Highlights of Hip and Knee Societies/AAHKS Specialty Day 2012

James Huddleston, MD
Assistant Professor
Department of Orthopaedic Surgery
Stanford University Medical Center

California Orthopaedic Association
2012 Annual Meeting
Carlsbad
Conflicts

• Research support: Biomet, OREF, and Robert Wood Johnson Foundation

• Consultant: Biomet, Smith and Nephew, Zimmer, and Porosteon

• Stock options: Porosteon
Hip Symposium Topics

- Hip Preservation
- Bearing Dilemma
- Diagnosis of Failed MOM
- Registries
- Socket Positioning
- Complications
- Revisions
Hip Outline

- XLPE
- MOM
- Cup Position
John Charnley Award

- “Clinical Multi-centric Studies of the Wear Performance of Highly Cross-linked Re-melted Polyethylene in THR”


- MGH, Rush, U Chicago, Washington U, Chapel Hill, Albuquerque, Mayo Clinic, Utah Bone and Joint Center, Sahlgrenska U, and Hvidovre Copenhagen U
John Charnley Award

- 900 THA patients, 3 studies, up to 13 years follow-up
- 26, 28, 32, and 36mm heads
- Plain radiographs- NO osteolysis
- Femoral head penetration rate extremely low and did not correlate with time *in vivo*
- Higher wear rates with 36 mm heads, may not be of clinical significance
Irradiated UHMWPE

1st generation XLPEs

- Slight decline in mechanicals
  - Melting
    - No oxidation
      - No change in mechanicals in over 7 years
  - Annealing
    - Preserve mechanicals in short term

- 1st generation XLPEs
  - No change in mechanicals in over 7 years
  - Slight decline in mechanicals in less than 3 years
Minimum Ten Year Follow-Up of Highly Cross-linked Polyethylene Liners in Total Hip Arthroplasty

+1 Bragdon, CR; 1 Jarrett, B; 1 Doerner, M; 1 Burke, D; 1 Freiberg, AA; 1 Rubash, HE; 1 Malchau, H
Harris Orthopaedic Laboratory, Massachusetts General Hospital, Boston, MA
cbragdon@partners.org

Steady State Linear Wear

2D Linear Wear (mm)

THIRTY-TWO

TWENTY-EIGHT

Years

y = 0.0212x - 0.0332
R² = 0.0272

y = 0.0122x + 0.0778
R² = 0.0133
Results-Multicenter

- 176 hips
  - Average follow-up: 6.5 ± 1.1 years
    - range 4.5-9.3 years

- 2676 film comparisons
  - 417 film comparisons were excluded
    - Short interval between films of <0.5 years
    - Pelvic rotation between films of >25°
    - Poor film quality
Group Regression

Steady State Head Penetration for the
Early and Late Time Periods

Early Penetration Rate: 0.0088 mm/yr
Late Penetration Rate: -0.0083 mm/yr

Early period: 8.8 µm/year  Late period: -8.3 µm/year
(p=0.456)
Individual Latest Follow-up

- 93 hips with paired early and late rates

- Early period
  - 19.6 ± 95 µm/year

- Late period
  - 24.5 ± 226 µm/year

- Student’s t-test
  p=0.848
Conclusions

- No significant increase in femoral head penetration in late period (> 5 years f/u)
Otto Aufranc Award

- “The Interpretation of Metal Ion Levels in Unilateral and Bilateral Hip Resurfacing: Practical Guidelines for Hip Resurfacing Follow-Up”
- De Smet et al., Belgium
• Goal: determine “safe” upper limits of ion levels
• 453 unilateral and 139 bilateral resurfacings
• “Well-functioning” group 251 unilateral (55%) and 58 bilateral (42%)
• Majority males in well-functioning group, majority females in “non-optimal” group (p<0.001)
Otto Aufranc Award

• Optimal group
  • Larger size implants (p<0.001)
  • Uni and bilateral lower ion levels (p<0.001)

• Safe upper limits
  • Chromium 4.6 µg/l and cobalt 4.0 µg/l for uni
  • Chromium 7.4 µg/l and cobalt 5.5 µg/l for bilateral
  • Uni ion levels lower than bilateral (p<0.001)
Use of upper limits in predicting poor function:

