Shoulder Arthroplasty Review

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Etiologies of degenerative joint disease of shoulder:

- Osteoarthritis
- Rheumatoid Arthritis/Inflammatory Arthritis
- Cuff Tear Arthropathy
- Post traumatic
- Post surgical/Post-Capsulorrhapy DJD
- AVN
- Others

Pre-operative Evaluation:

1. **History**
   - Pain
     - Location, duration, night pain, character
     - Injections: location, response
     - Therapy
     - NSAIDs

   - Function
     - Active motion, Passive motion, loss of ADL ability
     - Recreation
     - Occupation

   - Surgical History
     - Rotator cuff surgery
     - Instability/Dislocations

   - Trauma History

2. **Physical Examination**

   **Inspection**
   - Atrophy around shoulder girdle
   - Scapular dyskinesis
   - Swelling (under deltoid in CTA)
Incisions/scars
Other shoulder
Ipsilateral arm- elbow and hand

Palpation
  Crepitus
  Range of motion parameters and motion loss
    (Passive range of motion with evaluation of scapular vs. GH motion)
  Pain location
    AC joint, biceps, radicular patterns

Range of Motion
  Passive vs Active vs Active Assisted
  Compare to contra-lateral shoulder

Cervical Spine status
Lower extremity issues- walker, cane dependent, etc
Obesity- BMI

Medical Co-morbidities
  DM, HTN, CAD, pulmonary, other musculoskeletal conditions

3. Radiographs
  True AP (Grashey view), Axillary, outlet views
    These are the minimum that are required!

Plain radiographs can tell the tale:
  Joint space narrowing
  Glenoid morphology: A1,A3,B1,B2,C
  Acromiohumeral distance
  Bone erosion
  Bone Quality
  Osteophytes
  AVN
  Vascular clips: previous mastectomy
  Need to further imaging

4. Advanced Imaging Studies
   a. Limited CT scan
      Shoulder in center of gantry
      3-5 mm cuts from AC thru the glenoid
-Will give excellent information on glenoid osteology and retroversion
- Give information on RC muscle belly status
- Less time, money, radiation than standard CT
- Do not need 3D recon for most DJD conditions of shoulder

b. MRI
Most patients walk in with MRI from primary care MD
Excellent for soft tissue, not as good for osseous aspects

c. Arthro/CT
Patients with complex deformity, previous surgery, metallic retained implants

d. CT scan with 3D reconstruction
Complex post-traumatic or post surgical deformity

5. Laboratory Studies
Typically not needed
However:
If any previous surgery: CBC, Sed Rate, CR-P
Aspiration
   Cell count, cultures, gram stain
   Office vs OR setting

Pre-operative evaluation will help determine:
- Pattern of joint disease
- Magnitude of motion loss and shoulder dysfunction
- Potential rotator cuff involvement and rehabilitation
- Will help determine implant choices and realistic functional outcomes for the patient

Osteoarthritis
Cuff Pathology
1. Rare 3-10%
2. Repairable
3. Usually does not affect outcome
Rheumatoid Arthritis
A. Cuff Pathology
   1. Common (Only 16 – 25% normal)
   2. Attenuation (35%)
   3. Tears (40%)
   4. Contractures
B. Osseous Pathology
   1. Glenoid Wear
   2. Humeral Wear
C. Medical Pathology
   1. Multiple Joints
   2. “Poisons”

Cuff Tear Arthropathy –
The degenerative condition itself is a consequence of the primary rotator cuff insufficiency
Pain
Poor Active ROM; Pseudo-paralysis
Almost Normal Passive ROM
Dysfunction

IV. Complications of Shoulder Arthroplasty

1. Early Prosthesis Problems
   a. Instability
   b. Aseptic loosening
   c. Septic loosening
2. Late Prosthesis Problems
   a. Glenoid loosening
   b. Radiolucent lines?
   c. Poly wear?
3 Stiffness
4. Subscapularis weakness, deficiency?
5. Infection
6. Intra-op/ Peri-prosthetic fx
7. Neurologic injury
8. Late glenoid erosion from hemi-
Recent Studies and What can we say about Results

Comparison Problems
A. Follow-up time frames
B. Pre-op diagnosis mixture
C. Rotator Cuff status
D. Outcome measures
E. Radiographic evaluation
F. Differences in technique, implant design, materials, cement vs. non-cement, and time

Single Diagnosis- Osteoarthritis
Godeneche JSES 2002
268 Shoulders Avg. F/U= 30 months (1-6.5 yrs)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Excellent</td>
<td>59%</td>
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<tr>
<td>Good</td>
<td>18%</td>
</tr>
<tr>
<td>Fair</td>
<td>15%</td>
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<tr>
<td>Poor</td>
<td>8%</td>
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<tr>
<td>Re-op</td>
<td>4.9%</td>
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Patient Satisfaction 94%

