Rotator Cuff Tears in Athletes

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Introduction

- 1843 - Rupture first described by J.G. Smith in London Medical Gazette
- 1934 - Codman’s classic monograph established basis for modern understanding

Anatomy

- Supraspinatus suprascapular
- Infraspinatus suprascapular
- Teres minor axillary
- Subscapularis upper subscapular
**Acromial Morphology**  
*Bigliani, Morrison*

- Type III
  - High association with full-thickness tears
  - 73% tears had Type III, 24% II, 3% I
- Age more important than morphology *(Gill, 2002)*

**Coraco-Acromial Arch**

- C-A ligament prevents superior migration
- Supraspinatus, biceps pass beneath
- Repetitive humeral impact causes spurs
- Neer
  - Spurs are “traction osteophytes”
  - ? Does acromial morphology change with age

**Biomechanics**  
*Soslowsky, 1997*

- Depress humeral head
- Counteract force of deltoid and pectoralis
- Adds power to glenohumeral elevation and rotation
- Centers HH in glenoid cavity
- Dynamic stabilizer
- Stabilization in AP and cranio-caudal direction
Impingement Anatomy

- Coraco-acromial arch
  - “outlet impingement”
- Acromial morphology
- Subacromial / subdeltoid bursa
- RTC tendons
- LHB through rotator interval
- Greater tuberosity
- A-C Joint

Mechanism of Outlet Impingement

- Cause or effect of RTC disease
- Eccentric overload
- RTC fiber failure
- Proximal migration of humeral head
- Impingement under coraco-acromial arch
- Cuff tear

Internal Impingement

- Jobe, Walch (JSES, 1992)
- Postero-superior labrum vs. posterior cuff
- “Arthroscopic impingement test”
- Throwers
- Pain with ERA
- Debridement
- Rotational osteotomy
Internal Impingement

- Result of increased glenohumeral ROM (ABD, ER)
- Hyperangulation with throwing
  - fatigue
  - improper mechanics
  - arm lags behind scapula during acceleration

Internal Impingement and Instability

- Jobe - increased anterior humeral translation intensifies internal impingement
- Walch - internal impingement not possible in setting of anterior instability

Internal Impingement: Treatment

- Non-operative
- Proper throwing mechanics
- Concentric and eccentric strengthening of the cuff and scapular stabilizers
- Avoid stretching the anterior capsule
- Arthroscopy
  - rotational humeral osteotomy
Impingement Pathology: Neer's Three Stages

<table>
<thead>
<tr>
<th>Stage</th>
<th>Age</th>
<th>Pathology</th>
<th>Course</th>
<th>Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>&lt; 25</td>
<td>edema, hemorrhage</td>
<td>reversible</td>
<td>conservative</td>
</tr>
<tr>
<td>II</td>
<td>25-40</td>
<td>fibrosis, tendinitis</td>
<td>activity pain</td>
<td>P.T. / O.R.</td>
</tr>
<tr>
<td>III</td>
<td>&gt; 40</td>
<td>A-C spur, RTC tear</td>
<td>disability</td>
<td>ASD / repair</td>
</tr>
</tbody>
</table>

Impingement

- Age - not in 20’s
- Overhead athletes
  - lower age restrictions
- Weight lifters
- Occupational
  - toll collectors
  - construction
  - electricians

Impingement History

- Insidious onset (important)
- Worse at night
  - “Does your shoulder wake you up?”
- Worse with overhead activities
  - “Can you take dishes off the top shelf?”
  - “Can you throw / serve a tennis ball?”
- Location of pain - referred to deltoid insertion
Impingement: History

- Remember…very RARE under 30 years old!

Impingement Examination

- Atrophy of fossae
- Neer test
  - pain with FF past 90 degrees
- Hawkins test
  - FF, ADD, IR
  - more sensitive
- Painful arc
- MUST exclude instability!