- Specificity >95%
- Sensitivity ≤ 25%
Diagnosis of Failed MOM

- Blood work
  - Serum/whole blood cobalt and chromium levels
  - www.orthopaedicanalysis.com
  - ESR/CRP
- Imaging
  - MARS MRI
  - Ultrasound
- Aspiration r/o infection
Arthroprosthetic Cobaltism: Neurological and Cardiac Manifestations in Two Patients with Metal-on-Metal Arthroplasty

A Case Report

By Stephen S. Tower, MD

Investigation performed at the Anchorage Fracture and Orthopedic Clinic, Anchorage, and the Alaska WWAMI Biomedical Program, Anchorage, Alaska

Stephen S. Tower
Cobaltism

- 54 yo F primary THA for OA 2006
- Pain free after 3 months
- Several “squeaking” episodes at 6 months, none since
- Severe, constant groin, trochanteric and buttock pain last few years
- Fatigue, vertigo, heart palpitations and flutters, headache, shortness of breath, nose bleeds, tingling in bilateral hands and feet, tinnitus, and general irritability
Cobaltism

- Aspiration 1-2011: 7 cc brownish fluid, cx neg
- Serum cobalt: 167 ppb
- Serum chromium: 120 ppb
- Serum creatinine 0.9 mg/dl
- Operative findings 4-2011: extensive metallosis with brown fluid, implants osseointegrated and osteolysis @ socket rim
- Cup revised because unable to remove 36 mm ID Pinnacle metal liner after 20 minutes
Socket Positioning

- Great unsolved problem in THA today
- “Cup Positioning in THA Improves with Clinical Feedback” - MGH group
  - Abduction improved (p<0.01)
  - Anteversion worsened (p<0.01)
  - Sweet spot improved 7% (p=0.01)
- Hip Sextant - Steve Murphy, MD
- Robot - Larry Dorr, MD
  - 4 degrees
“Safe Zone”

anteversion 0°-30°

abduction inclination 30°-50°

Kummer FJ, J Arthroplasty 1999
Lewinnek GE, JBJS-A 1978
Widmer KH, J Orthop Res 2004
Combined Anteversion

- Sum of acetabular and femoral anteversion
- Infant cadavers
- $30^\circ$-$40^\circ$ acetabular anteversion
- $15^\circ$ femoral anteversion
- Prevent impingement
  - dislocation, wear, liner fracture, and pain
Combined Anteversion

“Ranawat Sign”
- \(25^0 - 30^0\) men
- Up to \(45^0\) women


- Finite element analysis
- \(37^0\) optimal
Combined Anteversion

- $25^0 - 50^0$
- anterior dislocations only when $> 50^0$
- Individual variation!
Pelvic Tilt

- 477 hips, lateral decubitus
- Range $20^0$ anterior to $25^0$ posterior
- 6% had zero tilt
- 50% $1^0$ - $5^0$
- 25% $6^0$ - $9^0$
Pelvic Tilt
Prevalence

The John Charnley Award
Risk Factors for Cup Malpositioning

*Quality Improvement Through a Joint Registry at a Tertiary Hospital*

Mark C. Callanan MA, Bryan Jarrett BS, Charles R. Bragdon PhD, David Zurakowski PhD, Harry E. Rubash MD, Andrew A. Freiberg MD, Henrik Malchau MD, PhD

<table>
<thead>
<tr>
<th>Surgeon volume</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1619</td>
<td>264</td>
</tr>
<tr>
<td></td>
<td>827 (51.1%)</td>
<td>90 (34.1%)</td>
</tr>
<tr>
<td></td>
<td>792 (48.9%)</td>
<td>174 (65.9%)</td>
</tr>
</tbody>
</table>
## Table 4. Odds ratios for increased risk of malpositioning

<table>
<thead>
<tr>
<th>Factor</th>
<th>Abduction</th>
<th>Version</th>
<th>Abduction and version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body mass index (obese versus not obese)</td>
<td>1.33 (1.1–1.6)</td>
<td>1.35 (1.0–1.8)</td>
<td>1.35 (1.1–1.7)</td>
</tr>
<tr>
<td>Head size:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32 mm versus &gt; 32 mm</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 32 mm versus &gt; 32 mm</td>
<td>†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approach</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterolateral versus posterolateral</td>
<td>1.81 (1.5–2.3)</td>
<td>2.05 (1.5–2.7)</td>
<td>2.02 (1.6–2.5)</td>
</tr>
<tr>
<td>Direct lateral versus posterolateral</td>
<td>*</td>
<td>2.17 (1.0–4.7)</td>
<td>†</td>
</tr>
<tr>
<td>Minimally invasive surgical versus posterolateral</td>
<td>4.81 (3.0–7.7)</td>
<td>1.76 (1.0–3.0)</td>
<td>6.10 (3.5–10.7)</td>
</tr>
<tr>
<td>Surgeon volume (low versus high)</td>
<td>1.41 (1.1–1.9)</td>
<td></td>
<td>2.07 (1.5–2.8)</td>
</tr>
</tbody>
</table>