Correlation of RCT or fatty infiltration of cuff muscle with a decrease in Constant Score and Active Forward Elevation

Glenoid radiolucencies in 58%, progressive in 23%
Radiolucencies associated with decrease in Constant Score

Mixed Diagnosis
Torchia JSES 1997
113 Shoulders, 89 available for F/U at avg. 12 yrs. (5-17)

Active ROM
Avg. AFE= 117°
Normal RC 136°
Small RCT 113°
Large RCT 68°
Pain Relief
83% pain relief
Increase pain correlated with glenoid loosening

Radiographic Analysis
Humerus
- Press-fit: 49% shift in position
- Cemented: 0% shift in position

Glenoid
- 75 of 89 (84%) with radiolucencies
- 39 (44%) loose
- 34 (38%) shift in position

Lucencies more common in males
Pre-op dx did not correlate with presence of lucencies

Time
Pain relief 93% decrease to 83% due to glenoid loosening
Glenoid revision rate for loosening 5.6% (5 cases)

Kaplan-Meier Survival for TSA:
- 10 Years: 93%
- 15 Years: 87%

Anatomic TSA
I. Soft tissue balancing operation
   - Humeral anatomy: Variable
     - Neck-shaft angle
     - Posterior offset
     - Medial offset
     - Head Height to Size is relatively fixed ratio: .74

Glenoid Anatomy
- Walch Morphology
- Re-establish relative normal version
- Secure Fixation
- Exposure is the key
- Advanced imaging to determine glenoid osteology pre-op

Summary
- TSA is predictable and durable treatment option for DJD
- Pre-op diagnosis will effect treatment choices
- Rotator Cuff status will have major effect on AFE and outcome scores
- Cemented humeri do not move nor cause pain
- Cemented glenoids will have and/or develop radiolucent lines
- Cemented glenoids will have progressive lucencies 10-50%
- Glenoid loosening increases with time
- Clinical results will decrease with time, due primarily to pain, which is due to glenoid loosening
- Poly wear debris has not been identified as a major factor

Survival Rates:
- 5 year: 98%
- 8 year: 93%
- 10 year: 85%
- 10-15 yr.: 60-87%

Reverse Shoulder Arthroplasty

**Indications for Reverse Shoulder Arthroplasty**

A. Symptomatic cuff deficiency with joint injury
B. Pain
C. Poor active elevation
D. Shoulder dysfunction
E. No other satisfactory option is available

**Terminology/Definition of Cuff Deficiency and Joint Injury:**

**Cuff Tear Arthropathy or Arthritis with Massive Cuff Tear**

A. Large Rotator Cuff Tear (Irreparable)
B. Upward Humeral Migration
C. Subacromial Narrowing
D. Glenohumeral Cartilage Wear
Are There Classifications With Relevance?

Radiographic classifications:

Sirveaux/Oudet
Hamada
Seebauer

However there are no classification schemes commonly in use that allow communication for: severity of involvement, pre-op motion, magnitude of cuff deficiency, or factors associated with success or failure of treatment.

Hemiarthroplasty versus Reverse Arthroplasty

Comparative Study of Hemi- vs. Reverse for CTA

Favard, et al Nice 2001

62 HHR 80 Reverse Prosthesis

AFE:

HHR = 96 degrees  RBS = 138 degrees

Constant:

HHR = 46.1  RBS = 65.5

33 of 62 HHR had progressive acromial wear on radiologic follow-up

Problem Conditions

CTA with pseudoparalysis (AFE < 45 degrees)
Previous CA arch surgery
Multiple Failed RCR Syndrome

Age-matched, Diagnosis-matched, No previous surgery-matched population.

Previous RCR, CA arch violation, poor AROM, Irreparable RC tissue, Atrophy of RC muscle belly, nau. dysfunciton

-CA arch
deficiency
-RC
deficiency
-Loss of containment
-Severe dysfunciton
Anterosuperior Instability (ASI)
Failed Hemi/Bipolar for Fracture
(usually GT non-union, malunion, or gone)
Failed Hemi/Bipolar for CTA

VIII. Consider Using the Reverse as the Primary Arthroplasty

- CTA with pseudoparalysis (AFE < 60 degrees)
- CTA with insufficiency fx of acromion
- Previous CA arch violation
- Anterosuperior Instability (ASI)
- Multiple Failed RC Repair Syndrome

IX. Biomechanical Considerations in Reverse Arthroplasty Design

I. Constrained and Semi-Constrained Designs
   A. Prevent Upward Migration
   B. Fixed Fulcrum for action
   C. Based off Hip designs
      1. Poor motion (rarely > 90 degrees)
      2. Early Failure
        Scapular fixation failure due to excessive torque at interface

