral neck fracture in an elderly patient include:

- A) Increased blood loss
- B) Increased operative time
- C) Decreased incidence of dislocation
- D) Increased perioperative complications
- E) Incidence of blood transfusion is decreased

Discussion: Potential advantages for performing a hemiarthroplasty include decreased operative time and incidence of postoperative dislocation. Although decreased blood loss has also been demonstrated, the incidence of blood transfusion is not decreased. For medically ill patients, these can be advantageous in decreasing the incidence of perioperative complications.

References: Blomfeldt R, Tornkvist H, Eriksson K, et al. A randomized controlled trial comparing bipolar hemiarthroplasty with total hip replacement for displaced intracapsular fractures of the femoral neck in elderly patients. *J Bone Joint Surg Br.* 2007 Feb; 89(2):160-5.

Baker RP, Squires B, Gargan MF, et al. Total hip arthroplasty and hemiarthroplasty in mobile, independent patients with a displaced intracapsular fracture of the femoral neck. A randomized, controlled trial. *J Bone Joint Surg Am.* 2006 Dec; 88(12):2583-9.

413. Answer: B

In regards to surgical timing for an elderly patient with a displaced femoral neck fracture, which of the following is true?

- A) Mortality at 3 months is increased if surgery is delayed greater than 12 hours
- B) 1 year mortality is increased if surgery is delayed greater than 4 days
- C) Timing of operative intervention does not affect postoperative mortality
- D) Mortality at 6 months is decreased if surgery is delayed for 3 days
- E) Delay of operative intervention up to 72 hours due to associated medical comorbidities does not affect postoperative mortality

Discussion: Numerous studies have reported the correlation between time to surgery and mortality rates associated with femoral neck and hip fractures. It is recommended that patients are treated as expediently as possible with appropriate optimization of their medical comorbidities.

References: Moran CG, Wenn RT, Sikand M, Taylor AM. Early mortality after hip fracture: is delay before surgery important? *J Bone Joint Surg Am.* 2005 Mar;87 (3):483-9
Radcliff TA, Henderson WG, Stoner TJ, et al. Patient risk factors, operative care, and outcomes among older community-dwelling male veterans with hip fracture. *J Bone Joint Surg Am.* 2008 Jan; 90(1):34-42.

414. Answer: D

A 70-year-old male sustains a displaced transcervical femoral neck fracture while riding his bicycle. The optimal treatment for this patient is:

- A) Open reduction internal fixation with cannulated screws
- B) Closed reduction and traction
- C) Hemiarthroplasty
- D) Total hip arthroplasty
- E) Open reduction internal fixation with sliding hip screw

Discussion: In a chronologically old, but physiologically young and cognitively intact patient, the optimal treatment is a total hip arthroplasty. Prior studies have demonstrated early failure rates nearing 50% for attempted internal fixation with nonunion and osteonecrosis as the most common complications. Reoperation and complication rates for primary total hip arthroplasty in this same cohort have been consistently less than 10%. Patient reported pain control as well as hip function scores are improved with a total hip arthroplasty as well.

References: Callaghan JJ, Liu SS, Haidukewych GJ. Subcapital fractures. A Changing Paradigm. *J Bone and Joint Surg Br.* 2012 Nov; 94(11 Suppl A):19-21
Chammout GK, Mukka SS, Carlsson T, et al. Total hip replacement versus open reduction and internal fixation of displaced femoral neck fractures: a randomized long-term follow up study. *J Bone Joint Surgery Am.* 2012 Nov 7; 94(21):1921-8.

415. Answer: A

A 75-year-old female with a Garden I femoral neck fracture is most appropriately treated with:

- A) Operative fixation with cannulated screws
- B) Closed reduction and traction
- C) Bipolar hemiarthroplasty
- D) Total hip arthroplasty
- E) Unipolar hemiarthroplasty

Discussion: Nonoperative treatment of Garden 1 femoral neck fractures is associated with prolonged immobilization and rates of displacement nearing 50%. In situ fixation with multiple screws can be performed safely and is recommended to prevent further displacement and improve mobility. The role of releasing an intracapsular hematoma in these patients is controversial.

References: Rodriguez-Merchan EC. In situ fixation of nondisplaced intracapsular fractures of the proximal femur. Clin Orthop Relat Res. 2002 Jun;(399):42-51

Verheyen CC, Smulders TC, van Walsum AD. High secondary displacement rate in the conservative treatment of impacted femoral neck fractures in 105 patients. Arch Orthop Trauma Surg. 2005 Apr;125(3):166-8

Shuqiang M, Kunzheng W, Zhichao T, et al. Outcome of non-operative management in Garden 1 femoral neck fractures. Injury. 2006; 37(10):974-8

416. Answer: C 2017

Which of the following statements regarding optimal treatment modalities for depressed tibial plateau fractures is correct?

- A) The standard surgical approach for tibial plateau fracture is a medial arthrotomy with submeniscal window
- B) High-energy bicondylar fracture-dislocations are best managed by early open reduction with internal fixation on the day of injury
- C) Fractures with articular depression of <2mm, in presence of a stable ligamentous knee exam, are amenable to non-operative management
- D) Fractures with articular depression >2mm are best managed by indirect reduction through ligamentotaxis

Discussion: Most articular fractures of the tibial plateau are due to low-energy trauma mechanisms which exert valgus stress on the lateral tibial plateau, leading to articular depression or split/depression fractures. Articular depression of <2mm in presence of a stable knee exam represents the rare condition which is amenable to non-operative management. Unstable ligamentous knee injuries associated with tibial plateau fractures are exclusively managed by surgical fixation, in terms of ORIF. The “standard” surgical approach is represented by an anterolateral arthrotomy and submeniscal window for direct visualization of the depressed articular surface. Anatomic fracture reduction cannot be achieved by ligamentotaxis alone, because the depressed articular fractures frequently incarcerated within the metaphyseal bone. The safe strategy for managing high-energy bicondylar fracture dislocations is represented by a staged protocol of initial spanning external fixation, and delayed conversion to ORIF, due to the high risk of soft tissue-injury related complications, including fracture blisters and degloving injuries which may lead to wound breakdown and postoperative infection.

References: Papagelopoulos PJ, Partsinevelos AA, Themistocleous GS, Mavrogenis AF, Korres DS, Soucacos PN: Complications after tibial plateau fracture surgery. Injury 2006, 37(6):475-484.

Manidakis N, Dosani A, Dimitriou R, Stengel D, Matthews S, Giannoudis P: Tibial plateau fractures: functional outcome and incidence of osteoarthritis in 125 cases. International orthopaedics 2010, 34(4):565-570.

Luo CF, Sun H, Zhang B, Zeng BF: Three-column fixation for complex tibial plateau fractures. Journal of orthopaedic trauma 2010, 24(11):683-692.

Giannoudis PV, Tzioupis C, Papathanassopoulos A, Obakponovwe O, Roberts C: Articular step-off and risk of post-traumatic osteoarthritis. Evidence today. Injury 2010, 41(10):986-995.

Broome B, Mauffrey C, Statton J, Seligson D: How to avoid the ‘trap door’ effect in reducing tibial plateau fractures. Orthopaedics Today 2011, 6:8-9.

417. Answer: B 2017

Which of the following statements regarding fracture classification systems for tibial plateau fractures is correct?