Associated Pathology

- AC arthritis
- Biceps
- Labral tears
- Loose bodies
- Os acromiale
AC Joint

- Point tenderness
- Cross-body adduction test
- Injection test

Instability

- Rotator cuff lesions may be associated or caused by instability
- Increase in passive ER
  » think subscapularis

Conventional Radiography

- True AP view
- Supraspinatus outlet view
- Axillary view
Radiographic Findings

- Cranial migration of HH
- Ca++
- Cystic lesions and osteopenia of the greater tuberosity
- Arthritic changes of glenohumeral joint
- Acromial morphology
- CA spurs
- Os acromiale

Other Radiologic Investigations

- Sonography
  - esp. post-surgical
- Arthrography
- Arthro-CT
- Limited indications for their use

Impingement Treatment

- Non-operative for at least 6 months
- Up to 3 injections
- NSAID’s
- Physical Therapy
**Impingement Test**

- Subacromial injection
- 9cc 1% Lidocaine, 1cc Celestone
- Posterior approach
- No pain, full strength - impingement
- No pain, weak - RTC tear
- Pain - wrong diagnosis!!
- AC joint, Biceps too…

**Impingement Program:**

**Theraband**

- Elastic bands with staged resistance / colors
- RTC / periscapular strengthening
- Exercises: ER, IR, Punch, Rows, Shrugs
- Very effective

**Role of Arthroscopy**

- Failure to improve after 6 months
- No associated instability
- Don’t forget biceps, A-C joint!
- Acromioplasty ... ?
Arthroscopic Approach

- Posterior “soft spot”
  » 2 cm inferior
  » 2 cm medial
- Anterior working portal
  » anterior to AC joint
- Pinch / shuck AP portal sites
  » confirm direction
- Aim for coracoid

ASD Tips

- Don’t be afraid to extend lateral portal and insert finger to palpate acromion and rotator cuff as final step if...
  » ? Adequacy of decompression
  » ? Degree of partial-thickness tear
  » Difficult case
  » Revision
  » Early in personal series

Mechanism of Rupture - Theories

- Impingement
- Vascular pathology
- Degenerative etiologies
- Attrition vs. tensile overload
Prevalence and Incidence

- Partial thickness tears 13 - 32% of cadavers
- Full thickness tears 5 - 27% of cadavers

Mechanism of Rupture: Attrition

- C-A arch can create bursal side tears
- Associated findings
  » acromial spurs
  » os acromiale

Mechanism of Articular Sided Tear

- Deep surface tear of SS tendon anteriorly
- Etiology
  » single traumatic episode
  » repetitive microtrauma leading to mechanical overload of the tendon
  » postero-superior gleno-humeral impingement in full ABD/ER (Walch)
Mechanism of Rupture:
Tensile Overload

- Articular side tears
- Intra-tendinous tears
- Ultimate cause of failure in majority
- Aging - weakens the tendon’s collagen
- Vascular - reduced nutrition
- Biologic strength vs. mechanical load

Natural History

- Healing of articular side partial tears
  » rarely occurs
  » synovial fluid
  » mechanical overload
  » retraction of avulsed tendon fibers
- Healing of bursal side tears is possible
  » Bridging with bursal scar tissue

Natural History of Ruptures

- “Once a partial tear occurs, progression to a full-thickness tear with retraction is inevitable unless the underlying cause can be eliminated”
  » Overuse (especially in athletes)
  » Primary attritional etiologies
Natural History

- Partial tear can act as a stress riser, causing future progression of the rupture (Blevins, 1997)
- Extension occurs with episode of acute pain
- Inflammatory phase - capsular stiffness
- Function can remain good
  » humeral head must remain centered

Classification

- Etiology
  » traumatic vs. atraumatic
- Chronicity
  » acute vs. chronic
- Patho-anatomic findings
  » retraction
  » quality of tissue
  » muscle function

Size:
How big is big?

- Cofield
  » small 0-1cm
  » medium 1-3cm
  » large 3-5cm
  » massive > 5cm
- Gerber
  » # tendons
Strength testing

- Position of near maximal muscle shortening
  - larger difference between normal and affected side then at mid-motion
- Assess close to starting position for lag signs

Rotator Cuff Tears

- Partial vs. full-thickness
- Can be very debilitating / painful
- Hx:
  - pain at night
  - overhead use
  - ball release

MRI and Arthro-MRI

- Pathology or treatment options remain unclear after standard clinical and conventional radiologic investigation
- Arthro-MRI
  - small lesions
  - undersurface partial-thickness tears
- Labral tears
Rotator Cuff Tears

- Incidence in sport unknown
- Athletes sustain tears but remain very functional

Incidence in Sports

- Weaver (1987)
  - 135 consecutive skiing-related shoulder injuries
  - 20% (27 patients) had acute RTC injury
- Blevins (1996)
  - 10 RTC injuries in football players aged 24-36
  - 2 contusions, 5 PT tears, 3 full-thickness tears
  - RTP at 4 months post surgery

DDx:

