Reverse Total Shoulder Arthroplasty: A New Frontier (of Complications)

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Prevalence and projections of total shoulder and elbow arthroplasty in the United States to 2015

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Hypothesis: This study examined national trends and projections of procedure volumes and prevalence rates for shoulder and elbow arthroplasty in the United States (U.S.). This study hypothesized that the growth in demand for upper extremity arthroplasty will be greater than the growth in demand for hip and knee arthroplasty and that demand for these procedures will continue to grow in the immediate future.

Materials and methods: The Nationwide Inpatient Sample (1993-2007) was used with U.S. Census data to quantify primary arthroplasty rates as a function of age, race, census region, and gender. Poisson regress-
Procedure volumes and rates increased at annual rates of 6% to 13% from 1993 to 2007. Compared with 2007 levels, projected procedures were predicted to further increase by between 192% and 322% by 2015. The revision burden increased from approximately 4.5% to 7%. The growth rates of upper extremity arthroplasty >= THA, TKA. Of particular concern was the increased revision burden.

Figure 1  Total annual procedure counts were plotted for each procedure (squares). The resulting model fits and projections from the variable rate Poisson regression were plotted (solid line) together with the 95% confidence intervals (dotted lines). Results from a fixed-rate Poisson regression were also plotted (dashed line) with their 95% confidence intervals (dotted lines).
Indications for RTSA

1. Cuff Tear Arthropathy
2. Massive RCT
3. Pseudoparalysis
4. RA
5. Fx sequelae
6. Complications of ORIF
7. Complications of HHR
8. Complications of TSA
Indications

- No other satisfactory option available
Alternatives to Reverse

- Hemi
- Conventional Unconstrained TSA
- Arthrodesis
- Bipolar hemi
Advantages of Reverse

- Semi-constrained
- Resurfaces both pain generators in arthritis: glenoid and humerus
- Does not rely upon the supraspinatus for function
- Eliminates need for prolonged rehab associated with RCR
- Will allow pts to use hand away from body
4 yrs. Left shoulder
Concerns

• Long-term mechanical failure rate unknown
• When complications happen, they may be catastrophic
• Revising a failed reverse is a technical challenge
• As with other new technologies, it may be subject to overuse
Complications: Outline

- Instability
- Hematoma
- Infection
- Pptx fracture
- Glenoid loosening
- Scapular notching
## Results

<table>
<thead>
<tr>
<th>Study</th>
<th>Patients</th>
<th>Results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Favard, CORR 2011</td>
<td>527</td>
<td>89% survival @ 10 yrs</td>
<td>Results &amp; x-rays deteriorate with time</td>
</tr>
<tr>
<td>Wall, JBJS 2007</td>
<td>240</td>
<td>94% satisfied</td>
<td>CTA, RTC with OA, MRTC better outcomes</td>
</tr>
<tr>
<td>Guery, JBJS 2006</td>
<td>57</td>
<td>91% survival @ 7 yrs</td>
<td>Results decline after 8 yrs</td>
</tr>
<tr>
<td>Frankle, JBJS 2005</td>
<td>60</td>
<td>94% satisfied</td>
<td>17% complications, 13% revision</td>
</tr>
<tr>
<td>Sirveaux, JBJS 2004</td>
<td>77</td>
<td>96% no-minimal pain</td>
<td>88% survival @ 5 yrs</td>
</tr>
<tr>
<td>Flurin, ORS 2011</td>
<td>45</td>
<td>Improvements in pain &amp; function</td>
<td>8.9% notching, no instability or glenoid failures</td>
</tr>
</tbody>
</table>
RSA: Systematic Review

• Zumstein et al, JSES 2012
  – 18 level IV, 3 level II studies
  – 782 RSAs >24 month f/u
  – 71% Grammont, 29% Encore
  – 42% subscap repaired
  – 44% problem, 24% complication rate
    • 2x in revisions, higher in RA & Fx, DP approach
  – 3.5% reoperation, 10% revision rate
### Complications

