Shoulder Prosthesis
Postoperative Imaging

Florian M. Buck, MD
Shoulder Prosthesis

Surgical Approach Findings

Imaging Modalities

Postoperative Problems
Shoulder Prosthesis

What are we talking about

Anatomical Prostheses
- Conventional prosthesis
- Fracture prosthesis

Inversed prosthesis

Glenoid components
Shoulder Prosthesis

Different Types

Anatomical Total Shoulder Prosthesis

+ Glenoid Allograft
Shoulder Prosthesis

Different Types

Inverted Total Shoulder Prosthesis
Deltopectoral approach

- Between deltoid and pectoralis major muscle
- Same approach as for instability surgery
Deltopectoral approach

- Between deltoid and pectoralis major muscle
- Same approach as for instability surgery
Deltopectoral approach

- Detachment of subscapularis tendon more often than lesser tubercle osteotomy
- Fixation with transosseous seam
Complications of deltopectoral approach

- Subscapularis muscle insufficiency due to tendon detachment

Ref.: Scheibel et al. AJSM, 2007
Axillary nerve branch injury

- Deltoideus fatty change

Brachial plexus injury

- Plexus traction due to lengthening of the arm & preoperatively shortened arm (high Hamda grade)
Symptoms

- Deltoid muscle dysfunction
- Inferior instability
- If deltoid muscle function is insufficient not even inverse prosthesis can be used
Imaging Modalities

Plain Films

Computed Tomography

MR Imaging
Plain Films

Shoulder Status

H0 view

G0 view
Computed Tomography

Anatomical Prosthesis

Conventional CT

CT Recon with triple slice thickness
Computed Tomography

Inversed Prosthesis

Conventional CT  D60s Kernel & IMAR 3D  Conventional CT  D60s Kernel & IMAR 3D
MR Tomography

Inversed Prosthesis

- Location of glenosphere screws
- Soft tissues around joint

PD WARP
MR Tomography

Inversed Prosthesis

- Osseous structures

PD WARP
MR Tomography

Inversed Prosthesis

- AC joint arthrosis (DD acromial fx)
- Muscle atrophy
- Humeral shaft loosening
Teres Major Transfer

Teres major Transfer (L’Episcopo transfer)

Complications of Shoulder Arthroplasty

Multitude of complications reported:

- Prosthetic loosening
- Glenohumeral instability
- Periprosthetic fracture
- Rotator cuff tears
- Infection
- Neural injury
- Deltoid muscle dysfunction

Complications in 33 series including 2540 shoulders:

<table>
<thead>
<tr>
<th>Complication</th>
<th>No. of Shoulders</th>
<th>Percentage of All Complications</th>
<th>Percentage of All Shoulders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component loosening</td>
<td>161</td>
<td>39</td>
<td>6.3</td>
</tr>
<tr>
<td>Glenoid</td>
<td>134</td>
<td>32</td>
<td>5.3</td>
</tr>
<tr>
<td>Humerus</td>
<td>27</td>
<td>6.5</td>
<td>1.1</td>
</tr>
<tr>
<td>Instability</td>
<td>124</td>
<td>30</td>
<td>4.9</td>
</tr>
<tr>
<td>Superior</td>
<td>77</td>
<td>19</td>
<td>3.0</td>
</tr>
<tr>
<td>Posterior</td>
<td>25</td>
<td>6</td>
<td>1.0</td>
</tr>
<tr>
<td>Anterior</td>
<td>22</td>
<td>5</td>
<td>0.9</td>
</tr>
<tr>
<td>Periprosthetic fracture</td>
<td>46</td>
<td>11</td>
<td>1.8</td>
</tr>
<tr>
<td>Intraoperative</td>
<td>27</td>
<td>6.5</td>
<td>1.1</td>
</tr>
<tr>
<td>Postoperative</td>
<td>19</td>
<td>4.6</td>
<td>0.7</td>
</tr>
<tr>
<td>Rotator cuff tear</td>
<td>32</td>
<td>7.7</td>
<td>1.3</td>
</tr>
<tr>
<td>Neural injury</td>
<td>20</td>
<td>4.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Infection</td>
<td>19</td>
<td>4.6</td>
<td>0.7</td>
</tr>
<tr>
<td>Deltoid detachment</td>
<td>2</td>
<td>0.5</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Prosthetic Loosening