* Comparison not significant (p > 0.70); † comparison not significant (p > 0.07); variable not significant.
# Prevalence

Table 6. Comparison of results to recent literature

<table>
<thead>
<tr>
<th>Authors</th>
<th>Number of hips</th>
<th>Average abduction angle</th>
<th>Average version angle</th>
<th>% of optimally positioned cups</th>
<th>Factors affecting position</th>
<th>Factors NOT affecting position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bosker et al. [5]</td>
<td>200</td>
<td>49.7° ± 6.7°</td>
<td>16 ± 8.1</td>
<td>85.2% (30–50° abduction criteria), 82.7% (5–25° anteversion criteria), 70.5% combined, 21.5% (± 5°)</td>
<td>Surgeons versus residents (abduction only)</td>
<td>BMI, gender, (un)cemented fixation, surgical approach</td>
</tr>
<tr>
<td>Leichtle et al. [24]</td>
<td>950</td>
<td>48.7° ± 7°</td>
<td>18.6 ± 9 (−9–30)</td>
<td>22.7% (45 ± 5° abduction, 20 ± 5° version), 65.5% (± 10°)</td>
<td></td>
<td>Surgeon qualifications, implanted model, operated side</td>
</tr>
<tr>
<td>Myers et al. [36]</td>
<td>64 (BHR)</td>
<td>37.5° (56°–50°)</td>
<td>for posterior approach 43° (30°–56°) for lateral approach</td>
<td></td>
<td></td>
<td>Surgical approach</td>
</tr>
<tr>
<td>Pinard and DeLint [41]</td>
<td>323</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>BMI</td>
</tr>
<tr>
<td>Reize et al. [45]</td>
<td>85</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Surgical experience</td>
</tr>
<tr>
<td>Saxler et al. [48]</td>
<td>105</td>
<td>45.8° ± 10.1°</td>
<td>27.3° ± 15 (−23.5°–59°)</td>
<td>41% (30–80° abduction, 5–25° abduction criteria)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Todkar [53]</td>
<td>111</td>
<td>44.5°, 46.8°, 44° for healthy, overweight, obese</td>
<td>116°, 12.2°, 10.7° for healthy, overweight, obese</td>
<td>25.7% (30–50° abduction, 5–25° abduction criteria)</td>
<td></td>
<td>BMI</td>
</tr>
<tr>
<td>Callanan et al. [current study]</td>
<td>1952</td>
<td>42.2° ± 6.8° (21°–73°)</td>
<td>12.7° ± 7.4° (−17°–3°)</td>
<td>62% (30–45° abduction), 79% (5–25° version), 47% combined</td>
<td>BMI, surgeon volume, surgical approach, head size (version alone)</td>
<td>Age, gender, cup outer diameter, (un)cemented fixation, surgical approach, head size (version alone)</td>
</tr>
</tbody>
</table>
Dislocation

Dislocation

- Biedermann R, JBJS-B 2005
- Ali Khan MA, JBLS-B 1981
- Kummer FJ, J Arthroplasty 1999
- Lewinnek GE, JBJS-A 1978
- Newington DP, JBJS-B 1990
- Pederson DR, Med Eng Phys 2005
- Widmer KH, J Orthop Res 2004

22.5%

Medicare revisions 2006
$504 million charges /year
$200 million pay out /year
Bozic et al., JBJS-A, 2009
@ 45 degrees of cup abduction

22 mm Head Dislocation
- Lateral Displacement: 14 mm
- Drop Height: 7 mm

36 mm Head Dislocation
- Lateral Displacement: 21 mm
- Drop Height: 11 mm
@ 90 degrees of cup abduction