- A) The Schatzker classification is based on the AO/OTA classification and characterizes all extra- and intra-articular tibial plateau fractures (A-,B-,C-types)
- B) The Schatzker classification is based on the AO/OTA classification and characterizes all intra-articular tibial plateau fractures (B- and C-types)
- C) The Schatzker and AO/OTA classifications are distinct entities which characterize different fracture patterns without any overlap in classification
- D) The Moore classification was designed to characterize low-energy postero-medial fracture fragments

Discussion: The AO/OTA classification is designed to characterize any meta- or diaphyseal fracture in any anatomic location. Applied to tibial plateau fractures, the AO/OTA system is used to classify either extra- (A-type) or intra-articular (B- or C-type) fractures. In contrast, the Schatzker classification is exclusively applied to intra-articular fracture, either partial articular (equivalent to AO/OTA B-types) or bicondylar / complete articular fractures (equivalent to AO/OTA C-types). The Moore classification is exclusively applied to high-energy uni- or bicondylar tibial plateau fracture-dislocations, which are associated with a high risk for associated significant ligamentous and vascular injuries.

References: Moore TM: Fracture-dislocation of the knee. Clin. Orthop. Relat. Res 1981, 156:128-40.

Fakler JK, Ryzewicz M, Hartshorn C, Morgan SJ, Stahel PF, Smith WR: Optimizing the management of Moore type I postero-medial split fracture dislocations of the tibial head: description of the Lobenhoffer approach. J. Orthop. Trauma 2007, 21(5):330-6.

Marsh JL, Slongo TF, Agel J, Broderick JS, Creevey W, DeCoster TA, Prokuski L, Sirkin MS, Ziran B, Henley B, Audige L: AO/OTA fracture and dislocation classification compendium - 2007. J. Orthop. Trauma 2007, 21, Suppl. 10.

Stahel PF, Smith WR, Morgan SJ: Posteromedial fracture fragments of the tibial plateau: an unsolved problem? J. Orthop. Trauma 2008, 22(7):504.

Zeltser DW, Leopold SS: Classifications in brief: Schatzker classification of tibial plateau fractures. Clin. Orthop. Relat. Res 2013, 471(2):371-4.

418. Answer: D

Which of the following statements regarding novel treatment options for depressed tibial plateau fractures is incorrect?

- A) Articular fracture reduction may be achieved by indirect visualization using arthroscopy- or fluoroscopy-guided techniques
- B) Recent studies postulate the use of inflatable bone tamps to achieve anatomic reduction of depressed articular tibial plateau fragments
- C) Any of the above-mentioned reduction techniques may be safely combined with minimal-invasive fracture fixation modalities, either with plates (MIPO) or percutaneous lag screws
- D) The use of inflatable bone tamps represents a safe technique associated with low risk for technical intraoperative complications

Discussion: Most articular fractures of the tibial plateau are due to low-energy trauma mechanisms which exert valgus stress on the lateral tibial plateau, leading to articular depression or split/depression fractures. Articular depression of <2mm in presence of a stable knee exam represents the rare condition which is amenable to non-operative management. Unstable ligamentous knee injuries associated with tibial plateau fractures are exclusively managed by surgical fixation, in terms of ORIF. The “standard” surgical approach is represented by an anterolateral arthrotomy and submeniscal window for direct visualization of the depressed articular surface. Anatomic fracture reduction cannot be achieved by ligamentotaxis alone, because the depressed articular fractures frequently incarcerated within the metaphyseal bone. The safe strategy for managing high-energy bicondylar fracture dislocations is represented by a staged protocol of initial spanning external fixation, and delayed conversion to ORIF, due to the high risk of soft tissue-injury related complications, including fracture blisters and degloving injuries which may lead to wound breakdown and postoperative infections.

References: Musahl V, Tarkin I, Kobbe P, Tzioupis C, Siska PA, Pape HC: New trends and techniques in open reduction and internal fixation of fractures of the tibial plateau. *J. Bone Joint Surg. (Br)* 2009, 91(4):426-433.

Biggi F, Di Fabio S, D'Antimo C, Trevisani S: Tibial plateau fractures: internal fixation with locking plates and the MIPO technique. *Injury* 2010, 41(11):1178-1182.

Siegler J, Galissier B, Marcheix PS, Charissoux JL, Mabit C, Arnaud JP: Percutaneous fixation of tibial plateau fractures under arthroscopy: a medium term perspective. *Orthop. Traumatol. Surg. Res.* 2011, 97(1):44-50.

Hahnhaussen J, Hak DJ, Weckbach S, Heiney JP, Stahel PF: Percutaneous inflation osteoplasty for indirect reduction of depressed tibial plateau fractures. *Orthopedics* 2012, 35(9):768-772.

Mauffrey C, Fader R, Hammerberg EM, Hak DJ, Stahel PF: Incidence and pattern of technical complications in balloon-guided osteoplasty for depressed tibial plateau fractures: A pilot study in 20 consecutive patients. *Patient Saf. Surg.* 2013, 7(1):8.

419. Answer: A 2017

Which of the following statements regarding locked plating technique for tibial plateau fractures is correct?

- A) Locked plating is the preferred method of tibial plateau fracture fixation in patients with osteoporosis
- B) Locked plating technology has completely replaced the need for dual plating in bicondylar tibial plateau fractures
- C) Locked plating represents the fixation of choice for lateral tibial plateau fractures
- D) Locked plating represents the new "gold standard" for any tibial plateau fracture

Discussion: The introduction of locked plating technology for periarticular fractures in the past decade has induced a paradigm-shift, which led to an over-utilization of locking plates for unjustified indications. Locked plating unquestionably provides superior biomechanical properties in osteoporotic fractures and for selected bicondylar tibial plateau fractures. However, "dual plating" remains a valid concept for complex bicondylar fractures, in terms of providing increased medial support and improved reduction of medial condyle fracture by adjunctive medial buttress plating for selected indications. Isolated lateral plateau fractures (Schatzker types I-III) represents another entity where conventional plating may provide superior biomechanical properties by allowing compression to the fracture with the use of non-locking screws. In summary, locked plating technology has improved the quality of fracture fixation and retention of fixation in a variety of indications related to complex periarticular fractures, however, the indication for locking plates in tibial plateau fractures should be scrutinized and applied judiciously.

References: Smith WR, Ziran BH, Anglen JO, Stahel PF: Locking plates: tips and tricks. *Instr. Course Lect.* 2008, 57:25-36.

Zhang Y, Fan DG, Ma BA, Sun SG: Treatment of complicated tibial plateau fractures with dual plating via a 2-incision technique. *Orthopedics* 2012, 35(3):e359-64.

Biggi F, Di Fabio S, D'Antimo C, Trevisani S: Tibial plateau fracture: internal fixation with locking plates and the MIPO technique. *Injury* 2010, 41(11):1178-82.

Yoo BJ, Beingessner DM, Barei DP: Stabilization of the posteromedial fragment in bicondylar tibial plateau fractures: a mechanical comparison of locking and nonlocking single and dual plating methods. *J. Trauma* 2010, 69(1):148-55.

Anglen J, Kyle RF, Marsh JL, Virkus WW, Watters WC 3rd, Keith MW, Turkelson CM, Wies JL, Boyer KM: Locking plates for extremity fractures. *J. Am. Acad. Orthop. Surg.* 2009, 17(7):465-72.

420. Answer: E

A 25-year-old male presents to the emergency department after a lawnmower accident with traumatic loss of his great toe. On examination, his wound is grossly contaminated with soil. In addition to a cephalosporin and an aminoglycoside, penicillin is given. Which of the following is true with regards to the organism that penicillin is targeting in this injury?

