Rotator Cuff

- Bony Anatomy
- Muscular/Tendinous Anatomy
- Blood Supply
- Innervation
- Biomechanics
- Rotator cuff disease
Bony Anatomy of Shoulder

- Scapula, Humerus, Clavicle
- Joints:
  - Sterno-clavicular
  - Acromio-clavicular
  - Scapulo-thoracic
  - Gleno-humeral
- Synchronized Scapulo-Thoracic Motion
Bony Anatomy
Bony Anatomy
Bone Density

- Greater tuberosity demineralization with rotator cuff tear
  - Dependent on chronicity of tear
    Cadet, J SES ‘08
  - May affect achor pullout

Proximal ant and middle GT strongest
Tingart AJ SM ‘04
Muscle/Tendon Anatomy

- **Attach Scapula to Humerus**
  - Rotator Cuff
    - Supraspinatous
    - Infraspinatous
    - Teres Minor
    - Subscapularis
  - Teres Major
  - Deltoid

- **Suspend Scapula from Trunk**
  - Trapezius, Pect Minor, Serratus Ant, Rhomboids, Levator Scap

- **Attach Trunk to Humerus**
  - Latissimus Dorsi, Pectoralis Major
Supraspinatous
Infraspinatous/Teres Minor
Rotator Cuff “Footprints”

- Insertion sites on humerus
- Of interest in rotator cuff repair and recreating “normal” anatomy
  - Single vs. Double row repairs
- Maximize coverage
Subscapularis Footprint

Richards et al.
Arthroscopy ‘07

A = 39.5 mm
B = 16.0 mm

Ide et al., Arthroscopy ‘08
Supra- and Infra- Spinatous Footprints

A - commonly accepted model
B - Mochizuki et al., JBJS ‘08
TABLE I Measurements of the Footprints of the Supraspinatus and Infraspinatus

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Average and Standard Deviation (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supraspinatus</td>
<td></td>
</tr>
<tr>
<td>Maximum medial-to-lateral length</td>
<td>$6.9 \pm 1.4$</td>
</tr>
<tr>
<td>Anteroposterior width of medial margin</td>
<td>$12.6 \pm 2.0$</td>
</tr>
<tr>
<td>Anteroposterior width of lateral margin</td>
<td>$1.3 \pm 1.4$</td>
</tr>
<tr>
<td>Infraspinatus</td>
<td></td>
</tr>
<tr>
<td>Maximum medial-to-lateral length</td>
<td>$10.2 \pm 1.6$</td>
</tr>
<tr>
<td>Anteroposterior width of medial margin</td>
<td>$20.2 \pm 6.2$</td>
</tr>
<tr>
<td>Anteroposterior width of lateral margin</td>
<td>$32.7 \pm 3.4$</td>
</tr>
<tr>
<td>Articular capsule</td>
<td></td>
</tr>
<tr>
<td>Medial-to-lateral length at posterior edge of supraspinatus footprint</td>
<td>$4.5 \pm 0.5$</td>
</tr>
</tbody>
</table>

Mochizuki et al., JBJS ‘08
Rotator Cuff “Layers”

- Layer 1: thin 1mm, coracohumeral ligament
- Layer 2: 3-4mm, tendon fibers
- Layer 3: 3mm, 45 deg tendon fibers
- Layer 4: connective tissue
- Layer 5: 1-2mm, capsular tissue

Clark and Harryman, JBJS ‘92
Vascularity of Rotator Cuff: “Macro” Circulation

Fig. 1
Schematic of the anterior part of the shoulder, demonstrating the consistent vascular contributions to the gleno-humeral capsule from the anterior circumflex artery. Branches run deep to the subscapularis and travel medially to supply the anterior part of the lateral aspect of the capsule. Also depicted is an inconsistent vessel from the circumflex scapular artery passing anterior to the scapula to supply portions of the anterior part of the medial aspect of the capsule.
“Micro” Circulation

Biberthaler, JBJS ‘03

Affect of exercise and age
Rudzki, JSES ‘08
“Watershed” Areas

Fig. 7
Gross specimen of a shoulder, sectioned in the coronal plane with the humeral head removed and the capsular insertions maintained, showing the inside of the anterior aspect of the capsule. Note the proximity of the hypovascular zone (arrow) to the rolled intra-articular subscapularis tendon (S) and the humeral insertion (arrowheads).