22 mm Head Dislocation

Drop Height Zero

Lateral Displacement 3 mm

36 mm Head Dislocation

Drop Height Zero

Lateral Displacement 3 mm
Femoral Head Drop Height Before Dislocation

Abduction Angle

mm

0 22.5 45 67.5 90

40mm
36mm
32mm
28mm
26mm
22mm
Impingement

- Impingement- liner cracking
  - Shon WY, J Arthroplasty 2005
  - Widmer KH, J Orthop Res 2004
  - Yamaguchi M, J Arthroplasty 2000
Acetabular Component Stress Analysis

40mm Head Changing Abduction Angle

Force
Cup Position And Polyethylene Stress

40mm Head, 58mm Cup, 600 lbs Joint Load

Polyethylene Yield Strength

psi

Acetabular Component Abduction
At 45° of abduction the maximum polyethylene tension occurs on the articular surface.
With high abduction orientation the maximum polyethylene tension occurs at the shell edge.
Vitamin E Stabilized XLPE

- 55 yo F
- RA, primary THA 1996
- Revised 2008 osteolysis
- $45^0$ abduction and $44^0$ anteversion
- 36mm +5 offset vitamin E infused liner
Liner Fracture

Top View

Side View

Plastic Deformation Due to Impingement
Normal

Load transfer supported by shell

Subluxation

Edge loading
Load transfer through unsupported rim

Impingement on Rim
Accelerated Wear

- Yamaguchi M, J Arthroplasty 2000
- Leslie IJ, Clin Orthop Rel Res 2009
- Gallo J, Int Orthop 2010
Problems

- Long-term complications
  - Wear
  - Osteolysis
  - Aspetic loosening

- 2006, wear-related complications most common reason for revision
  - 27.7% revisions in the US Healthcare Cost and Utilization Project Nationwide Inpatient Sample

Indications for Revision THA

<table>
<thead>
<tr>
<th>Reason for reoperation</th>
<th>1979-2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>Total</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aseptic loosening</td>
<td>13,702</td>
<td>1,143</td>
<td>1,104</td>
<td>986</td>
<td>989</td>
<td>972</td>
<td>18,896</td>
<td>59.1%</td>
</tr>
<tr>
<td>Dislocation</td>
<td>2,338</td>
<td>242</td>
<td>255</td>
<td>314</td>
<td>258</td>
<td>244</td>
<td>3,651</td>
<td>11.4%</td>
</tr>
<tr>
<td>Deep infection</td>
<td>1,965</td>
<td>216</td>
<td>236</td>
<td>269</td>
<td>239</td>
<td>233</td>
<td>3,158</td>
<td>9.9%</td>
</tr>
<tr>
<td>Fracture</td>
<td>1,493</td>
<td>163</td>
<td>166</td>
<td>170</td>
<td>171</td>
<td>148</td>
<td>2,311</td>
<td>7.2%</td>
</tr>
<tr>
<td>2-stage procedure</td>
<td>907</td>
<td>84</td>
<td>107</td>
<td>98</td>
<td>98</td>
<td>75</td>
<td>1,369</td>
<td>4.3%</td>
</tr>
<tr>
<td>Technical error</td>
<td>807</td>
<td>24</td>
<td>17</td>
<td>17</td>
<td>18</td>
<td>13</td>
<td>896</td>
<td>2.8%</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>759</td>
<td>29</td>
<td>19</td>
<td>33</td>
<td>25</td>
<td>15</td>
<td>880</td>
<td>2.8%</td>
</tr>
<tr>
<td>Implant fracture</td>
<td>318</td>
<td>20</td>
<td>34</td>
<td>33</td>
<td>22</td>
<td>23</td>
<td>450</td>
<td>1.4%</td>
</tr>
<tr>
<td>Pain only</td>
<td>261</td>
<td>8</td>
<td>10</td>
<td>16</td>
<td>8</td>
<td>14</td>
<td>317</td>
<td>1.0%</td>
</tr>
<tr>
<td>Secondary infection</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0.0%</td>
</tr>
<tr>
<td>(missing)</td>
<td>36</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>41</td>
<td>0.1%</td>
</tr>
<tr>
<td>Total</td>
<td>22,586</td>
<td>1,930</td>
<td>1,949</td>
<td>1,937</td>
<td>1,832</td>
<td>1,737</td>
<td>31,971</td>
<td>100%</td>
</tr>
</tbody>
</table>
Is transverse acetabular ligament an anatomical landmark to reliably orient the cup in primary total hip arthroplasty?

Viste A, Chouteau J, Testa R, Chèze L, Fessy MH, Moyen B.