- A) It is an Aerobic, Gram-positive rod
- B) It is an Anaerobic, Gram-positive coccus
- C) It is an Anaerobic, Gram-negative rod
- D) It is Catalase positive
- E) It may cause botulism

Discussion: The organism being covered with penicillin is Clostridia spp. Clostridium botulinum is a Gram Positive Bacilli that is the cause of botulism.

Clostridia spp, is a Gram-positive, obligate anaerobic spore-forming rod that is found in soil and gut flora. It produces gas by the fermentation of glucose and may cause gas gangrene. Common bacteria of this genus are C. perfringens (most common), C. tetani (causes tetanus), C. difficile, and C. botulinum (causes botulism). If wounds are grossly contaminated with soil, penicillin is given to cover against Clostridia.

DeCoster et al. performed a review of traumatic foot wounds. They report that lawnmower injuries to the foot are relatively common. IV antibiotic therapy should be initiated with a broad-spectrum cephalosporin and an aminoglycoside to provide coverage against Gram-negative organisms. Penicillin should be given to protect against Clostridial infection. They conclude that irrigation and debridement is indicated initially followed by packing of open wounds. Repeat debridements are necessary as nonviable tissue demarcates. If major reconstructive procedures are necessary, they should be delayed as they have a high rate of failure if performed too soon.

Cross et al. wrote a review on treatment principles in the management of open fractures and they note that in open fractures with soil contamination, additional coverage should be added for anaerobic bacteria, typically Clostridia. Another member of the genus Clostridia is C. tetani, the causative agent of tetanus. Vaccine status for tetanus must also be assessed in these situations as well.

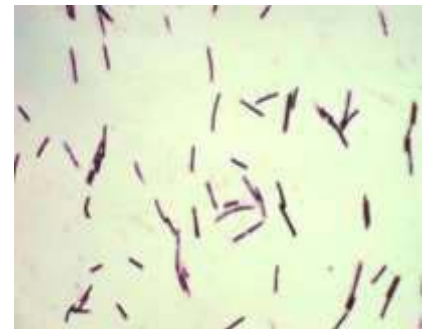


Illustration A is a radiograph demonstrating soft tissue swelling and subcutaneous emphysema, consistent with gas gangrene. Illustration B is a clinical photograph of gas gangrene evidenced by edema, discoloration, ecchymosis, and hemorrhagic bullae. Illustration C is a pathology slide of C. perfringens, a Gram-positive rod.

References: Management of Traumatic Foot Wounds. DeCoster, JAAOS 1994 Treatment principles in the management of open fractures. Cross, INDJO 2008

421. Answer: E

A 32-year-old female sustained the injury seen in Figure A after a motor vehicle accident. On physical exam there was obvious deformity about the arm with a laceration that probed to bone over the lateral aspect of the arm. The patient was neurovascularly intact. She was treated with an intramedullary nail. Which of the following is true?

- A) Intramedullary nailing is associated with an increased range of motion post-operatively when compared to compression plating.
- B) There is a lower risk of iatrogenic radial nerve palsy with antegrade intramedullary nailing when compared to compression plating.
- C) There is a lower risk of nonunion with antegrade intramedullary nailing when compared to compression plating.
- D) The musculocutaneous nerve is at risk with lateral to medial distal locking screw placement
- E) There is a higher risk of shoulder impingement with antegrade nailing compared to compression plating.

Discussion: When compared to compression plating, antegrade intramedullary nailing results show increased risk for shoulder impingement.

Options for operative management of humeral shaft fractures mainly consist of intramedullary nail or plate and screw constructs. The main advantage to intramedullary nailing is when the soft tissue envelope makes a large incision undesirable or the fracture pattern dictates a relative stability construct - such as segmental or massively comminuted injuries. The disadvantages include trauma to the rotator cuff, post operative shoulder pain, indirect reduction leading to increased risk of malrotation, and increased reoperation for implant removal. Li et al. performed a randomized controlled trial with 45 patients that investigated the difference in post operative malrotation and functional outcomes when comparing intramedullary nails versus open reduction and internal fixation. They concluded that when comparing the two operative options, patients who underwent intramedullary nailing had a greater degree of malrotation, which was associated with decreased range of motion. Additionally, they found lower functional scores with patients who underwent intramedullary nailing.

Kurup et al. performed a systematic review comparing outcomes between compression plating and intramedullary nailing for operative treatment of humeral shaft fractures. With a total of 260 patients, they found no difference with blood loss, fracture union, iatrogenic radial nerve palsy, iatrogenic fracture comminution, elbow impingement, return to pre-injury occupation, and functional shoulder scores. They did show a statistically significant increase in shoulder impingement and reduction of range of motion when using an intramedullary nail.

Figure A is a AP radiograph of a comminuted humeral shaft fracture. Illustration A is a radiograph of a humerus fixed with an intramedullary nail. Illustration B is a radiograph of a humerus fixed with a compression plate.



References: Dynamic compression plating versus locked intramedullary nailing for humeral shaft fractures in adults. Kurup, COCHD 2011. Postoperative malrotation of humeral shaft fracture after plating compared with intramedullary nailing Li, JSES 2011.

422. Answer: E

A 24-year-old male presents following a motorcycle crash with an isolated injury to his right lower extremity. He has a 3x2cm wound over the fracture site, and he immediately receives Gram positive and Gram negative coverage along with a tetanus booster. The patient is splinted, optimized, and brought to the operating room where the wound is debrided and classified as a Type IIIB fracture. Deemed stable, the plastic surgery team arrives and acutely performs a free flap for coverage, following definitive fixation with an intramedullary nail. All of the following are factors that have been shown to increase infection risk EXCEPT:

- A) Time to antibiotic administration
- B) Thoroughness of debridement
- C) Time to initial debridement
- D) Ability to close/cover an open wound
- E) Time to definitive fixation

Discussion: Time to definitive fixation is not a modifiable risk factor concerning open fractures. The other factors are risk factors that have been studied in regards to infection, and all are more important than definitive fixation. Definitive fixation can wait until complete closure and/or coverage.

When concerning management of open fractures, the most important factor is a thorough debridement. However, the quality of debridement is often not able to be quantified and thus, often not mentioned in studies. While early clinical and animal studies have shown that initial debridement should occur within 6 hours of injury, more recent clinical trials have not found a significant correlation within that urgent time frame, but rather recommend initial debridement as soon as possible within 24 hours. Time to antibiotic administration has been found to have a significant impact in lowering infection risk. Immediate administration in the emergency room is recommended. The ability to cover and/or close an open wound also has a significant impact on infection. Recent studies have recommended placing hardware after fasciotomy closure and have also demonstrated lower infection rates when flaps are placed within 72 hours of injury.



Pape and Webb concisely review the evolution of open fractures and wound management. The authors describe the early days where amputation was favored, to wet-to-dry dressings, to the advent of negative pressure wound therapy. Throughout, however, the authors emphasize the importance of soft tissue coverage. They also stress the importance of a technically thorough debridement, the most important factor of any wound management.

Schenker et al. performed a systematic review and meta-analysis of 16 studies to determine if time to the operating room for debridement was an independent, modifiable risk factor in regards to subsequent infection following open tibia fracture. At the time of the study, the gold standard (based on a previous rat model), had recommended initial debridement within 6 hours of injury. The results of this meta-analysis, however, could not find conclusive evidence to suggest that late debridement alone placed the patient at a significantly higher risk for infection. The authors provided a moderate recommendation that initial debridement should occur as soon as possible within 24 hours, although more data is required in order to find a definitive time.