<table>
<thead>
<tr>
<th>Complication/Problem</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scapular Notching</td>
<td>34.5%</td>
</tr>
<tr>
<td>Instability</td>
<td>4.7%</td>
</tr>
<tr>
<td>Infection</td>
<td>3.8%</td>
</tr>
<tr>
<td>Aseptic Glenoid Loosening</td>
<td>3.5%</td>
</tr>
<tr>
<td>Intraoperative Fractures</td>
<td>2.9%</td>
</tr>
<tr>
<td>Hematomas</td>
<td>2.6%</td>
</tr>
<tr>
<td>Acromion &amp; Spine Fractures</td>
<td>1.5%</td>
</tr>
<tr>
<td>Glenoid Disassembly</td>
<td>1.5%</td>
</tr>
<tr>
<td>Humeral Disassembly</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

Zumstein et al, JSES 2012
## Instability 0-30%

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Comments</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP Approach</td>
<td>97% of 37 cases</td>
<td>Zumstein JSES 2011</td>
</tr>
<tr>
<td>Revision</td>
<td>2x more likely, 87.5% requiring re-operation</td>
<td>Zumstein JSES 2011</td>
</tr>
<tr>
<td>Subscapularis repair</td>
<td>5.1%, all occurred in irreparable subscap</td>
<td>Edwards JSES 2009</td>
</tr>
<tr>
<td>Articulation</td>
<td>Compressive force&gt;socket depth&gt;glenosphere size</td>
<td>Guittierrez CORR 2008</td>
</tr>
<tr>
<td>Version</td>
<td>Neutral humeral version, &lt;10° glenosphere retroversion</td>
<td>Favre JSES 2010</td>
</tr>
</tbody>
</table>
Instability

- Anterior
- Subscap repair
  - DP approach
  - Dynamic stability
- Version
  - Neutral-20° humeral retroversion
  - Neutral glenosphere
- Scaled contralateral x-rays
  - Revision with humeral bone loss
  - Appropriate height
- Adequate deltoid tension
Instability
# Infection 1-15%

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Comments</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revision</td>
<td>2x more likely</td>
<td>Zumstein JSES 2011</td>
</tr>
<tr>
<td>Hematomas</td>
<td>20 cases, 70% required intervention → no subsequent infection</td>
<td>Zumstein JSES 2011</td>
</tr>
<tr>
<td>P. Acnes</td>
<td>75% of shoulder revision arthroplasty</td>
<td>Kelly CORR 2009</td>
</tr>
<tr>
<td>Rheumatoid Arthritis</td>
<td>Concerns regarding infection</td>
<td>Guery JBJS 2006</td>
</tr>
</tbody>
</table>
Infection

• Hematomas
  – 1-21%
  – Aggressively treat
  – HV drain 24 hours
  – Restrict early motion

• Revisions

• P. Acnes
  – Hold cultures x 2 weeks

• Rheumatoid arthritis
<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Comments</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Bony Ingrowth</td>
<td>Lack of baseplate ingrowth associated with failure</td>
<td>Cheung JAAOS 2011</td>
</tr>
<tr>
<td>Screw Angle</td>
<td>Increasing screw angle minimizes micromotion</td>
<td>Hopkins JSES 2008</td>
</tr>
<tr>
<td>Lateral Offset</td>
<td>11.7% glenoid sided failure correlated with poor fixation and superior tilt</td>
<td>Frankle JBJS 2005</td>
</tr>
<tr>
<td>Locking Screws</td>
<td>5mm Locking screws kept micromotion below 150 microns despite 70% moment arm increase</td>
<td>Harman JSES 2005 Cuff JBJS 2008</td>
</tr>
</tbody>
</table>

Glenoid Loosening 2.5-5.8%
Glenoid Loosening

- **Fixation**
  - Bony ingrowth
  - Peripheral screws
    - Large diameter
    - Locking
    - Variable angle

