Diagnosis of Shoulder Periprosthetic Joint Infection

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Management of Advanced Shoulder Arthroplasty Complications
VuMedi Webinar
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Disclosures

- Eric T. Ricchetti, MD (2, 5 – Depuy Synthes)

Introduction

- PJI can be a diagnostic and therapeutic challenge in the shoulder, due to the indolent nature of the common infecting organisms:
  - ~50% positive culture rate in revision shoulder arthroplasty
  - *Propionibacterium acnes* (*P. acnes*) represents ~2/3 positive cultures
  - Coagulase-negative *Staphylococcus* species (CNSS)

- Established diagnostic tests for hip/knee PJI often negative in the shoulder despite post-operative growth of intra-operative cultures.
  - Rates as high as 56% of positive culture cases with negative perioperative work-up

Topolksi et al., JSES 2006; Kell & Integrated, CSIR 2006; Forrester et al., JSES 2013; Piper et al., J Ortho Mon 2009; Singh et al., JSES 2012; Frangialore et al., JSES 2014; Prange et al., JSES 2015; Ricchetti et al., JBJS Reviews 2014; Grosso et al., JSES 2012; Grosso et al., JSES 2014; Frangio lore et al., JBJS 2015 (a & b); Frangiamore et al., JSES 2015; Grosso et al., 2015
Evaluation

- Diagnostic work-up of a painful shoulder arthroplasty:
  - History & Physical
  - Imaging
  - Serum ESR & CRP
  - Preoperative aspiration
  - Intraoperative culture & pathology
  - Newer diagnostic tests

Evaluation

- History & Physical:
  - Acute infection uncommon: drainage, cellulitis, systemic findings
  - Subtle, non-specific clinical picture with delayed, chronic presentation
  - Pain ± stiffness, present since surgery

Evaluation

- Risk factors for PJI of the shoulder:
  - Male gender (P. acnes)
  - Postoperative hematoma
  - Arthroplasty after trauma
  - Reverse TSA
  - Younger age
  - Humeral and/or glenoid component loosening, osteolysis (early)

Cheung et al, JBJS 2008; Singh et al, JSES 2012; Puttenger et al, JBJS 2012; Richards et al, CORR 20014; Hou et al, JSES 2015
Preoperative Serum Markers

- Low sensitivity of standard serum markers due to indolent pathogens, but high specificity:
  - Serum ESR sensitivity & specificity:
    - Hip & Knee PJI: 75-86%, 69-74%
    - Shoulder PJI: 21-42%, 65-93%
  - Serum CRP sensitivity & specificity:
    - Hip & Knee PJI: 74-97%, 74-97%
    - Shoulder PJI: 9-53%, 73-95%

- Newer pro-inflammatory markers: serum IL-6
  - Berberi et al, JBJS 2010: >97% sensitivity in meta-analysis of hip and knee PJI
  - Results not replicated in shoulder PJI:
    - Villacis et al JBJS 2014: 14% sensitivity
    - Grosso et al JSES 2014: 12% sensitivity

Culture Analysis

- No standardized protocol for preoperative & intraoperative culture sampling & analysis:
  - Variable number of intraoperative specimens taken & sites of sampling
  - Hold preoperative antibiotics
  - Fluid vs. periprosthetic tissue specimens
  - Variable culturing techniques:
    - Increased sensitivity: Implant sonication with culture of sonicate fluid
  - Variable culture length: *P. acnes* culture protocols from 7-28 days

- Significance of positive culture result:
  - True positive vs. culture contaminant
  - Culture characteristics: Days to positive culture growth, proportion of positive culture results

Culture Analysis

- 46 revision shoulder arthroplasty cases with ≥1 *P. acnes* positive culture
- Two culture groups based on periprosthetic shoulder infection criteria:
  - Probable true positive group
  - Probable contaminant group
- Time to culture growth significantly shorter in probable true positive culture group (median 5 vs. 9 days, p<0.002).
- Regardless of group classification, significantly fewer days to *P. acnes* culture growth:
  - Cases with higher number of positive cultures
  - Case with higher proportion of positive cultures
Frozen Section Analysis

- May help intraoperative decision-making (one vs. two-stage reimplantation).
  - Sensitivity 77-95%, Specificity 92-96% in diagnosis of hip and knee PJI.
- Effectiveness in shoulder arthroplasty less clear:
  - Up to 92% negative intraoperative histologic evaluations for patients with culture positive PJI.
  - Again, may be related to indolent organisms.