The SPRINT investigators report a landmark study that randomized over 1200 patients to either reamed or unreamed tibial IMN with the primary outcome analyzed as return to the operating room for either non-union treatment or deep infection. A notable difference between the two cohorts was a significantly higher primary event rate in the unreamed group.

Figure A exhibits a distal third open tibia fracture.

References: History of open wound and fracture treatment. Pape, JOT 2008

Does timing to operative debridement affect infectious complications in open long-bone fractures? A systematic review. Schenker, JBJS 2012

Randomized trial of reamed and unreamed intramedullary nailing of tibial shaft fractures. Study, JBJS 2008

423. Answer: A

A 45-year-old male with well-controlled diabetes and hypertension is involved in a high-speed motor vehicle collision. He is complaining of left knee pain only. On physical examination, his skin is intact and his neurovascular examination is normal. His injury films are seen in Figure A. Which of the following places this patient at an increased risk for postoperative infection after open reduction and internal fixation (ORIF)?

- A. Intraoperative time over 3 hours
- B. Age
- C. Fracture Pattern
- D. Medical comorbidities
- E. Mechanism of injury

Discussion: Intraoperative times approaching 3 hours have been associated with an increased risk of infection after undergoing ORIF of tibial plateau fractures.

The optimal treatment for displaced tibial plateau fractures is ORIF. The goals of care are preservation of the soft tissues, restoration of the mechanical axis, and restoration of the articular surface. These injuries are associated with complications such as infections, arthrofibrosis, malunion/nonunion, and compartment syndromes. Infections have been associated with male gender, smoking, pulmonary disease, bicondylar fracture patterns, and intraoperative time over 3 hours. Modern techniques such as delay of definitive surgery, the use of temporary spanning external fixators, and dual incision approaches have improved the results of ORIF.

Basques et al. performed a database study to identify factors that are associated with short-term outcomes after ORIF of tibial plateau fractures. They examined adverse events (AAE), severe adverse events (SAEs), infectious complications, extended length of stay (LOS), and readmission within 30 days. They found that AAE was associated with increased ASA class and history of pulmonary disease. SAE was associated with male sex and increased ASA class. Infectious complications were associated with male sex, increased ASA class, smoking, pulmonary disease, and bicondylar fracture patterns.

Colman et al. performed a retrospective study to identify the relationship between surgical site infection and prolonged operative time in fractures of the tibial plateau. They found that mean operative time for patients who had an infection was 2.8 hours vs. 2.2 hours for patients without an infection. They also found that compartment syndromes that underwent fasciotomy had a higher infection rate than patients that did not develop this complication. Open fracture grade was also related to infection rate. They concluded that operative times approaching 3 hours and open fractures are related to an increased overall risk for surgical site infection.

Figure A is an AP radiograph of the knee demonstrating an intra-articular split of the lateral tibial plateau (Schatzker 2). Illustration A is an illustration of the Schatzker classification of tibial plateau fractures.

References: Adverse events, length of stay, and readmission after surgery for tibial plateau fractures. Basques, JOT 2015

Prolonged operative time increases infection rate in tibial plateau fractures. Colman, INJURY 2013



424. Answer: D

A 21-year-old woman is struck by a car and sustains a Gustillo IIIB fracture of the tibia. The wound was debrided and immobilized with an external fixator. Radiographs are shown in Figure A. The soft tissue defect was covered with a free flap. Her recovery was complicated by wound infection with *Klebsiella pneumoniae* and *Escherichia coli*. One month after her injury, she underwent intramedullary nailing and placement of an antibiotic spacer measuring 15cm in length. Radiographs are shown in Figure B. At the next stage of surgery 6 weeks later, the surgeon should plan to do all of the following:

- A) Excise the spacer
- B) Excise the spacer, debride all membranous tissue, perform exchange nailing
- C) Excise the spacer, debride all membranous tissue, bone graft the cavity
- D) Excise the spacer, preserve all membranous tissue, bone graft the cavity
- E) Excise the spacer, preserve all membranous tissue, bone graft the cavity, remove the nail



Figure A



Figure B

Discussion: The second stage of the Masquelet technique requires removal of the cement bolus, incision into the induced membranes and bone grafting. The existing hardware is preserved where possible as the fracture is still not stable. Bone graft is inserted INTO the membranous cavity, AROUND the nail.

The Masquelet staged technique of induced membranes is an option for filling large bone defects up to 25cm in length. This technique protects against autograft resorption, stimulates mesenchymal cell-to-osteoblast differentiation, maintains graft position, and prevents soft tissue interposition. Cement impregnation achieves high local antibiotic concentration without risk of systemic toxicity.

Ashman et al. discussed the techniques of addressing bone defects. Options include: (1) acute limb shortening (up to 4cm in the tibia and humerus, and 7cm in the femur); (2) distraction osteogenesis for defects up to 10cm long (at 1mm/day with consolidation period of 5 days per mm, or total treatment time of up to 60 days/cm), (3) autograft (up to 25cm of vascularized fibula, or 3cm of nonvascularized iliac crest), and (4) Masquelet technique.

Taylor et al. reviewed the induced membranes technique. They found that the membrane is well vascularized and composed of type I collagen with fibroblasts with an inner epithelial cell layer. There is a high concentration of VEGF, RUNX2 (CBFA1), TGF β 1, and BMP2. The membrane is sutured over bone graft to create a closed pouch. When a nail is present, they note a second internal membrane around the nail, potentially increasing local vascularity and osteoinductive factor concentration.

Figure A shows a Gustillo IIIB tibia fracture with a large bone defect held in a temporizing external fixator. Figure B shows the same defect following intramedullary nailing and with a cement spacer placed circumferentially around the nail in the defect.

References: Treatment of non-unions with bone defects: which option and why? Ashman, INJURY 2013 Induced membrane technique for reconstruction to manage bone loss. Taylor, JAAOS 2012

Upper Extremity

425. Answers: C

Alpha defensin has been found to be highly sensitive. However, certain conditions or factors may affect its diagnostic value. Increased false negatives and lower sensitivity can be seen with:

- A) Metallosis
- B) Antibiotic administration
- C) Indolent infections (*C. acnes* in the shoulder)
- D) Autoimmune disease
- E) Crystalline arthropathy

Discussion: Alpha defensin has been found to be a good marker of infection, with very high sensitivity and specificity. Additionally, the administration of antibiotics does not seem to affect its diagnostic value. Metallosis may cause false positivity, as may other inflammatory disease. While sensitivity is generally high, indolent infections, such as from *C. acnes* in the shoulder, are associated with higher risk of false negatives and therefore lower sensitivity.

Reference: Team Orthobullets (D) MD

426. Answer: B

What risk factor is most predictive of deep infection following TSA?

- A) Posttraumatic arthritis
- B) Male gender
- C) Body mass index higher than 30
- D) Diabetes

Discussion: *Propionibacterium acnes* and *Staphylococcus* species are the most common pathogens causing deep infection after TSA. In a recent long-term follow-up study of total shoulder infections, male gender and younger patient age were significantly associated with a higher infection risk. Other comorbidities and indications for TSA were not predictive.

Reference: Team Orthobullets (D) MD

427. Answer: C

From a DRG standpoint (drug-related cost), what is the difference in cost between ambulatory versus inpatient TSA's?

- A) < \$1000
- B) \$1000 - \$3000
- C) \$3000 - \$5000
- D) >\$5000

Discussion: 706 patients who underwent ambulatory total shoulder arthroplasty were compared to 4,459 patients who underwent inpatient total shoulder arthroplasty. There were no differences in complications or readmission rate. The patients undergoing ambulatory total shoulder arthroplasty had significantly lower costs ($p < 0.0001$) at \$14,722 compared with the matched controls at \$18,336 in numerous itemized cost categories as well as costs related to diagnosis-related groups.

