Normal Anatomy

- The Shoulder
  - Greatest ROM
  - No inherent bony stability
  - Relies on soft tissues for stability
  - Many injuries involve the soft tissues (rotator cuff, labrum)
  - Little glenoid bone stock

Normal Anatomy

- Humeral Head
  - Center medial and posterior to the humeral axis
  - Inclination ~ 40°
  - Neck-shaft angle ~ 130°
  - Superior aspect above GT
  - Retroverted 20-30°

Normal Anatomy

- Glenoid
  - Pear shaped
    - Upper half 4/5 AP diam lower half
    - Sup-inf distance = 30-48 mm
    - Radius of curvature 2.3 mm greater than humeral head
    - Superior tilt ~ 5°
    - Retroverted ~ 2-10°

Normal Anatomic Shoulder

- Rotator cuff & deltoid work together to stabilize the glenohumeral joint
- Glenohumeral motion 120°
**Normal Anatomy Shoulder**

- The deltoid moment leads to glenohumeral instability
- Glenohumeral and scapulo-thoracic motion is lost

**Pathologic Anatomy**

- DJD – Bony
  - Narrowed joint space
  - Subchondral sclerosis and cyst formation
  - Flattened humeral and glenoid surfaces
  - Ring of osteophytes around anatomic neck
  - Posterior glenoid erosion
  - Glenoid retroversion

**Clinical Evaluation**

- **History**
  - Unremitting dull ache in the shoulder
  - Stiffness, loss of function
  - Muscle fatigue and difficulty at extremes of motion
  - Difficulty with ADL’s when severe
  - May complain of positional night pain
  - Different from RCT pain that wakes pt

- **Physical Exam**
  - Assessment of active and passive ROM
    - Limited external rotation common with OA
  - Cuff Exam
    - Pseudoparalysis, Hornblower sign
  - Poor AROM, near norm PROM
  - Neurologic exam
    - Cervical spondylosis/radiculopathy frequently present

**Imaging**

- Plain films
  - AP, Axillary lateral, Scapular Y
- CT
  - Glenoid resurfacing
    - Bone stock
    - Version
- MRI
  - Rotator cuff

**Treatment Options:**

- **Non-Operative (AAOS Clinical Practice Guidelines)**
  - Activity modification
  - NSAIDs (Inconclusive)
  - Physical Therapy
    - Maintain range of motion and cuff strength
    - Be cognizant of mechanical block to motion
  - Injections
    - Corticosteroid
    - Hyaluronic Acid
    - PRP/Toradol
Operative Treatment

- Non-Prosthetic
  - Arthroscopic Debridement (Inconclusive)
    - Washout degradative enzymes
    - Smooth irregular cartilage
    - Short term improvement
    - 80-88% good results at 2 years
    - Not a long term solution
  - Microfracture
    - Lesions > 2cm² do poorly
    - Often global wear not isolated lesions with discrete edges
  - Microfracture

- Interposition grafts (Inconclusive)
  - Option for younger patients
  - Mixed results depending on series
  - Improved functional outcomes
  - High reoperation/failure rates
  - Lateral meniscus/Achilles tendon allograft
    - Bovine/porcine membrane xenograft
    - Biologic acellular matrix scaffold (Graftjacket™)

- Humeral Head Resurfacing
  - Preserve bone stock
  - No comparative data
  - Good functional outcomes

- Hemiarthroplasty (for GH OA)
  - Proven treatment for OA
    - Good pain relief/improved range of motion
    - Good functional outcomes
    - Progression of glenoid erosion
    - 10% conversion to TSA
    - Worse functional outcomes than primary TSA

- Total Shoulder Arthroplasty
  - Recommended over Hemi for OA
    - More predictable pain relief
    - Better functional outcomes
    - Increased range of motion

Indications for Shoulder Arthroplasty

- Osteoarthritis
- Rheumatoid arthritis
- Rotator cuff tear arthropathy
- Avascular necrosis
- Post-traumatic arthritis
- 3 & 4-part proximal humeral fractures
- AMS - “Ankle Mortise” Shoulder
Contraindications to TSA:

- Active or recent shoulder joint infection
- Axillary nerve palsy
- Deltoid dysfunction
- Neuropathic arthropathy
- Irreparable rotator cuff tear is a contraindication to glenoid resurfacing.