Frozen Section Analysis

- Poor sensitivity for shoulder PJI using existing thresholds
- Increased sensitivity with new threshold based on ROC analysis: >10 PMNs in each of 5 most dense HPFs

<table>
<thead>
<tr>
<th>Institutional Guidelines</th>
<th>PJI AAOS #1</th>
<th>PJI AAOS #2</th>
<th>Morawietz 2009</th>
<th>New Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. Acnes Infection</td>
<td>50% (9/18)</td>
<td>52% (9/18)</td>
<td>39% (7/18)</td>
<td>56% (10/18)</td>
</tr>
<tr>
<td>Other Infection</td>
<td>67% (8/12)</td>
<td>58% (7/12)</td>
<td>58% (7/12)</td>
<td>67% (8/12)</td>
</tr>
<tr>
<td>Total</td>
<td>57% (17/30)</td>
<td>53% (16/30)</td>
<td>47% (14/30)</td>
<td>61% (18/30)</td>
</tr>
</tbody>
</table>

Grosso et al, JJIS 2014

Newer Diagnostic Testing

- Synovial fluid biomarkers have been identified as part of the innate response to pathogens:
  - Pro-inflammatory cytokines
  - Antimicrobial peptides
- Sensitivity & specificity nearly 100% for several markers in diagnosis of hip & knee PJI

Deirmengian et al, CORR 2014; Jacovides et al, J Arthroplasty 2011; Deirmengian et al, CORR 2010; Deirmengian et al, CORR 2009
Synovial IL-6 and α-defensin

- Frangiamore et al, JBJS 2015: IL-6
- Frangiamore et al, JSES 2015: α-defensin (Synovasure™)

### Performance of IL-6

<table>
<thead>
<tr>
<th>Factor</th>
<th>Mean IL-6 (pg/mL)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frozen section histology</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>No acute inflammation</td>
<td>191.6</td>
<td></td>
</tr>
<tr>
<td>Acute inflammation</td>
<td>24,621</td>
<td></td>
</tr>
<tr>
<td>P. acnes</td>
<td>8,531</td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td>8.531</td>
<td></td>
</tr>
<tr>
<td>No infection</td>
<td>93.20</td>
<td></td>
</tr>
<tr>
<td>Reoperation</td>
<td>125.35</td>
<td>0.099</td>
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</table>

### Performance of α-defensin

<table>
<thead>
<tr>
<th>Factor</th>
<th>Mean α-defensin (S/CO)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frozen section histology</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>No acute inflammation</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td>Acute inflammation</td>
<td>4.45</td>
<td></td>
</tr>
<tr>
<td>P. acnes</td>
<td>1.33</td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>No infection</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td>Reoperation</td>
<td>0.21</td>
<td></td>
</tr>
</tbody>
</table>

### Synovial Fluid Analysis

- Prospectively evaluate the efficacy of broader synovial fluid cytokine analysis in diagnosis of PJI in revision shoulder arthroplasty.

- Analysis of 9 pro-inflammatory cytokines:
  - IL-6, GM-CSF, IL-1β, IL-12, IL-2, IL-8, IFN-γ, IL-10, TNF-α
Control vs. Revision Cases

No Growth vs. P. Acnes
Predictive Model

- Combinations of the nine synovial fluid cytokines were also assessed for diagnostic performance compared to the individual cytokines alone.

- Using logistic regression analysis, a predictive model of infection was constructed using a reduced subset of three cytokines.

- All candidate models were assessed, and the combined model found to have the optimal predictive power consisted of IL-6, TNF-α, and IL-2.