Reference: Team Orthobullets (D) MD

428. Answer: D

Which of the following structures are most at risk when medializing the starting point during suprapatellar tibial nailing:

- A) anterior cruciate ligament
- B) posterior cruciate ligament
- C) quadriceps tendon
- D) intermeniscal ligament
- E) tibial eminence

Discussion: In a cadaveric study by Eastman et al 2010, the intermeniscal ligament and the medialmeniscus are most at risk during SP nailing. This can be avoided if the entry point does not error medially .

Reference: Team Orthobullets (D) MD

429. Answer: A

Which of the following statements is true regarding the use of PRP in upper extremity injuries?

- a. The use of PRP have no improvement in structural integrity, clinical outcomes and perioperativemorbidity following rotator cuff repairs
- b. The use of PRP can improve structural healing but not clinical outcomes following rotator cuff repairs
- c. The use of PRP can significantly improve healing of lateral epicondylitis
- d. PRP can be helpful to decrease symptoms from shoulder impingement
- e. PRP can improve clinical outcomes following rotator cuff repairs

Discussion: PRP has been studied in a randomized double-blinded study to show that there's no difference in post-operative narcotic use, clinical outcomes scores and function up to a year from surgery

Reference: Weber SC, Kauffman JI, Parise C, Weber SJ, Katz SD: Platelet – rich fibrin matrix in the management of arthroscopic repair of the rotator cuff: a prospective randomized double-blinded study. Am J Sports Med 2013 Feb 1 (20): 263-70

430. Answer: A

Two patients are discharged from a surgicenter after upper extremity procedures. The surgeon gives them prescriptions for oral opioid analgesics. Patient A had open reduction and internal fixation of a distal radius fracture. Patient B had cubital tunnel release without transposition. Which of the following is most likely true regarding analgesic use

- A) Patient A will use more medication than Patient B
- B) Patient A will use less medication than Patient B
- C) Analgesic use will be similar between Patients A and B
- D) Both patients will consume more than 30 pills
- E) A reasonable prescription is 40 pills with 1 refill for Patient A, and 40 pills with no refills for Patient B

STANDARDIZED POSTOP PAIN REGIMEN FOR HAND/UE

1. Intraoperative nerve block with mix of long and short acting anesthetic
2. Consider prece dex if repairing nerve (0.5 micrograms/kg IV over 20min at start of procedure)
3. Ibuprofen 800 mg po q 8h x 3 days then prn (unless on anticoagulant or elev creatinine/ renal dysfxn)
4. Tylenol should not exceed 3000 mg/day if using regular Tylenol or a narcotic with Tylenol.
5. Ice to armpit 15 min/1-2x/hour while awake for 3 days then prn
6. Elevation of extremity
7. see reverse for narcotic recs

7. Narcotic guidelines

No narcotics: small Moh's (<3 cm, no wide undermining), triggers, nonop Dupuytren's releases, flexor retinacular cysts, nevi, small lumps/bumps

10 narcotics: small joint (mucous cysts), carpal tunnel, deQuervain's, operative Dupuytren's, nonop hand fractures, small joint fusion

20 narcotics: wrist ganglion cysts, fixation of hand fx, LRTI, nonop scaphoid/distal radius fracture, simple tendon/tendon transfer/tendon stabilization

40 narcotics: large trauma, wrist fusion, open carpal surgery, DRUJ recon

8. Other: consider acute gabapentin for trauma-assoc neuralgic pain

9. Vit C: 500 gm/day x 8 wks for DRFs

Reference: Opioid consumption following outpatient upper extremity surgery. Rodgers, JHS 2012

The effect of an educational program on opioid prescription patterns in hand surgery: a qualityimprovement program. Stanek, JHS 2015

431. Answer: C

A 45-year-old man sustains the injury seen in Figures A and B following a motor vehicle accident. Postoperative radiographs are seen in Figures C and D. Which of the following is the most accurate when comparing outcomes between intramedullary nailing (IMN) and open reduction internal fixation (ORIF) for this injury?

- A) Union rates at one year are higher with ORIF
- B) Infection rates are higher with IMN
- C) Functional shoulder outcomes at one year are equivalent with IMN and ORIF
- D) Iatrogenic radial nerve injury rate is higher with ORIF
- E) Shoulder stiffness rates at one year are equivalent with IMN and ORIF



Figure A



Figure B



Figure C

Discussion: Although shoulder pain and stiffness is increased following IMN compared to ORIF, functional outcome scores at one year have been shown to be equivalent in both treatment groups.

Diaphyseal humeral shaft fractures outcomes following IMN and ORIF are under further investigation. Diaphyseal humeral shaft fractures have historically been treated with ORIF, however proponents for IMN cite benefits of less periosteal stripping and soft tissue dissection. Recent investigations have shown outcomes with regard to nonunion, infection, re-operation, and nerve palsy appear equivalent between both groups. Rates of shoulder stiffness and shoulder pain have been demonstrated to be higher in IMN compared to ORIF. American Shoulder and Elbow Scores (ASES) have shown no difference at one year post-operatively.



Figure D

Bhandari et al. performed a meta-analysis of 3 prospective randomized trials. They found lower rates of re-operation and shoulder impingement with ORIF of humeral shaft fractures.

Wali et al. performed a prospective randomized study of IMN or ORIF on 50 patients with mid-diaphyseal humeral shaft fractures. They found IMN had shorter operative time, shorter hospital stay, and lower blood loss. They found no difference in union rates, complication, or shoulder functional outcomes scores. They conclude IMN to be an effective option for treating mid-diaphyseal humeral shaft fractures.

Heineman et al. have recently conducted an update on their meta-analysis to include more recent randomized studies. With the inclusion of newer studies the author found a statistically significant increase in total complication rate with the use of IM nailing compared with ORIF. The authors found no significant difference between the two treatment modalities for the secondary outcomes (nonunion, infection, nerve palsy, re-operation).

Figures A and B show a diaphyseal humeral shaft fracture. Figure C and D show postoperative radiographs following intramedullary nailing of a humeral shaft fracture.

References: Compression plating versus intramedullary nailing of humeral shaft fractures--a meta-analysis.

Bhandari, ACTA 2006

Internal fixation of shaft humerus fractures by dynamic compression plate or interlocking intramedullary nail: a prospective, randomised study. Wali MG, 2014

Plate fixation or intramedullary fixation of humeral shaft fractures--an update. Heineman, ACTA 2012

432. Answer: E

A 42-year-old man presents to the clinic with two months of left upper extremity pain, numbness, and tingling. His MRI images are shown in Figure A and B. The axial image in Figure B correlates with the level marked by the green lines on the sagittal image. In which of the following locations would you expect the patient to have diminished sensation?