CHALLENGES

- Glenoid Erosion
  - Posterior Erosion
  - Superior Erosion
- Shoulder arthritis
  - Limited ER
  - Posterior Glenoid Wear
  - Posterior Subluxation
- Cuff Tear Arthropathy
  - Static Superior Subluxation

GLENOID EROSION

Glenoid Wear Locations
- Posterior
- Superior
- Central
- Anterior
- Inferior

GLENOID EROSION CLASSIFICATION

- Walch Classification

FRONTAL PLANE

HORIZONTAL PLANE

Glenoid Issues:

- Glenoid bone loss
  - > 40% posterior glenoid wear in OA patients (Walch et al, 1999)
  - 37.5% glenoid wear in patients requiring rTSA (Frankle et al, 2006)

<table>
<thead>
<tr>
<th>Type of Glenoid</th>
<th>No. Patients</th>
<th>Mean Age (y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>60</td>
<td>62</td>
</tr>
<tr>
<td>A2</td>
<td>10</td>
<td>71</td>
</tr>
<tr>
<td>B1</td>
<td>19</td>
<td>63</td>
</tr>
<tr>
<td>B2</td>
<td>17</td>
<td>73</td>
</tr>
<tr>
<td>C</td>
<td>10</td>
<td>61</td>
</tr>
<tr>
<td>Total</td>
<td>113</td>
<td>66.4</td>
</tr>
</tbody>
</table>

TREATMENT of BADLY WORN GLENOIDS

- Accept Altered Version
- Ream Anterior High Side
- Bone Graft
- Augmented Glenoid
ECCENTRIC REAMING

- Anterior Reaming possible if:
  - Depth of medullary canal > 15mm
  - AP glenoid diameter > 20mm

POSTERIOR BONE GRAFT

- Technically difficult
- Bone Resorption - loosening

POSTERIOR BONE GRAFTING

- Bone Resorption - loosening

POSTERIOR AUGMENTATION???

Augmented design is intended to minimize removal of anterior cortical bone when eccentric reaming of posteriorly worn glenoids to correct version.

Improved Outcomes ??
ANATOMIC REDEFINED

TSA Complications
- Instability - 1.2%
  - Excessive retro/anteversion
  - Head too small/too low
  - Subscap rupture
- Rotator Cuff Tear - 2%
  - Superior migration of HH
  - Glenoid loosening
- Infection 0.5%
- Heterotopic Ossification 10-45%
  - Does not affect outcome
- Peri-prosthetic fracture
  - 1% intraop, 0.5-2% post-op

GOOD PATIENT POSITIONING
ADEQUATE ANESTHESIA
ADEQUATE ASSISTANTS AND ARM HOLDERS
ADEQUATE INCISION
ADEQUATE HUMERAL RESECTION
EXTENSIVE SOFT TISSUE RELEASES
AXILLARY NERVE EXPOSURE/PROTECTION
PROPER RETRACTORS

EXPOSURE !!!

INITIAL EXPOSURE

MANAGEMENT OF SUBSCAP

GLENOID EXPOSURE
History of the Reverse

Paul Grammont
1st Generation - 1989

<table>
<thead>
<tr>
<th>Date</th>
<th>1990's</th>
<th>1990-00's</th>
<th>2007</th>
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<tbody>
<tr>
<td>Philosophy</td>
<td>Medialized COR</td>
<td>Lateralized COR</td>
<td>Next Generation</td>
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<tr>
<td>Complication</td>
<td>Scapular notching</td>
<td>Baseplate failures?</td>
<td></td>
</tr>
</tbody>
</table>
Grammont’s Rationale