Calcified, hypertrophied
Mechanical Navigation

Improving Cup Positioning Using a Mechanical Navigation Instrument
Simon D. Steppacher MD, Jens H. Kowal PhD, Stephen Barry Murphy MD


Fig. 4 Scatterplot showing cup orientation using mechanical navigation and CT-based navigation. There were no outliers using mechanical navigation. The control group of CT-based navigation had a higher percentage (9.6%, p = 3.4%) of outliers.
Computer-Assisted Navigation

time, cost, complexity
Summary-Cup Malposition

- Common
- Impingement
  - Dislocation, accelerated wear, liner fracture, and psoas tendonitis
- Anatomical landmarks
  - Unreliable
- Mechanical and computer-assisted navigation
  - Reduces outliers
- Fluoroscopy
  - No better than traditional
Knee Symposium Topics

- TKA in the Younger Patient
- Long-term Follow-up
- Registries
- Sepsis Prevention
- Sepsis Treatment
- 2022: XLPE and CAS
- Revisions
Knee Outline

- MIS
- Perioperative analgesia
- Insert exchange for infection
John Insall Award

- “A Randomized Controlled Trial of Minimally Invasive TKR: Comprehensive Gait and Strength Testing Outcomes”
- Mark Pagnano et al.
- 40 patients randomized into 2 groups: mini subvastus or standard medial parapatellar
- Assessed at pre-op and 2 months post-op
- SF-12, KSS, KOOS, UCLA, activity logs
John Insall Award

- Substantial improvements for both groups in:
  - functional scores and QOL ($p<0.0001-0.003$)
  - kinematics and kinetic gait parameters during level walking and stairs ($p<0.0001-0.048$)
  - isometric quad strength ($p=0.022-0.038$)

- Marginally higher speed of stair ascent for MIS group ($p=0.018$)
John Insall Award

- No differences between groups in:
  - SF-12, KOOS, UCLA, and patient activity diaries
  - Isometric quad strength or 3D gait parameters (p=0.65-1.00)
Minimal Incision Surgery as a Risk Factor for Early Failure of Total Knee Arthroplasty

Robert L. Barrack, MD,* C. Lowry Barnes, MD,† R. Stephen J. Burnett, MD, FRCS(C),‡ Derek Miller, DO,* John C. Clohisy, MD,* and William J. Maloney, MD§

- Time to revision
  - 14.8 months MI TKA
  - 80 months standard TKA
  - P<0.001
Personal Experience

- **Time to revision**
  - 29 months MI TKA
  - 65 months standard TKA
  - \(p=0.032\), OR 14.7

- **Reasons for revision**
  - Aseptic loosening 55%
  - Pain/stiffness 27%
  - Malrotation 9%
  - Instability 9%
Chitranjan Ranawat Award

- “Efficacy of Postoperative Intraarticular Analgesia Following TKA: A Randomized, Double-Blinded, Placebo-Controlled, Prospective Study”
- 75 patients continuous infusion 300cc of 0.5% bupivacaine (5cc/hour)
- 75 patients 0.9% saline
Chitranjan Ranawat Award

- Outcome measures:
  - VAS, opioid consumption, opioid side effects, and adverse events
- Experimental group:
  - VAS lower highest (p=0.01), lowest (p=0.01), and current (p=0.03) on POD 1
  - VAS lower highest (p=0.04) on POD 2
  - 33% reduction in opioids POD 2 (p=0.021)
  - 54% reduction in opioids POD 3 (p=0.038)
Insert Exchange for Infection

- “Efficacy of Perioperative Irrigation and Debridement for the Treatment of Periprosthetic Infection” Thomas Fehring, MD

- Rapid formation of biofilm layer
- 3x failure rate for these failed insert exchanges when 2-stage needed
- MRSA and MRSE 84% failure rate
The Chitranjan Ranawat Award

Fate of Two-stage Reimplantation After Failed Irrigation and Débridement for Periprosthetic Knee Infection

J. Christopher Sherrell MD, Thomas K. Fehring MD, Susan Odum MEd, Erik Hansen MD, Benjamin Zmistowski BS, Anne Dennos BS, Niraj Kalore MD, the Periprosthetic Infection Consortium

- 1994-2008
- 83 knees failed I+D and insert exchange
- 28/83 (34%) failed 2 stage exchange
• Strep 65% (20/31) vs. others 71% (84/119)
• Staph sensitive (48/67) 72% vs. 76% (22/29) resistant
Thank You