### Predictive Model

<table>
<thead>
<tr>
<th>Factor</th>
<th>Threshold (pg/mL)</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>LR+</th>
<th>LR-</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL-6</td>
<td>453.6</td>
<td>0.82</td>
<td>0.87</td>
<td>0.79</td>
<td>0.89</td>
<td>6.4</td>
<td>0.20</td>
</tr>
<tr>
<td>GM-CSF</td>
<td>1.5</td>
<td>0.54</td>
<td>0.85</td>
<td>0.68</td>
<td>0.75</td>
<td>3.6</td>
<td>0.55</td>
</tr>
<tr>
<td>IFN-γ</td>
<td>4.5</td>
<td>0.60</td>
<td>0.62</td>
<td>0.76</td>
<td>0.76</td>
<td>6.0</td>
<td>0.50</td>
</tr>
<tr>
<td>IL-1β</td>
<td>3.6</td>
<td>0.71</td>
<td>0.87</td>
<td>0.77</td>
<td>0.84</td>
<td>5.6</td>
<td>0.33</td>
</tr>
<tr>
<td>IL-12</td>
<td>6.6</td>
<td>0.94</td>
<td>0.77</td>
<td>0.71</td>
<td>0.84</td>
<td>5.6</td>
<td>0.69</td>
</tr>
<tr>
<td>IL-2</td>
<td>1.6</td>
<td>0.54</td>
<td>0.87</td>
<td>0.71</td>
<td>0.76</td>
<td>4.2</td>
<td>0.53</td>
</tr>
<tr>
<td>IL-8</td>
<td>1,502.4</td>
<td>0.71</td>
<td>0.79</td>
<td>0.67</td>
<td>0.82</td>
<td>3.4</td>
<td>0.36</td>
</tr>
<tr>
<td>TNF-α</td>
<td>4.5</td>
<td>0.92</td>
<td>0.33</td>
<td>0.69</td>
<td>0.84</td>
<td>4.0</td>
<td>0.34</td>
</tr>
<tr>
<td>Combined</td>
<td>0.4</td>
<td>0.90</td>
<td>0.87</td>
<td>0.89</td>
<td>12.0</td>
<td>0.21</td>
<td></td>
</tr>
</tbody>
</table>

Diagnostic Performance

- Challenges to broader use:
  - Lack of commercial test or point-of-care test for intraoperative use & decision-making.
  - Preoperative aspirate possible to send for analysis prior to surgery (Synovasure™ ~ 24 hrs), but often dry tap with indolent pathogen.
Applying Algorithm for Evaluation to Determine Diagnosis

**Pre op**
- Risk factors, plain radiographs, ± CT
- Serum CRP, ESR
- Synovial aspirate; culture, α-defensin & other biomarkers

**Intra op**
- Synovial fluid (culture, α-defensin & other biomarker) & multiple (5) tissue biopsies for culture and frozen section: capsule, glenoid & humerus fibrous tissue (superficial & deep)

Hsu et al, JBJS 2016: 5 tissue specimens, 17 day culture hold in 3 media (aerobic/anaerobic/broth) optimizes P.acnes recovery

**14 day culture hold for P. acnes**

Diagnosis

- **MSIS Criteria:** Definite PJI exists when:
  - (1) There is a sinus tract communicating with the prosthesis; or
  - (2) A pathogen is isolated by culture from at least two separate tissue or fluid samples obtained from the affected prosthctic joint; or
  - (3) Four of the following six criteria exist:
    - (a) Elevated serum ESR and CRP
    - (b) Elevated synovial leukocyte count,
    - (c) Elevated synovial neutrophil percentage (PMN%),
    - (d) Presence of pusulence in the affected joint,
    - (e) Isolation of a microorganism in one culture of periprosthetic tissue or fluid, or
    - (f) >5 neutrophils per HPF in 5 fields on histologic analysis of periprosthetic tissue at x400 magnification.

- Acknowledged that in low-grade infections, several of these criteria may not be routinely met.
  Parvizi et al, Clin Orthop Relat Res 2011

Diagnosis

**Periprosthetic shoulder infection criteria**

<table>
<thead>
<tr>
<th>Category</th>
<th>Pre- or Intra-op findings of infection*</th>
<th>Preoperative synovial aspirate culture</th>
<th># of positive intraoperative cultures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definite infection</td>
<td>≥1</td>
<td>-</td>
<td>&gt;1</td>
</tr>
<tr>
<td>Probable infection</td>
<td>-</td>
<td>+</td>
<td>1</td>
</tr>
<tr>
<td>Probable contaminant</td>
<td>-</td>
<td>-</td>
<td>&gt;1</td>
</tr>
<tr>
<td>No evidence for infection</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Preoperative or intraoperative findings of infection:**
- Preoperative clinical signs (swelling, sinus tract, redness, drainage)
- Positive erythrocyte sedimentation rate or C-reactive protein
- Intraperative gross findings (purulent drainage, necrosis)
- Positive intraoperative frozen section

Grosso et al, JSES 2014; Grosso et al, JBJS 2014; Frangiamore et al, JBJS 2015; Frangiamore et al, JSES 2015
Evaluation of infection in revision shoulder arthroplasty remains a challenge due to the low virulence of the common offending organisms.