- A) Lateral shoulder
- B) Long finger
- C) Medial arm
- D) Volar ulnar forearm and small finger
- E) Dorsoradial forearm and thumb



Figure A

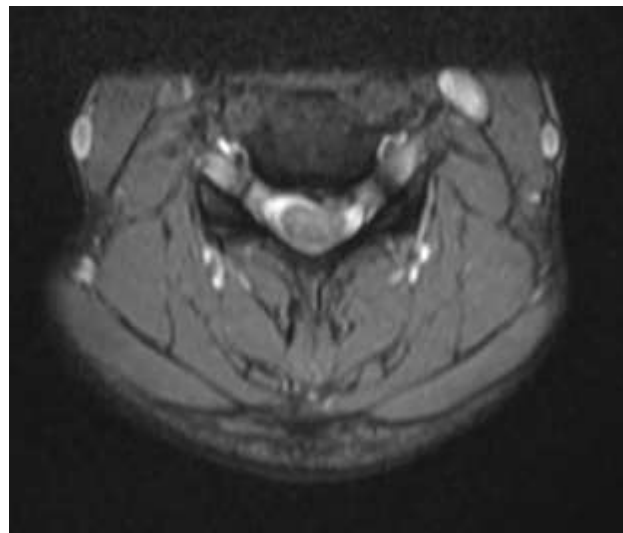


Figure B

Discussion: The patient is presenting with a C6 cervical radiculopathy secondary to disc herniation at C5-C6. He would be expected to have numbness and tingling in the dorsoradial forearm and thumb, decreased strength to wrist extension, and decreased strength of brachioradialis.

Cervical radiculopathy occurs most commonly secondary to a cervical disc herniation, which can lead to impingement of nerve roots exiting from the spinal canal. Symptoms can be any combination of pain, numbness, loss of reflexes, and/or muscle weakness. The majority of patients typically respond to conservative treatment in the form of NSAIDs, rest, and epidural steroid injections. For refractory single-level cases, anterior cervical discectomy and fusion (ACDF), a posterior cervical laminotomy, or cervical disc arthroplasty (CDA) are the mainstay of treatment.

Rhee et al. reviewed the pathophysiology and management of cervical radiculopathy. They report a success rate of up to 75% for nonoperative treatment. In cases where surgery is indicated, up to 90% of patients get relief from arm symptoms. Motor changes are less likely to recover than sensory ones.

Meredith et al. performed a retrospective chart review of 16 professional football players with cervical disc herniations. The authors recommended surgery if patients had MRI with cord compression and signal change within the cord, but otherwise encouraged nonoperative treatment with return to sports after symptoms improved and repeat MRI demonstrated no cord compression. Symptoms generally improved with a course of anti-inflammatory medications including NSAIDs, oral methylprednisolone, and/or epidural steroid injections. Nine of the 16 patients were able to return to play, and at one year after return to play, there were no catastrophic spinal cord injuries among the group.

Caridi et al. review the clinical presentation of C6 radiculopathies. They explain key features that differentiate a C6 radiculopathy from common peripheral neuropathies such as carpal tunnel syndrome.

Figure A is a T2 sagittal MRI image showing a disc herniation at C5-6. Figure B is a T2 axial MRI image showing a left-sided disc herniation at C5-6 with severe foraminal stenosis (not a great axial MRI, but quality of image does not change answer). Illustration A is a post-operative radiograph of a patient who has undergone ACDF.

References: Cervical radiculopathy. Rhee, JAAOS 2007

Operative and nonoperative treatment of cervical disc herniation in National Football League athletes. Meredith, AJSM 2013

Cervical radiculopathy: a review. Caridi JM 2011.

433. Answer: A

A 65-year-old man experienced 6 years of worsening shoulder pain. Examination demonstrates stiffness and crepitus with range of motion, but full rotator cuff strength in all planes. Radiographs show advanced shoulder osteoarthritis, and an MRI scan ordered by the patient's primary care physician shows an intact rotator cuff. What is the most likely glenoid wear pattern seen in glenohumeral osteoarthritis with an external rotation deficit?

- A) Posterior wear
- B) Anterior wear
- C) Central wear
- D) Superior wear

Discussion: Posterior glenoid wear is the most common pattern seen in typical glenohumeral arthritis. Central wear can also be seen, but it is less common and anterior wear is least common.

Reference: Team Orthobullets (D) MD

434. Answer: C

A 25-year-old male sustains a humeral shaft fracture and is treated with the implant seen in Figure A. Compared with open reduction and internal fixation with a plate and screw construct, the treatment shown in Figure A is associated with all of the following EXCEPT?

- A. Increased shoulder impingement
- B. No difference in rate of union
- C. Increased shoulder range of motion
- D. No difference in rate of radial nerve injury
- E. Increased risk of revision surgery

Discussion: The radiograph shows a humeral shaft fracture treated with an intramedullary nail (IMN).

It is important to note that the answer to this question continues to evolve as more data and studies are performed.

McCormack prospectively randomized 44 humeral shaft fractures to treatment by intramedullary nailing vs. dynamic compression (DCP) plating and found the risk of shoulder impingement, iatrogenic comminution, and nonunion were higher in the nail treatment group resulting in a higher revision rate. They found no significant differences in shoulder/elbow function, VAS pain scores, ROM, or time to return to normal activity.

Chapman et al in their prospective randomized trial between IMN and plate fixation found that the IMN group had higher rates of post operative shoulder pain and a slower time to fracture union. The ORIF had faster time to union, but reduced elbow range of motion. Both studies show the effectiveness of IMN and ORIF in the treatment of humeral shaft fractures.

More recent meta-analysis such as by Ma et al show that both IMN and DCP can achieve similar fracture union with a similar incidence of radial nerve injury and infection. IMN was associated with an increased risk of shoulder impingement, more restriction of shoulder movement, an increased risk of intraoperative fracture comminution, a higher incidence of implant failure, and an increased risk of re-operation.

Reference: Fixation of fractures of the shaft of the humerus by dynamic compression plate or intramedullary nail. A prospective, randomised trial. McCormack, BJJ 2000

Randomized prospective study of humeral shaft fracture fixation: intramedullary nails versus plates. Chapman, JOT 2000

Intramedullary nail versus dynamic compression plate fixation in treating humeral shaft fractures: grading the evidence through a meta-analysis. Ma, PLOS 2013



435. Answer: C

A 52-year-old male presents with a chief complaint of left arm pain following a tennis match. He reports the symptoms began 3 weeks ago, and have been present ever since. He describes diffuse, moderate pain that radiates from the base of his neck to his forearm. The pain is relieved by elevating his left arm. He also describes numbness and tingling in his index, long, and ring fingers. He denies any numbness or tingling in his thumb. On physical exam he is noted to have decreased triceps strength on the affected side, and a decreased triceps reflex. These symptoms are most likely caused by:

- A) A left paracentral disc herniation at C5-6
- B) A left far lateral (foraminal) disc herniation at C5-6
- C) A left far lateral (foraminal) disc herniation at C6-7
- D) A left paracentral disc herniation at C7-T1
- E) Compression of a peripheral nerve within the arcade of Struthers

Discussion: The patient presents with symptoms of a left C7 cervical radiculopathy. Both a paracentral and far lateral (foraminal) disc herniation can compress the C7 nerve root due to the horizontal anatomy of the cervical nerve roots (Illustration A).

Cervical radiculopathy is defined as pain and/or sensorimotor deficit as a result of injury or compression of one or more of the cervical nerve roots. Despite the significant interweaving of the cervical nerve roots in the brachial plexus, there are physical exam findings that are typical of individual nerve distributions. Wrist flexion, elbow extension, sensation to the middle finger, and the triceps reflex are all relatively specific for a C7 radiculopathy (see illustration B). It is postulated that disc herniation and neural compression causes an inflammatory response and production of cytokines such as IL-6, IL-1, TNF-alpha, bradykinin, substance P, and various prostaglandins. Approximately 75% of patients with cervical radiculopathy will improve with non-operative management, which consists of activity modification, short-term immobilization, NSAIDs, PT, and possibly steroid injections.