II. “Grammont” Design Reverse Arthroplasty
   A. 1985-1991
   B. 1991- present
      Delta concept

III. Advantages from Earlier Designs
   A. Large Hemispheric “ball” on glenoid
      1. Back of glenosphere in direct contact with prepared bone surface
      2. More stability than a “smaller” ball
         More surface contact area
      3. Greater potential arc of motion

   B. Smaller lateral offset to glenoid component
      1. Absence of neck
      2. Center of rotation of glenoid component in contact with glenoid bone
      3. Reduced forces at implant-bone interface
C. Medialization and Inferiorization of Center or Rotation  
1. Recruits more deltoid muscle fibers for action (elevation)  
2. Increases deltoid tension  
3. Better deltoid function in absence of rotator cuff  
4. Increased deltoid torque due to increased lever arm and force  

IV. Technical Issues with Impact from this design  

A. Inferior glenosphere placement  
1. Largest area of glenoid surface area and vault volume  
   30 mm. circle with a superior tubercle  
2. Allows humerus to not impinge on scapula in adduction  
   (? Prevents scapular notching)  
3. Deltoid and myofascial sleeve tension  
4. Will create “deadspace” under deltoid (potential hematoma formation)  
5. Will lengthen the arm and avg. of 15 mm.  
6. Potential for over-tensioning with acromial stress fracture  

B. Inferior Tilt to Component  
1. Prevents scapular impingement in adduction  
2. Compression forces under the baseplate thru position and ROM  
3. Superior tilt: tension forces under component; early failure  
4. Allows a closer to normal scapulo-humeral rhythm during elevation  

V. Problems  

A. Instability  
   It is a semi-constrained device  
   Only so much motion available prior to the end arc  
   Under-tensioning of deltoid with global decoaptation of humerus to glenoid  

B. Limit to ER  
1. Posterior abutment of humerus upon scapula  
2. ? Contributes to early instability  
   with “open-book” anteriorly with ER and extension  
3. Slackening of any remaining posterior RC muscles  

C. Scapular Notching  
D. Glenoid Loosening
E. Polyethylene wear

X. Technical Considerations with Reverse Shoulder Arthroplasty

Glenoid Component is the Key!

Placement Issues

**Inferior Position**
- Glenoid is 30mm circle with a “tubercle” on top
- Place the baseplate on the 30mm circle.
- Rim of baseplate is on inferior rim of glenoid bone
- Remove labrum and hyaline cartilage to see the inferior rim
- Drill guide to position center drill hole correctly
- Must do an inferior capsular release off glenoid
  - Best done thru deltopectoral approach

**Inferior Tilt (10 degrees)**
- Inferior tilt: compressive forces upon baseplate thru ROM
- Less scapular impingement (notch) in adduction
- Hand Ream, Inferior pressure
- Create Subchondral “Smile” thru the bone
  - Crescent shaped area of early cancellous bone showing
  - Stop- Accept depth-
    - May need to bone graft superior defect
  - Superior-central defect in 25-30%
- Do not try to change retroversion dramatically

**Screw Placement**
- Find the best bone for the screws
- It is not necessarily at the 12 and 6 o’clock positions
- Divergent screws
  - Lateral pillar and Coracoid base

Humerus Component

Placement Issues

**Version**
- Between 0 and 20 degrees of retroversion
- Adjust with trial reduction to allow at least 20 degrees ER at side
- Increase retroversion of humerus = More ER prior to abutment

**Height**
- 1 mm push-pull
- Snap fit reduction
- Strap muscle tendons will be tight
- Lengthen the arm approx. 1.5 cm.

Drain for 24 Hrs
- Deadspace created, potential for hematoma formation
Stability

If stability is a question (ie- revision): Use abduction pillow for 3-5 weeks

**Absolute Necessities for Reverse Prosthesis**

- Intact Deltoid
- Adequate Glenoid Bone Stock
- Proper design
- Informed surgeon and patient

XIII. Complications (Reported Rates 15-25%)

Even significantly higher rate in revision surgeries

1. Infection
2. Hematoma
3. Dislocation
4. Glenoid Loosening
5. Glenoid/Scapular Notching

**Potential Problems**

Poor rotational ability ( ER and IR can be limited due to design)

But also due to poor posterior RC status

Teres Minor status is important

Longevity

Poor decisions, Poor technique

This is not an easy operation!

XIV. Clinical/Demographic Characteristics of Reverse Population

1. Older than TSA (Avg. 10 yrs. Older)
2. Co-morbidity (Avg. 2+ more)
3. Length of Stay issues (Longer due to infirmity of age, family, co-morbidity, medical, mobility issues)

XV. Summary

- Cuff-deficient shoulders with painful degenerative disease is an unsolved surgical problem at this time
- Population is getting progressively older and more active at the same time
- New options are presenting themselves – be careful what you chose
- Reverse Prosthesis:
  
  Provide stability, relieve pain, and improve potential active elevation
For Cuff Deficiency and Joint Injury where no other satisfactory option exists

References