Humeral Component

- rare
- often in combination with infection

Prosthetic Loosening

Humeral Capping

- 1% loosening (instead of 0.5% - double risk)
- Granuloma formation

Resurfacing – Cap
Granuloma in humeral head
Prosthetic Loosening

Glenoid Component

- frequent
- unresolved problem

Prosthetic Loosening

Glenoid Component

- frequent
- unresolved problem

Glenosphere Loosening - superior tilting/dislocation

Scapular Notching

Inversed Prosthesis

- frequent (ca. 60% after 4 years)
- not associated with inferior functional outcome

Grading:

Scapular Notching

Grade III

Scapular Notching

Inversed Prosthesis

• associated with:
  - too high position of glenosphere
  - superior tilting
• mostly posteroinferior location
• probably caused by abduction/elevation and external rotation

Glenohumeral Instability

Second leading cause of prosthesis dysfunction

Anterior:
- most common instability (80%)
- subluxation of > 5 mm seen on cross-table view
- Causes:
  - Subscapularis insufficiency
  - Anteversion of glenoid component
  - Oversized humeral head
  - Decreased humeral retroversion (< 20°)

Glenohumeral Instability

Anterior Deltoid Muscle Detachment
Glenohumeral Instability

Second leading cause of prosthesis dysfunction

Superior:

- Acromiohumeral distance < 5mm on G0 a.p. view
- Associated:
  - Anterior instability and rotator cuff tears (supraspinatus tendon)
  - Cranial placement of the humeral component with relative lengthening of the humerus
  - Superior tilting of glenoid component

Glenohumeral Instability

Second leading cause of prosthesis dysfunction

Posterior:

- Causes:
  - Wide dorsal capsule
  - Anterior soft tissue contracture
  - Infraspinatus tendon deficiency
  - Malrotation of humeral component (retroversion $> 45^\circ$)
  - Dorsal glenoid defect
  - Retroversion of glenoid component ($> 20^\circ$)

Glenohumeral Instability

Second leading cause of prosthesis dysfunction

Inferior:

- Causes:
  - Shortened humerus (e.g. after proximal humeral fractures or after humeral defects in tumor surgery)
  - Deltoid muscle weakness in axillary nerve palsy or deltoid muscle detachment

Humeral Torsion

Measurement according to Hernigou et al.

- Proximal:
  Line perpendicular to the articular surface

- Distal Reference:
  Transepicondylar line

Humeral Torsion

Measurement according to Hernigou et al.

- Proximal:
  Line perpendicular to the articular surface

- Distal Reference:
  Transepicondylar line

- Normal values:
  - Retroversion of 10-50° (wide range)
  - Side-to-Side Difference only 2°

Rotational Misplacement

A rare problem

- Shaft is placed to allow for future conversion to inverse prosthesis
- Head can be positioned almost freely on the shaft
- Problem Fracture prosthesis: Tubercula do not fit tendon position

Rotational Misplacement

Case: Inversed Prosthesis, 10° Antetorsion
Case: Inversed Prosthesis, 10° Antetorsion
Periarticular Ossification

Grading according to Kjaersgaard

Grade 0: No ossification
Grade 1: Ossification occupying < 50% of joint space
Grade 2: Ossification occupying > 50% of joint space
Grade 3: Bridging of joint

Periarticular Ossification

Grading according to Kjaersgaard

- Develop early in the postoperative course
- Typically low grade and often clinically unimportant

Scapular Fractures & Inverse Prosthesis

Prevalence

- Around 5%

**TABLE I Prevalence of Acromial Fractures Reported in Studies in the Literature**

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Patients</th>
<th>No. of Acromial Fractures</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crosby et al.(^6) (2011)</td>
<td>400</td>
<td>22</td>
<td>5.5%</td>
</tr>
<tr>
<td>Hamid et al.(^1) (2011)</td>
<td>162</td>
<td>8</td>
<td>4.9%</td>
</tr>
<tr>
<td>Hattrup(^7) (2010)</td>
<td>125</td>
<td>9</td>
<td>7.2%</td>
</tr>
<tr>
<td>Walch et al.(^8) (2009)</td>
<td>457</td>
<td>17</td>
<td>3.7%</td>
</tr>
<tr>
<td>Cuff et al.(^9) (2008)</td>
<td>114</td>
<td>1</td>
<td>0.8%</td>
</tr>
<tr>
<td>Frankle et al.(^1) (2005)</td>
<td>60</td>
<td>2</td>
<td>3.3%</td>
</tr>
<tr>
<td>Wemer et al.(^2) (2005)</td>
<td>58</td>
<td>4</td>
<td>6.8%</td>
</tr>
<tr>
<td>Boileau et al.(^4) (2005)</td>
<td>45</td>
<td>2</td>
<td>4.4%</td>
</tr>
<tr>
<td>Katzer et al.(^1) (2004)</td>
<td>21</td>
<td>1</td>
<td>4.7%</td>
</tr>
</tbody>
</table>

