Design Implications
A 12 Year Review of a Lateralized Implant

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Disclosure

Dr. Frankle is a paid consultant for and receives royalties from DJO Surgical

Background

- Reverse shoulder arthroplasty (RSA) was FDA approved in 2003 for treatment of cuff tear arthropathy (CTA)
- Indications continue to expand
  - CTA
  - 4 part fracture
  - Type B2 glenoid
  - Revision of failed arthroplasty
Background

• Over 22,000 RSA performed in 2011
• Projected to grow to over 80,000 in 2020
• Revision rate and outcome following revision is unknown

Purpose

1. To evaluate the rate of RSA revision as it is influenced by primary diagnosis & implant design features
2. To discuss surgical management of failed Reverse Shoulder Arthroplasties
3. To report outcomes following revision of patients with a minimum of 24 month follow-up

Study Design

<table>
<thead>
<tr>
<th>PRIMARY INDICATIONS for RSA PERFORMED by M.A.R. 2000 - 2012</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cuff Tear Arthropathy</td>
<td>649 (45.8%)</td>
</tr>
<tr>
<td>Failed Rotator Cuff Surgery</td>
<td>294 (20.7%)</td>
</tr>
<tr>
<td>Failed Hemiarthroplasty</td>
<td>251 (17.7%)</td>
</tr>
<tr>
<td>Failed Total Shoulder Arthroplasty</td>
<td>105 (7.4%)</td>
</tr>
<tr>
<td>Fracture (acute/malunion)</td>
<td>79 (5.6%)</td>
</tr>
<tr>
<td>Failed ORIF</td>
<td>14 (1%)</td>
</tr>
<tr>
<td>Other</td>
<td>26 (1.8%)</td>
</tr>
<tr>
<td>Total</td>
<td>1418</td>
</tr>
</tbody>
</table>

Of these, we identified 88 patients requiring removal or exchange of components
Study Design

For each of the 85 patients, we determined:
• Indication to reoperate
• Intraoperative management
• Outcome following revision surgery

Indications placed into seven categories:
1. Glenoid baseplate failure (35/85)
2. Glenosphere dissociation (8/85)
3. Humeral dissociation (10/85)
4. Glenohumeral dislocation (6/85)
5. Aseptic humeral loosening (4/85)
6. Periprosthetic fracture (6/85)
7. Infection (18/85)

*2 patients fit into two categories

Modes of Failure:
Baseplate Failure
• Radiographic changes in the baseplate position over time combined with presence of broken screws (35/85)
  • January 2000 – January 2004 (31/85)
    • 4 • 3.5mm non-locking peripheral screws (31/242)
  • February 2004 – December 2012 (4/85)
    • 4 • 5.0mm locking screws (4/1176)
**Modes of Failure: Glenosphere Dissociation**

- Isolated failure of the Morse taper engagement to the baseplate (8/85)
  - January 2000 – August 2005 (5/85)
    - no central hole in glenosphere (5/381)
  - August 2005 – December 2012 (3/85)
    - central hole present in glenosphere (3/1037)

**Modes of Failure: Humeral Dissociation**

- Radiographic separation of metaphyseal shell from humeral stem (10/85)
  - January 2000 – June 2005 (8/85)
    - modular polyethylene socket (8/392)
  - June 2005 – December 2012 (2/85)
    - modular metal metaphyseal shell with a polyethylene insert (2/1026)

**Modes of Failure**

- Aseptic Humeral loosening
  - Radiographic grossly loose stem without signs of infection (4/85)
Modes of Failure

- Periprosthetic Fracture
  - Fractures requiring removal or exchange of the reverse prosthesis (6/85)

- Glenohumeral dislocation
  - Radiographic loss of articulation between the glenosphere and humeral socket (6/85)

- Elevated preoperative inflammatory markers (CBC, ESR, CRP)
- Physical exam (erythema, drainage, sinus)
- Intraoperative findings
- Pathology
  - Frozen section
  - Culture
- 18/85 patients
Indications categorized when at least 2/3 reviewers agreed upon the primary reason for revision

Methods: Surgical Management

Operative reports were reviewed to understand surgical strategies utilized by the senior author

Methods: Outcome Measures

- ASES
- Simple Shoulder Test (SST)
- Range of Motion
# Results


<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Female</td>
<td>853 (60.2%)</td>
<td>48 (56.5%)</td>
</tr>
<tr>
<td>Male</td>
<td>563 (39.7%)</td>
<td>37 (43.5%)</td>
</tr>
</tbody>
</table>