Kahraman et al. performed a retrospective chart review of 235 patients who underwent anterior cervical surgery over a 10 year period. 3/235 patients developed dysphonia (likely related to a recurrent laryngeal nerve injury) during this period, and all recovered within a 3 month period. The authors conclude that most cases of dysphonia after anterior cervical surgery are likely temporary.

Davidson et al. report on a case series of 22 patients with severe cervical radiculopathy. They found that 15 of these patients had symptom relief with abduction of their arm above their head (shoulder abduction relief test). Of the 15 that had a positive shoulder abduction test, 13 later required surgery, while the other 9 patients were eventually managed conservatively, indicating the value of this maneuver as diagnostic of significant cervical extradural compressive radiculopathy.

Illustration A demonstrates that in the cervical spine, paracentral and far lateral disc herniations affect the exiting nerve root. Illustration B shows the sensory, motor, and reflex distributions of the C7 nerve root.

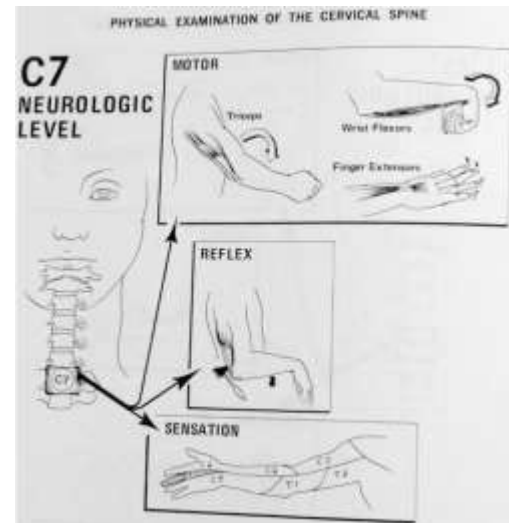
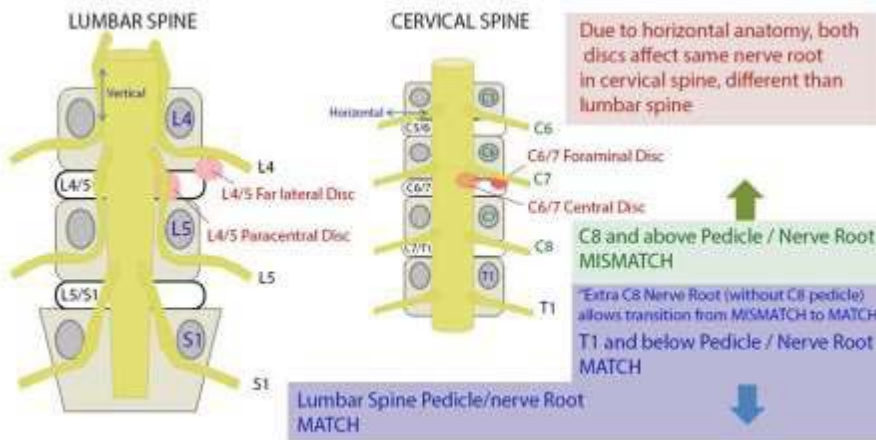


Figure A

Figure B

Reference: Is dysphonia permanent or temporary after anterior cervical approach? Kahraman, ESPNJ2007

Cervical radiculopathy: a review. Caridi JM 2011

The shoulder abduction test in the diagnosis of radicular pain in cervical extradural compressive monoradiculopathies. Davidson, SPINE 1981

Stem Cells

436. Answer: C 2022

Which of the following is NOT included in the minimal criteria definition of a mesenchymal stromal cell product, according to the International Society for Cellular Therapy (ISCT) Position Paper in 2006?

- A) Adherence to plastic
- B) Expression of surface markers CD73, CD90 and CD105
- C) Expression of surface markers CD34 and CD45
- D) Cells are able to differentiate into osteoblasts, adipocytes and chondroblasts.

Discussion: The International Society for Cellular Therapy (ISCT) proposed minimal criteria for defining multipotent mesenchymal stromal cells. These include:

1. Cell adherence to plastic
2. Expression of surface markers CD73, CD90 and CD105
3. Lack of expression of surface markers CD34 and CD45
4. Cells are able to differentiate into osteoblasts, adipocytes and chondroblasts.

Reference: Dominici M, Le Blanc K, Mueller I, Slaper-Cortenbach I, Marini F, Krause D, Deans R, Keating A, Prockop Dj, Horwitz E. Minimal criteria for defining multipotent mesenchymal stromal cells. The International Society for Cellular Therapy position statement. *Cytotherapy*. 2006;8(4):315-7. doi: 10.1080/14653240600855905.

437. Answer: A 2022

Which of the following is NOT included in the functional definition of a mesenchymal stromal cell product, according to the International Society for Cellular Therapy (ISCT) Position Paper in 2019?

- A) Demonstrated ability for self-renewal and differentiation
- B) Citing the tissue of origin
- C) A matrix of assays to demonstrate the secretome

Discussion: In 2019, the International Society of Cellular Therapy (ISCT) Position Paper attempted to further differentiate between mesenchymal stem cells which have self-renewal and differentiation abilities from mesenchymal stromal cells which refers to a bulk population with notable, secretory, immunomodulatory and homing properties. They advise reporting of the tissue source (e.g. bone marrow, adipose, umbilical cord). They also advise using functional matrix assays such as quantitative RNA analysis of selected genes, flow cytometry of cell surface markers and protein analysis of the mesenchymal stromal cell secretome.

Reference: Viswanathan S, Shi Y, Galipeau J, Nolte J, Phinney D.G, Sensebe L. Mesenchymal stem versus stromal cells: International Society for Cell and Gene Therapy (ISCT) Mesenchymal Stromal Cell committee position statement on nomenclature. *Cytotherapy*. 2019; 21(10): 1019-1024. doi: 10.1016/j.jcyt.2019.08.002

438. Answer: D 2022

The secretome of adipose derived mesenchymal stromal cells treated with synovial fluid from osteoarthritis patients does NOT include:

- A) Chondroprotective matrix metalloproteinase (MMP) inhibitors
- B) EV-miRNAs that reduce inflammation
- C) EV-miRNAs that reduce chondrocyte senescence
- D) Soluble factors that promote macrophage migration and proliferation

Discussion: The soluble factors and EV-miRNAs released by adipose mesenchymal stromal cells after treatment with synovial fluid from osteoarthritis patients was shown to recruit T cells and monocytes/macrophages and, when in proximity, to impair their proliferation, revert their activation state and alter their catabolic cytokine production promoting anti-inflammatory and chondrocyte catabolic activity.

Reference: Ragni E, Colombini A, Viganò M, Libonati F, Perucca Orfei C, Zagra L, de Girolamo L. Cartilage Protective and Immunomodulatory Features of Osteoarthritis Synovial Fluid-Treated Adipose-Derived Mesenchymal Stem Cells Secreted Factors and Extracellular Vesicles-Embedded miRNAs. *Cells*. 2021 Apr 30;10(5):1072. doi: 10.3390/cells10051072. PMID: 33946524; PMCID: PMC8147187

439. Answer: B 2022

Which of the following has more than one U.S. Food and Drug Administration cleared device for use in orthopedic applications?

- A) Stromal Vascular Fraction (SVF)
- B) Microfragmented Adipose Tissue (MFAT)
- C) Adipose Derived Mesenchymal Stromal Cells (AD-MSC)
- D) Bone Marrow Derived Mesenchymal Stromal Cells (BM-MSC)

Discussion: The processing of stromal vascular fraction (SVF), AD-MSC, and BM-MSC all exceed the FDA's definition of minimal manipulation. Several FDA cleared devices for the production of microfragmented adipose tissue exist.