New perioperative testing in combination with existing tests may increase the ability to detect infection.

Standardized protocols for perioperative testing may help to clarify diagnostic criteria for shoulder PJI.

This may impact clinical decision-making and lead to more well-defined treatment algorithms.

Summary
How to Make Revisions Simple

John W. Sperling, MD, MBA
Mayo Clinic

Disclosure

• Biomet: Royalties

Component Removal

• Removal of a well fixed humeral component represents a significant challenge
Humeral Bone Loss

SRS
Summary

• Know the type of component to be removed
• Be prepared with a variety of grafts and implant sizes
• Advanced imaging studies extremely helpful in pre-op planning and component placement
Vertical Humeral Osteotomy
Stem Removal and Revision

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Geoffrey S. Van Thiel, MD, MBA
Shoulder Service
Rush University Medical Center - Chicago, IL USA

Disclosures
Gregory P. Nicholson, MD
Consultant – Tornier
Royalties and Designer- Innomed

Shoulder Arthroplasty

• 35–40,000/yr in USA
• Improvements
  – Implant, Design, Technique
• Increasing in Number
• Population is Aging
  – BUT – More active

Increased Potential for Revisions
Failure - Shoulder Arthroplasty

**Glenoid**

**More Common**
1) BMDosing
2) Infection
3) Malposition
4) Malposition
5) RC Dysfunction
6) Infection
7) Stiffness

**Humerus**

**Less Common**
1) Malposition
2) Malposition
3) Malposition
4) Malposition
5) RC Dysfunction
6) Infection
7) Stiffness

Revision

1) Reverse Shoulder Arthroplasty
   • Increased Options

2) Glenoid is Most Common
   • Reason for Revision

3) Humeral Stem Frequently
   • Remains Well Fixed

Problems with Humeral Revision

**Anatomic**

1) Thinner Bone than Femur
2) Smaller Canal
3) Tuberosity Fragility
4) Axillary, MC and Radial
   Nerves
5) Usually NOT Loose!

**Technique**

• Removal Based on Femoral
  Techniques
• Distal Window
• L-Shaped Osteotomy
• Slap Hammers
• Large Cement Removal Tools
• Extractors Don’t Grip Well
Complications – Humeral Revision

1) Tuberosity fracture
2) Bone loss - proximal, middle, distal
3) Diaphyseal fx potential, with need for long stems
4) Prolonged OR time, blood loss

VHO Purpose

Develop Technique to Efficiently Remove Humeral Stem
- Preserve Tuberosities
- No Need for Windows
- No Need for Specific Extractors
- No Need for Long Stem
- Cemented or Uncemented Components

Report results of Vertical Humeral Osteotomy

VHO Technique

VHO Materials and Methods

35 cases
19 ♀ 16 ♂

Etiology
- Fracture: 20
- CTA: 8
- OA: 7

Avg Age: 63 y (47-79 y)
Avg F/U: 28 m (1.5-7 y)
- 23 Cemented
- 12 Uncemented

6 Infected but Not Loose
VHO Procedures

- HHR to Reverse: 23
- HHR to TSA: 5
- TSA to Reverse: 5
- HHR to HHR: 2

VHO Technique

1) Small Osteotome Around Proximal Implant
   "Breaks the Bond"

2) Small Oscillating Saw Down Anterior Humerus
VHO Technique

1. Small Osteotome Around Proximal Implant
2. Oscillating Saw Down Anterior Humerus
3. Down to Implant

VHO Technique

1. Small Osteotome Around Proximal Implant
2. Oscillating Saw Down Anterior Humerus
3. Down to Implant
4. Spread Humeral Tube with Osteotomes

VHO Technique

1. Small Osteotome Around Proximal Implant
2. Oscillating Saw Down Anterior Humerus
3. Down to Implant
4. Spread Humeral Tube with Osteotomes
5. Footed Impactor on Proximal Collar
Cement Assessment

• If not infected, can cement back into existing cement mantle
• Need to remove proximal cement at times
• Need proper tools for the job
• Hospitals have the femoral cement instruments: TOO BIG