## Periprosthetic Fractures

### Classification

<table>
<thead>
<tr>
<th>Classification</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groh et al.</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>Fracture exclusively proximal to the tip of the stem</td>
</tr>
<tr>
<td>II</td>
<td>Fracture at the tip of the stem, running from proximal of the tip to distal</td>
</tr>
<tr>
<td>III</td>
<td>Fracture exclusively distal of the tip of the stem</td>
</tr>
<tr>
<td>Campbell et al.</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>Fracture of the greater or lesser tuberosity</td>
</tr>
<tr>
<td>II</td>
<td>Fracture of the proximal humeral metaphysis</td>
</tr>
<tr>
<td>III</td>
<td>Fracture of the proximal humeral diaphysis</td>
</tr>
<tr>
<td>IV</td>
<td>Fracture of the mid and distal humeral shaft</td>
</tr>
<tr>
<td>Worland et al.</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Fracture of the tuberosities</td>
</tr>
<tr>
<td>B1</td>
<td>Spiral fracture with stable stem</td>
</tr>
<tr>
<td>B2</td>
<td>Short oblique or transverse fracture with stable stem</td>
</tr>
<tr>
<td>B3</td>
<td>Any fracture with unstable stem</td>
</tr>
<tr>
<td>Wright and Cofield</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Fracture at the tip of the stem extending proximally more than one third the length of the stem</td>
</tr>
<tr>
<td>B</td>
<td>Fracture at the tip but with less proximal extension</td>
</tr>
<tr>
<td>C</td>
<td>Fracture distal to the implant and fractures extending into the humeral metaphysis</td>
</tr>
</tbody>
</table>
Periprosthetic Fractures

Intraoperative Fracture
Scapular Fractures

Classification

- **Type I: Acromion**
  Involvement of insertion of a portion of anterior and middle deltoid origin

- **Type II: Scapular spine**
  Involvement of at least the entire middle deltoid origin

- **Type III: Base of scapular spine**
  Involvement of the entire middle and posterior deltoid origin

Scapular Fractures

Classification

• Type I

  often chronic

Scapular Fractures

Classification

• Type II

Scapular Fractures

Classification

• Type III

Acromion Fractures & Inversed Prosthesis

Lateral position of rotation center

- Deltoideus can act
- Less force needed
- More stress on acromion

- Lengthening of arm – Tension on deltoideus muscle

Detection of Fractures

- 80% visible on plain films
- Helpful signs:
  - Decreasing acromion-tuberosity distance

Detection of Fractures

- 80% visible on plain films
- Helpful signs:
  - Decreasing acromion-tuberosity distance
  - Increasing acromial tilt

Don’t forget to inspect cross-table and Neer view for spine fractures!

Conclusion

Take Home Messages

- Knowledge about the prosthesis types used
- Surgical approach and associated problems
- Imaging of the postoperative shoulder
- Most common postoperative complications
Thank you for your attention!
Articular Metallosis

Metal-on-Metal

- Polyethylene wearing
Articular Metallosis

Metal-on-Metal

- Lymphocellular infiltration
Fractures

Early, Late or Incidental

- **Early:**
  Intraoperative Fractures

- **Late:**
  Insufficiency fractures

- **Incidental:**
  Traumatic (e.g. fall)

**Risk factors:**

- Osteoporosis, Surgery Technique
- Inversed prosthesis, Hamada ⊲, Os aromiale

Wall B et al. Reverse Total Shoulder Arthroplasty: A review of results according to etiology. JBJS Am. 2007;89:1476-85.
Hamada Classification

Pathologic Stage:
1. AHI > 6mm
2. AHI < 6mm
3. Acetabulation – 2 subtypes:
   - concave undersurface of acromion
   - spur along coraco-acromial lig.
4. Narrowing glenohumeral joint
5. Humeral head collapse

Fractures

Early, Late or Incidental

- Early:
  Intraoperative Fractures

- Late:
  Insufficiency fractures

- Incidental:
  Traumatic (e.g. fall)

Risk factors:

- Osteoporosis, Surgery Technique
- Hamada ↑, Os aromiale, Inversed prosthesis
- Age: Comorbidity, osteoporosis

Wall B et al. Reverse Total Shoulder Arthroplasty: A review of results according to etiology. JBJS Am. 2007;89:1476-85.