1991 – Paul Grammont redesigned his initial reverse shoulder

- **Grammont’s Philosophy:**
  - Prevent superior humeral migration by reversing anatomic concavities
  - Center of rotation is shifted medially (improves glenoid fixation, by decreasing lever arm)
  - Humerus shifted inferiorly (tensions deltoid)
  - **Humerus is shifted medially (introduces scapular notching)**

Cuff Tear Arthropathy (CTA)

- Clinical Problem
  - Neer coined the term CTA in 1972
  - Arthritic, eroded/collapsed condition of the glenohumeral joint
  - Prolonged/progressive subacromial impingement
  - Massive, full thickness rotator cuff tears
  - Extreme pain and near complete loss of function
  - Expanding indications for Reverse (beyond CTA)

Contemporary Solutions
- Bipolar
- Hemiarthroplasty
- CTA Head (Hemiarthroplasty)
- Reverse Shoulder

Indications for a Reverse
- Cuff Tear Arthropathy
- Irreparable massive cuff tear in elderly
- Failed cuff surgery in the elderly
- Osteoarthritis with cuff tear in elderly
- Proximal humerus nonunions and malunions
- Acute proximal humerus fractures in elderly

Indications for RTSA
- Revision TSA – loose glenoid or failed cuff
- Inflammatory arthritis with severe cuff deficiency
- Tumor resection

Pseudoparalysis

No Joint destruction with humeral dissociation

Joint destruction with no dissociation

Contraindications for RTSA
- Infection
- Advanced glenoid destruction
- Incompetent deltoid
- Axillary nerve palsy
- Unrealistic Expectations
Humeral Dissociation From Glenoid

- Humeral has shifted in position due to RC deficiency
- Minimal joint destruction
- Complete loss of fulcrum

Neutralization of Deltoid Deforming Forces

- Reversed GH orientation with increased constraint of articulation
- Effective in neutralizing the destabilizing force of the deltoid
- Deltoid translational force is converted to rotational motion

Demonstration of Neutralization of Deltoid Deforming Force

Complications after RTSA:

- Acute
  - Hematoma
  - Infection
  - Nerve palsy
  - Instability
  - Fracture
  - CRPS/RSD

- Chronic
  - Scapular Notching
  - Instability
  - Infection
  - Stress Fracture
  - Component Failure
  - Poly Wear

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Patients</th>
<th>TP (preop/postop)</th>
<th>AP (preop/postop)</th>
<th>ER (preop/postop)</th>
<th>Average Arc of Motion (degrees)</th>
<th>Average Disabilities Score (preop/postop)</th>
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<tr>
<td>Triple et al.*</td>
<td>16</td>
<td>79/123</td>
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<td>Complete, 3/188</td>
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<td>54 (56 shoulders)</td>
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<td>41/414.4</td>
<td>124/11</td>
<td>Average, 36/300</td>
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<td>41/158</td>
<td>12/59</td>
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<td>20</td>
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<td>88/127</td>
<td>88/127</td>
<td>Complete, 22/350</td>
<td></td>
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</tbody>
</table>

- CRPS/RSD: Complete, 22/350
Complications after RTSA:

- Instability
- Stress Fracture

Therapy after TSA/Reverse TSA
- Abduction pillow for 3-4 weeks
- Immediate passive/assisted ROM motion
  - Define ER at time of surgery
- Gentle strengthening at 6 wks
- Full strengthening at 3 months
- Goal return to activities 4-6 months

Future Directions:

Subscapularis Sparing Approach to TSA

Brief Technique:

Activity after Subscap Sparing TSA
- Abduction pillow for 3 days
- Immediate active motion
- Immediate rehabilitation
- Running at 6 w
- All sports (cycling, climbing, water skiing, Ice skating, skiing,..) at 2-3 months
Pre-op X-rays:

Pre-op CT:

Case 1: Postop X-rays