In 21 CFR 1271.10, the regulations identify the criteria for regulation solely under section 361 of the PHS Act and 21 CFR Part 1271. An HCT/P is regulated solely under section 361 of the PHS Act and 21 CFR Part 1271 if it meets all of the following criteria (21 CFR 1271.10(a)):

- 1) The HCT/P is minimally manipulated;
- 2) The HCT/P is intended for homologous use only, as reflected by the labeling, advertising, or other indications of the manufacturer's objective intent;
- 3) The manufacture of the HCT/P does not involve the combination of the cells or tissues with another article, except for water, crystalloids, or a sterilizing, preserving, or storage agent, provided that the addition of water, crystalloids, or the sterilizing, preserving, or storage agent does not raise new clinical safety concerns with respect to the HCT/P; and
- 4) Either:
 - i) The HCT/P does not have a systemic effect and is not dependent upon the metabolic activity of living cells for its primary function; or
 - ii) The HCT/P has a systemic effect or is dependent upon the metabolic activity of living cells for its primary function, and:
 - a) Is for autologous use;
 - b) Is for allogeneic use in a first-degree or second-degree blood relative; or c) Is for reproductive use.

Reference: Regulatory Considerations for Human Cells, Tissues, and Cellular and Tissue-Based Products: Minimal Manipulation and Homologous Use. Guidance for Industry and Food and Drug Administration Staff.

<https://www.fda.gov/media/109176/download>

440. Answer: D 2022

Bone marrow aspirate concentrate (BMAC) is a rich source of:

- A) Mesenchymal stem cells (MSC)
- B) Matrix metalloproteinases (MMP)
- C) Erythrocytes
- D) Interleukin 1 receptor antagonist (IL-1Ra)

Discussion: Interleukin 1 receptor antagonist (IL-1Ra) inhibits interleukin 1 beta and its proinflammatory and catabolic effects. Bone marrow aspirate concentrate (BMAC) has a higher concentration of IL-1Ra than bone marrow aspirate, whole blood, leukocyte poor platelet rich plasma (LP-PRP) and leukocyte rich platelet rich plasma (LR-PRP). Only 0.001% to 0.01% of mononuclear cells in bone marrow aspirate concentrate represents mesenchymal stem cells. When the bone marrow aspiration is performed correctly, bone marrow aspirate concentrate contains fewer erythrocytes than whole blood.

Reference: Ziegler CG, Van Sloun R, Gonzalez S, Whitney KE, DePhillipo NN, Kennedy MI, Dornan GJ, Evans TA, Huard J, LaPrade RF. Characterization of Growth Factors, Cytokines, and Chemokines in Bone Marrow Concentrate and Platelet-Rich Plasma: A Prospective Analysis. *Am J Sports Med.* 2019 Jul;47(9):2174-2187. doi: 10.1177/0363546519832003. Epub 2019 Apr 29. PMID: 31034242.

441. Answer: D 2022

Which of the following is NOT a challenge to the safe and effective use of allogeneic mesenchymal stromal cells (MSC) in orthopedics?

- A) The expression of major histocompatibility complex (MHC) markers on unmatched cell membranes identifies these cells for destruction by the host's immune system.
- B) Memory T cells are generated after the administration of allogeneic MSCs leading to cytotoxic lymphocyte proliferation upon repeat injection.
- C) Significant antibody production against allogeneic MSCs occurs.
- D) Single doses of allogeneic MSCs have demonstrated a high rate of short term adverse events in human clinical trials.

Discussion: Allogeneic mesenchymal stromal cells express major histocompatibility complex markers that allows the host's immune system to identify these cells for destruction. After repeat dosing of allogeneic MSCs, cytotoxic lymphocyte proliferation occurs due to memory T cells. Significant antibody production to allogeneic MSCs occurs potentially limiting their use. Despite these concerns, single doses of allogeneic MSCs have not demonstrated an increased rate of short term adverse events in human clinical trials thus far.

Reference: Kamm L, Riley C, Parlane N, Gee E, McIlwraith CW. Interactions between allogeneic mesenchymal stromal cells and the recipient immune system: A comparative review with relevance to equine outcomes. *Front. Vet Sci.* Jan. 2021 (7). doi.org/10.3389/fvets.2020.617647.

442. Answer: B

What may increase the concentration of stem cells and platelets when preparing PRP?

- A) Stopping all anti-inflammatory medication
- B) Short-Term Exercise
- C) 24 hours of rest
- D) Drinking coffee
- E) Heat exposure

Discussion: Recent data has shown that short term exercise can mobilize stem cells and increase platelet concentrations in PRP preparations.

References: Team Orthobullets (D) M

General Orthopaedic

443. Answers: C

All of the following antibiotics function by interfering with protein synthesis by inhibiting ribosomes EXCEPT:

- A) gentamicin
- B) tobramycin
- C) vancomycin
- D) erythromycin
- E) linezolid

Discussion: Gentamicin and tobramycin are aminoglycosides that function by inhibition of bacterial protein synthesis via irreversible binding to ribosomal subunits. Erythromycin functions by binding to the 50S subunit of the bacterial 70S rRNA complex and thereby inhibits protein synthesis. Linezolid binds to the 23S portion of the ribosomal subunit and inhibits protein synthesis. In contrast, Vancomycin acts by inhibiting proper cell wall synthesis and does not inhibit the ribosome.

Reference: Paul D. Kim MD, Derek Moore MD, Patrick McCulloch MD

444. Answer: B

Which of the following processes relies on an exopolysaccharide glycocalyx?

- A) Osteoclast differentiation
- B) Biofilm creation
- C) Metastatic bone disease
- D) Endochondral bone formation
- E) Intramembranous bone formation

Discussion: Exopolysaccharide glycocalyx allows bacteria to adhere to orthopaedic implants and elude antimicrobial therapies through the creation of biofilms.

Biofilms are defined as a structured community of bacterial cells enclosed in a self-produced polymeric matrix and adherent to an inert or living surface. Biofilm production usually occurs within 4 weeks, and is extraordinarily hard to eradicate with antibiotic therapy alone. In the setting of a chronic infection of an orthopaedic implant (>4 weeks), explantation of the implant followed by antimicrobial therapy is the most reliable method of curing the infection.

Nguyen et al. reviewed 21 patients who underwent revision arthroplasty with negative intraoperative cultures. After standard cultures were obtained (all negative), the implants underwent an ultrasound protocol to theoretically disrupt the biofilm. 1 of the 21 implants grew coag-negative Staph after the bath.

Fux et al. reviewed biofilms with respect to orthopaedic and non-orthopaedic conditions. They discussed how aspirations are often falsely negative possibly because the microorganisms persist only within a biofilm on the synovia but not in planktonic form.

Illustration A and the video provided show the process of biofilm formation. https://youtu.be/tw_JXac77pg

References: Detecting bacterial colonization of implanted orthopaedic devices by ultrasonication. Nguyen, CORR 2002. Bacterial biofilms: a diagnostic and therapeutic challenge. Fux CA 2003



445. Answer: D

The primary benefit of minimally invasive surgery at this time is:

- A) It is less costly
- B) Surgical time is less
- C) Better outcomes when compared to open surgery
- D) Fewer risks of complications such as wound infections

Discussion: At this time, the best support for minimally invasive surgery is that there are fewer complications such as wound infections.

References: Team Orthobullets (D) MD