Subscapularis hypovascular zone
Andaray, JBJS ’02
“Watershed” Areas

A : Supraspinatous hypovascular zone
Rotator Cuff Innervation

- Suprascapular Nerve
  - Supraspinatus
  - Infraspinatus

- Axillary Nerve
  - Teres Minor
  - ? Subscapularis (variable)

- Upper and Lower Subscapular Nerves
  - Subscapularis
Suprascapular Nerve

- 2 sites of compression/traction injury:
  - Suprascapular notch
  - Spinoglenoid notch – ganglion cyst
Axillary Nerve

Arthroscopic position between 5:30 & 6:00 inf border of sub-Scapularis

Yoo et al, Arthroscopy ‘07
Subscapular Nerves

- Upper – Posterior cord
- Lower – Variable (post cord, axillary, thoraco-dorsal)
Biomechanics

- Balance & Stability
Biomechanics

1º Function to Balance Force Couples:
- Coronal Plane: Deltoid vs Inferior Cuff
Force Couples

- Transverse plane force couple
  - Subscap vs infraspinatous/teres m

\[ \Sigma M_O = O = l x R - S x r \]
\[ \therefore l x R = S x r \]
Rotator Cable

- “Suspension Bridge” theory
- Maintain function in presence of rotator cuff tear or partial surgical repair
Rotator Cuff Pathology

- **Intrinsic Factors**
  - Vascularity – decreases with age
  - Gender (male>female)

- **Extrinsic**
  - Impingement – external vs internal
  - Tensile overload

- **Tendinosis**
Intrinsic Factors

- Watershed areas of blood flow
- Age – greater incidence and size with increasing age
  - 50% bil cuff tear after age 66
  - >60 yo, 30% tear
  
  Lehman, 1995

- ↑ type III collagen, GAGs, apoptosis

The Demographic and Morphological Features of Rotator Cuff Disease

A Comparison of Asymptomatic and Symptomatic Shoulders

By Ken Yamaguchi, MD, Konstantinos Ditsios, MD, William D. Middleton, MD, Charles F. Hildebolt, PhD, Leesa M. Galatz, MD, and Sharlene A. Teeple, MD

Investigation performed at the Department of Orthopaedic Surgery and the Department of Diagnostic Radiology, MIR Institute of Radiology, Barnes-Jewish Hospital, Washington University School of Medicine, St. Louis, Missouri
Extrinsic Factors

- **Subacromial Impingement – Neer**
  - 3 Stages: inflammation, fibrosis, frank tear

- **Acromial morphology**
  - Type III acromion cause of cuff tear or effect of aging?

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The relative importance of acromial morphology and age with respect to rotator cuff pathology

Thomas J. Gill, MD, Elizabeth McIrvin, BS, Mininder S. Kocher, MD, Karen Homa, MS, Scott D. Mair, MD, and Richard J. Hawkins, MD, Boston, Mass., Vail, Colo., and Lexington, Ky
Extrinsic Factors

- Internal Impingement (Throwers)
  - GI RD vs anterior microinstability
Extrinsic Factors

- Coracoid Impingement
  - Association with Subscapularis tears

5 vs 10 mm for subscap tear
Richards, Burkhart, Campbell
Arthroscopy, 2005
Tensile Overload

- **Windup:** little EMG activity

- **Early cocking:** trap & serratus protract/up rotate scapula, deltoid & supraspin abduct

- **Late cocking:** IGHL static restraint, scap & cuff active
  - Cuff 49-99% of max vol isometric contraction (baseball)

- **Acceleration:** 14,000 in-lb @6100 deg/sec, 860 N compressive force, pect/lat/subscap/scap active

- **Follow-through:** deceleration using teres minor, post delt, trap/serratus/rhomboids
  - Cuff 37-84% MVIC (baseball)

Andrews, sports Med ’09
Summary

- Shoulder motions are complex, involving multiple articulations.
- Rotator cuff muscles are active force couples for stabilization, and can be subject to high tensile forces.
- Rotator cuff pathology is multifactorial, and appears to be, to some degree, inevitable.
- Understanding anatomy and biology will hopefully make us better surgeons.
Thank You