- **Decrease moment arm**
  - Minimize lateral offset
Glenoid Loosening

- **Equinoxe baseplate**
  - Large surface area
    - Bone ingrowth
  - Anatomic
    - Curved backside
      - Shear → Compressive
    - Cortical bone preserving
      - 20x stronger than cancellous
  - Screws
    - 4.5mm variable angle lag-locking
      - Baseplate compression
    - Six options
  - Central bone cage
    - Glenoid vault fixation
## Fractures 0.8-22%

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Comments</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trauma</td>
<td>All 11 cases of Postop humeral fx associated with traumatic event</td>
<td>Zumstein JSES 2011</td>
</tr>
<tr>
<td>Acromial Insufficiency</td>
<td>9%, good results despite preop acquired or congenital pathology</td>
<td>Walch JSES 2009</td>
</tr>
<tr>
<td>Acromial &amp; Scapular spine Fractures</td>
<td>1.5%, conservative tx of acromial fx no (-) influence, sx of scapular spine (-) outcome</td>
<td>Zumstein JSES 2011</td>
</tr>
<tr>
<td>Rheumatoid Arthritis</td>
<td>22%, increased risk of intra &amp; postop fracture</td>
<td>Young JBJS 2011</td>
</tr>
</tbody>
</table>
• Acromial fractures
  – Thin acromion is best neglected
  – Os acromial
• Spine fractures
  – Conservative treatment
    • Abduction pillow x 6-8 weeks
    • Cortisone injection
  – ?ORIF
• Humeral fractures
  – Small cemented stem in RA
  – Fall precautions
    • Sling, Cane, Endocrine, PCP
Scapular notching

Illustration demonstrating the scapular notching classification described by Sirveaux et al. Grade 1 defects are confined to the pillar. Grade 2 defects extend to...
Scapular Notching 50-96%

  - Incidence & extent of notching increases with f/u (7 yrs)
- Simovitch JBJS 2007
  - 77 shoulders, 2 yrs f/u
  - 44% notching
    - Lower Constant scores
    - Less ROM
- Cristofari JBJS 2010
  - 36 shoulders 6.6 yrs f/u
  - 53% notching
    - 64% baseplate loosening
    - 2.7% revision
- Sirveaux JBJSBr 2004
  - 77 shoulders, 3.7 yrs f/u
  - 63.6% notching
    - 6.2% baseplate loosening
    - Lower Constant scores
## Scapular Notching 50-96%

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Comments</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humeral Neck Shaft Angle</td>
<td>130° was most effective @ avoiding impingement</td>
<td>Gutierrez CORR 2008</td>
</tr>
<tr>
<td>Glenosphere Diameter</td>
<td>42mm glenosphere effective @ avoiding impingement</td>
<td>Gutierrez CORR 2008</td>
</tr>
<tr>
<td>Lateral Offset</td>
<td>Lateralized COR resulted in 0% notching</td>
<td>Valenti CORR 2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frankle JBJS 2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cuff JBJS 2008</td>
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## Scapular Notching 50-96%

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<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inferior Tilt</td>
<td>Effective @ avoiding impingement</td>
<td>Cuff JBJS 2008 Gutierrez CORR 2008</td>
</tr>
<tr>
<td>Inferior Tilt</td>
<td>Does not reduce incidence or severity of notching, 75% tilt group, 86% control group (PRCT)</td>
<td>Edwards JSES 2011</td>
</tr>
<tr>
<td>Risk Factor</td>
<td>Comments</td>
<td>Study</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>-------------------------------------------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>Glenoid Position &amp; Scapular Neck Angle</td>
<td>Neck angle &amp; glenoid position are coupled, higher angle more overhang</td>
<td>Simovitch JBJS 2007</td>
</tr>
</tbody>
</table>
Scapular Notching

- Inferior glenosphere placement
- Avoid superior tilt
- Increase offset
- Decrease neck shaft angle of humerus
- Increase glenosphere diameter
- Avoid excessive medial reaming
Summary

- Instability
- Hematoma
- Infection
- Pptx fracture
- Glenoid loosening
- Scapular notching
Thank You