VHO Technique

1. Small Osteotome Around Proximal Implant
2. Oscillating Saw Down Anterior Humerus
3. Down to Implant
4. Spread Humeral Tube with Osteotomes
5. Footed Impactor on proximal collar
6. Cerclage Wire Closure

VHO Technique Summary

- No Windows
- Preserves Tuberosity
- No Need to go Below Stem Tip
- Osteotomy Down to Implant
- Cement into Existing Mantle
- Cerclage Wires
- No Long Stems Needed
Results

Average Follow Up: 28 m (18 - 84 m)

<table>
<thead>
<tr>
<th>Radiographic</th>
<th>Clinical Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 Cemented</td>
<td>35 Revisions</td>
</tr>
<tr>
<td>• No loosening</td>
<td>• 28 Reverse</td>
</tr>
<tr>
<td>• No lucency</td>
<td>• 7 Non-constrained</td>
</tr>
<tr>
<td>• No extruded cement</td>
<td>ASES 64.7</td>
</tr>
<tr>
<td>• No cerclage wire issues</td>
<td>SST 6.3</td>
</tr>
<tr>
<td>• No intra-op or post-op fx</td>
<td>VAS pain 1.3</td>
</tr>
<tr>
<td>• No infections</td>
<td></td>
</tr>
</tbody>
</table>

Summary

Key Technical Features

1) Small Osteotome Around the Top
2) VHO Down the Anterior Cortex to the Implant
3) Osteotomes to “Flex” Open the Humeral Tube
4) Impactor on the Collar from Below
5) Cerclage Wire Closure

Thank you!

Gregory P. Nicholson, M.D.
Rush University Medical Center
Chicago, Illinois
Avoiding Instability in Shoulder Arthroplasty

MARK A. MIGHELL, MD
KATHRYN N. CHRISTMAS, BS
MANAGEMENT OF ADVANCED SHOULDER ARTHROPLASTY COMPLICATIONS

Disclosure

Speakers Bureau, Paid Consultant

stryker
Speakers Bureau, Paid Consultant

Instability

Multiparifactorial Problem

- Surgical
  - Anterior/ Superior vs. Deltopectoral
  - Repair of subscap

- Prosthetic Design
  - Muscle imbalance
  - Impingement i.e. levering out
Instability

Factors: Surgical

• Deltopectoral vs. Ant/Sup
  (Walch et al.)
  • Instability only observed in deltopec group
  • Large anterior/factor release of subscap & inferior GH ligament
  • Restoration of adequate tension of deltoid may prevent

• Repair of Subscap
  (Edwards et al.)
  • Found increased stability in patients where subscap was repaired

Factors Affecting Stability

CORR 2007

Center of Rotation Affects Abduction Range of Motion of Reverse Shoulder Arthroplasty

Sergio Gutiérrez, MD; Jonathan C. Lee, MD; William E. Lee, III, PhD; Tony S. Kello, PhD; and Murray E. Mattouf, PhD

CORR 2008

Hierarchy of Stability Factors in Reverse Shoulder Arthroplasty

Sergio Gutiérrez, MD; Tony S. Kello, PhD; Jonathan C. Lee, MD; William E. Lee, III, PhD; Fang Feng, Lee PhD

Levering out dislocation, poor compressive forces, or combination of both?

• Prosthetic Design
  • Compressive force of deltoid/cuff
    • Lateral offset
    • Humeral angle
  • DR ratio
  • Depth of socket
  • Impingement free arc of motion
    • COR offset
    • Glenosphere position

Hierarchy?
Prosthetic Design
Determination of Stability

Increased Soft Tissue Tension Decreases Dislocation Risk

Instability

Medialization on glenoid due to bone loss causes deltoid to pull humeral component out.
(Norris et al. Tech Sh Elb, 2007)
Instability
Lateralization of the RSA causes resultant compressive forces from deltoid and cuff muscles.

Instability
Restoration of proximal humeral bone causes resultant compressive forces from deltoid and cuff muscles.

Large spheres and deep sockets reduce risk of dislocation.
Stability = $\frac{D}{R}$

- $D$ = Depth of Socket
- $R$ = Radius of Glenosphere

Stability is increased with a deeper socket due to the increased D/R ratio.

Dislocations: may be due to levering out.