## Age

|   | 69.8 ± 10.3 | 66.7 ± 10.7 |

## Primary Diagnosis

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Failed CTA</td>
<td>649 (45.8%)</td>
<td>26 (4%)</td>
</tr>
<tr>
<td>Failed RCR</td>
<td>294 (20.7%)</td>
<td>18 (6.1%)</td>
</tr>
<tr>
<td>Failed HA</td>
<td>251 (17.7%)</td>
<td>26 (10.4%)</td>
</tr>
<tr>
<td>Failed TSA</td>
<td>105 (7.4%)</td>
<td>8 (7.6%)</td>
</tr>
<tr>
<td>Proximal Humerus Fracture</td>
<td>79 (3.8%)</td>
<td>3 (3.8%)</td>
</tr>
<tr>
<td>Failed ORIF</td>
<td>14 (1%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Other*</td>
<td>26 (1.8%)</td>
<td>4 (15.4%)</td>
</tr>
</tbody>
</table>

## Total

|        | 1418 | 85 |

## Revision Indications Over Time

### Revision Indications

- Baseplate failure
- Humeral Dissocation
- Glenosphere Dissociation

### Design modification

- Metal methaphyseal shell modular socket with PE insert

## Results

<table>
<thead>
<tr>
<th>Indication</th>
<th>Implant design iteration</th>
<th>Failed/Total</th>
<th>Percentage failed</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failed BP non-locking screws</td>
<td>31/242</td>
<td>12.8%</td>
<td></td>
<td>p &lt; 0.0001</td>
</tr>
<tr>
<td>Failed BP locking screws</td>
<td>4/1176</td>
<td>0.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humeral dissociation all PE modular socket</td>
<td>2/1057</td>
<td>0.2%</td>
<td>p = 0.000751</td>
<td></td>
</tr>
<tr>
<td>Humeral dissociation metal methaphyseal shell modular socket with PE insert</td>
<td>2/1057</td>
<td>0.2%</td>
<td>p = 0.000751</td>
<td></td>
</tr>
<tr>
<td>Glenosphere dissociation without central hole</td>
<td>5/992</td>
<td>1.5%</td>
<td>p = 0.042309</td>
<td></td>
</tr>
<tr>
<td>Glenosphere dissociation with central hole</td>
<td>5/1026</td>
<td>0.5%</td>
<td>p = 0.042309</td>
<td></td>
</tr>
</tbody>
</table>
Results – Surgical Approach: Baseplate Failure

- Removal of glenosphere & baseplate.
- Broken screws were left in the glenoid.
- A new baseplate with 5.0mm locking screws was implanted in 34/35 patients.
- Glenosphere was exchanged for a larger size in 29/34 patients.
- 1 patient required conversion to HA due to glenoid bone loss.

Results – Surgical Approach: Glenosphere Dissociation

- Isolated glenosphere exchange performed for 3/8 patients.
  - 2/3 kept the same size, 1/3 got a smaller size.

Results – Surgical Approach: Humeral Dissociation

- Exchanged to a new metal-backed socket.
Results – Surgical Approach: Dislocation

- Glenosphere exchanged to larger sphere in 4/5 patients.

Results – Surgical Approach: Humeral Loosening

- All patients with humeral loosening had bone loss extending into the metaphysis.
- 3/4 patients received proximal humeral allograft secured with cerclage wires.
- A longer humeral stem was then cemented in place.

Results – Surgical Approach: Periprosthetic Fracture

- Removal of humeral component & placement of cerclage wires around fracture site.
- Longer cemented humeral stem was implanted.
- Proximal humeral allograft utilized in 3/6 patients.
Results – Surgical Approach: Infection

- 13/18 one-stage revisions
- 5/18 two-stage revisions
- 3 patients elected not to undergo second stage
- 1 patient had recurrent infection after single stage revision

Results: Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Pre-op</th>
<th>Post-op</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASES Total</td>
<td>45.6</td>
<td>52.9</td>
<td>0.047</td>
</tr>
<tr>
<td>FF</td>
<td>74</td>
<td>97</td>
<td>0.011</td>
</tr>
<tr>
<td>AB</td>
<td>71</td>
<td>91</td>
<td>0.013</td>
</tr>
<tr>
<td>ER</td>
<td>22</td>
<td>25</td>
<td>0.954</td>
</tr>
<tr>
<td>IR</td>
<td>2.6</td>
<td>3.4</td>
<td>0.126</td>
</tr>
<tr>
<td>SST Total</td>
<td>2.6</td>
<td>4.4</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Conclusion

- Implant modifications have led to decreasing instances of baseplate failure, glenosphere dissociation, & humeral dissociation
- Patients exhibit significant clinical improvements following revision