- Smaller center of rotation (0mm) = Smaller arc of motion
- Larger center of rotation (10mm) = Larger arc of motion

Impingement-free arc of motion.
Impingement-Free Arc of Motion

- Center of Rotation at Glenoid
- Center of Rotation 10mm lateral to Glenoid

42mm diameter glenospheres placed inferiorly

Summary:
Impingement-Free Arc of Abduction ROM

Hierarchy
1. Center of Rotation Offset
2. Glenosphere Position
3. Glenosphere Tilt
4. Humeral Neck/Shaft Angle
5. Prosthetic Size
Purpose

To evaluate the outcomes of patients with postoperative dislocation

Hypothesis

- Early dislocations would be more successfully treated by closed reduction than late dislocations
- There would be no difference in outcomes between patients treated with closed reduction and those requiring revision surgery

Methods

- Retrospective review of all RSA’s performed by the senior surgeon (MAF) from 2002-2011
- Total of 30 dislocations identified

Overall Incidence = 2.3% (30/1293)
Methods:
Study Group
- 40 radiographically documented dislocations
- 10 patients referred for surgical management
- 21 managed by closed reduction
- 19 fixed with revision surgery

Methods:
Nonoperative
- 21 patients
- Managed by closed reduction
- Postreduction, patients placed into 30° ER brace for 6 weeks followed by activities as tolerated

Methods:
Operative
- 19 patients
- 9 Lateral COR (DJO)
- 10 Medial COR Type (Zimmer & DePuy/Tornier)
- All patients were revised to a larger sphere
- Any impingement was removed
Methods:
Preoperative Characteristics
- Average Age: 70.8 years (Range: 53-86)
- Most common preoperative diagnosis:
  - Cuff tear arthropathy (43%)
  - Previous surgery (46%)
  - Other (9%)
- Average time to dislocation: 6.5 months
  - Range: 2 days-32 months
  - 62% within first 90 days

Methods
- Most common glenosphere size for DJO's was 32N (52%)
- Subscap repaired in all cases
  - native tendon
  - allograft tendon or
  - pectoralis major transfer
- 35% found to have a deep infection intra-op
- 24% underwent proximal humerus bone grafting

Case Example
- 76 y.o. male 4 months s/p RSA with dislocation
- Revision performed with humeral augment
- Continued instability
IntraOp

Methods

Case Example

3 months post-op
Methods

Hierarchy

1. Compressive force of deltoid/cuff
   - Lateral offset
   - Humeral angle
2. D/R ratio
   - Depth of socket
3. Impingement free arc of motion
   - COR offset
   - Glenosphere position

Methods: Method of Lateralization

- Glenoid Component
  - Lateral offset increased with glenosphere > hemisphere
  - Prosthetic versus “biologic”/bony lateralization

- Humeral Component
  - Neck/Shaft Angle
  - Augments
  - Humerosocket medially offset pivot point

Methods

Lateralization from Glenoid Surface
Methods: Lateralization from Humeral Surface
- Neck Shaft Angle
  - Valgus Implant: Inferior displacement 4mm
  - Varus Implant: Greater lateral displacement 7 mm
- Neck/Shaft impact on lateralization increased with augments

Methods: Outcome Measures

<table>
<thead>
<tr>
<th>Primary Outcome Measure</th>
<th>Secondary Outcome Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability</td>
<td>ASES Score</td>
</tr>
<tr>
<td>defined as no further dislocations</td>
<td>Range of Motion</td>
</tr>
</tbody>
</table>

Results: Nonoperative

Average follow-up post dislocation: 22 months
- 62% (13/21) remained stable
- 29% (6/21) underwent revision surgery
- 9% (2/21) remained unstable
Results: Operative

- Average follow-up post dislocation: 21 months
- Every patient was revised to larger ball
- 9/10 Grammont Type remained stable post-op
- 7/9 DJO’s remained stable post-op

Results

- No difference between early and late time to dislocation for either
  - ASES Score at Final Follow-up
    - Successful closed reduction = 68.0
    - Revision for instability = 62.7
  - Final Elevation
    - Successful closed reduction = 134°
    - Revision for instability = 88°

Discussion

- Overall incidence of instability low = 2.3%
  - Likely underestimated given retrospective nature
- Large proportion of patients with previous surgery (48%)
  - Of these, 80% had previous arthroplasty
Discussion

- Women with instability had previous implant surgery in 75% cases
- Men with instability had previous surgery in only 22% cases
- One additional patient had instability subsequent to acromial stress fracture

Discussion

We hypothesize three potential mechanisms for instability

1. Bony/soft tissue impingement or asymmetric soft tissue tension
2. Excessive laxity in the shoulder from undersizing the implant
3. Newly induced laxity secondary to fracture

Discussion

- Dislocations can occur at any point in the postoperative period
  - Range: 2-961 days
  - Majority do occur within first 90 days
- Non-op success rate: 62%
- Operative success rate: 84%
- Time to dislocation not related to success
Discussion

Despite a lower success rate, non-op treated patients still had:

1. Improved outcome scores (ASES=68)
   • Not different from those requiring revision (ASES=63)
2. Improved range of motion (Elevation=134°)
   • Better than those requiring revision (Elevation=88°)

Discussion

• Surgically treated patients were always further lateralized by upsizing to a larger ball
• 35% were also infected
• 16% may still remain unstable
  • possibly due to soft tissue asymmetry

Conclusions

• <50% of dislocations after RSA can be successfully treated with closed reduction & immobilization
• If closed reduction is not possible:
  • Upsize glenosphere
  • Evaluate for levering out
• High suspicion for concurrent deep infection
Pearls:
7 Steps to Prevent Instability

1. Larger sphere
2. Larger insert
3. Lateralize COR (sphere design vs Bio RSA)
4. Proximal humeral allograft for bone loss
5. Constrained design
6. Relative anteversion (i.e. 20° retroversion)
7. Repair of soft tissue sleeve and Pec Major
VuMedi Webinar
‘Management of Advanced Shoulder Arthroplasty Complications’

Case Presentations

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Case 1

Primary OA
Painful Shoulder 7 weeks after TSA
Tripped walking her dog

- What is the problem?
- CTT
- MRI

Subscap Rupture/Anterior Instability after fall
Failed Primary Repair

- R/O infection (p.Acnes)
- Removed well-fixed glenoid component
- Humeral stem left in place
- Revised to RSA
CASE 2

Case 7

- 71 yo male
- Failed RCT repair
- Irreparable/OA
- RSA

- At 8 weeks
- Sudden onset pain
- Loss of motion
- Crepitus
- “shoulder out of place”
What happened?

• What is wrong
• Why did it happen
• What should we do now

What we did!

• Revision of Baseplate
• Removed impingement at baseplate bone interface
• Replaced new Glenosphere

Take away message

• Make sure that there is no bony impediments to seating the glenosphere on baseplate (or humeral tray on humeral component) especially in cases of Morse Taper Fixation
Case 3

- 82 year old female
- “Pseudoparalytic” shoulder
- Failed all conservative treatment
- Severe disability and pain

Imaging

Case 3

- What are concerns about this patient’s glenoid anatomy?
- What are the inherent risks?
- What are your solutions?
Case 3

- What should we do in cases of severe glenoid bone loss? (E3 in this case)

Treatment options

- Eccentric reaming
  - PSI guides
- Bone graft
- Augmented glenoid baseplates

Case 3

- Graft taken from humeral head bone cut
- Mini-baseplate and superior graft
  - Fixed with central compression screw and peripheral locking screws
Case 3

Baseplate and graft impacted over guide wire
Baseplate fixed with central compression screw and peripheral screws compress the graft

March 2012  September 2012

Case 3

Glenoid Bone Deformity

• Take home message
  – Recognition of deformity
    • Superior placement or tilt>notching or failure
  – Plan for Rx
    • PS Guides?→PS Components?
    • Reaming vs. Grafting vs. Offset Baseplate
  – Technical considerations
    • Fixation/Implant
Case 4

- 71 year old with severe “pseudoparalytic” CTA

- Active ROM
  - ABD 40 degrees
  - ER (-) 15 degrees
Case 4

- What do we need to recognize in this case (loss of FE and ER)?
- What should we do?

Functional Loss of FE and Ext Rotation

- Diagnosis
- Treatment options

- What was done
Case 6
RSA with Internal Lat d. transfer
Deltospectoral Approach
posterior transfer around humerus at level of original insertion on the humeral shaft

*Courtesy of Pascal Boileau
2007, 2008-Boileau, Chuinard et. al. Transfers with reverse shoulder arthroplasty

Case 4
Functional improvements

Case 4
Soft-tissue insufficiency in RSA

- Take home message
  - Recognize the deformity/disability

  - Be prepared to deal with it
    - Tendon transfers
    - Lateralization – Humeral vs. Glenosphere
THANK YOU