- Suprascapular nerve
  - Assess muscle contractility
- DJD
- Labral tears
- AC joint
Incidence in NFL:
Foulk et al, 2002

- 1983 - 1993, 28 teams
- 51 tears in 49 players
  - OL 22 (2 b/l)
  - LB 14
  - DB 6
  - DL 5
  - WR 2
  - RB 1
  - QB 1 (different than other overhead sports)

Rotator Cuff Tears

- Attritional tears vs. traumatic tear
  - bursal vs. articular-sided
- Literature
  - chronic, attritional tears
  - baseball pitchers
- Overhead sports
  - previous degenerative disease
  - pre-existing symptoms (Norwood)

Mechanism

- Etiology
  - 89% traumatic under 40 y.o. (Hawkins, 1999)
- Variables
  - Skills
  - Motions
  - Positions
Mechanism in Football

- Blunt trauma to ADD/IR arm
- Protective gear
  - different players subject to different degrees of injury
- Violent contraction of cuff vs. immovable object

Mechanism in NFL:
Foulk et al, 2002

<table>
<thead>
<tr>
<th>45 / 53 traumatic</th>
<th></th>
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<tbody>
<tr>
<td>Fall onto shoulder with another player on top</td>
<td>14</td>
</tr>
<tr>
<td>Unknown</td>
<td>11</td>
</tr>
<tr>
<td>Attrition</td>
<td>8</td>
</tr>
<tr>
<td>Fall on outstretched arm</td>
<td>6</td>
</tr>
<tr>
<td>ABD vs. resistance</td>
<td>5</td>
</tr>
<tr>
<td>Direct blow</td>
<td>3</td>
</tr>
<tr>
<td>Abducted extension</td>
<td>2</td>
</tr>
<tr>
<td>Blocking OL</td>
<td>2</td>
</tr>
<tr>
<td>Subluxation</td>
<td>1</td>
</tr>
<tr>
<td>Forced add w tackling</td>
<td>1</td>
</tr>
</tbody>
</table>

Clinical Evaluation

- History
  - mechanism
  - ? head, neck or neuro sx’s
- Strength
- Lift off / belly press test
- Increased passive ER
- r/o dislocation or peripheral nerve injury
Rotator Cuff Tear: Exam

- Impingement signs
- Weak on SS / ER resistance
- AROM vs. PROM
- ? Injection test
  - Pain vs. rupture
- Don’t be fooled by deltoid

Rotator Cuff Tear: Imaging

- Plain films  - r/o fx, DJD, Ca++
- MRI - confirms PE findings
  - Impingement
  - SLAP
  - Partial tears
  - Full-thickness tears
- Banks, 2000 - asymptomatic overhead athletes
  - 8/20 PT or full cuff tears
  - 5/20 Bennett’s lesions

Don’t Forget Subscapularis!

- Forceful hyperextension
- Forceful ER of adducted arm
- Arm tackling during football
- Gerber and Krushell, 1991
  - 16 tears
  - Lift-off test, belly press test
  - Increased passive ER
- Rx: Surgical repair  (Gerber, 1996)
Rotator Cuff Tear: Treatment

- Most full-thickness tears should be repaired
  - ? co-morbidities
  - timing in season
- Role of rehab
  - restore ROM pre-op, not “avoid surgery”
- Small tears tend to become large tears (Yamaguchi et al.)
- Large tears difficult/impossible to repair
  - higher rate of complications

Surgical Indications

- Significant partial-thickness RTC tear
- Full-thickness RTC tear
- Positive response to Impingement Test (Mair, Gill)
- ? Age (Morrison, JBJS, 1997)

What’s “Best”? ...

- Non-operative
- Arthroscopic
- “Mini-Open”
- Open

…does it matter?
Non-Operative Treatment in NFL:
Foulk et al, 2002

- 41 continued to play after dx
  - 22 without restrictions in performance
- Non-operative Rx - 4 players
  - RTP at 4.2 weeks (0-10 weeks)
  - 3/4 had full use with no pain
- “Acute repair may not be needed in athletes with preservation of function”

Arthroscopic Approach

- Goals - same as for open Rx
  - Strong repair
  - Early ROM
  - RTP guidelines
- Easy conversion to (mini) open
- Nicholson, 2001
  - 26% had “unexpected pathology”
  - addressed arthroscopically prior to repair

Arthroscopic Repair

Check tear mobility
Prepare Bone Surface

Arthroscopic Repair
Anchor placement

Retrieve Sutures
Pass Sutures Through Tendon

Retrieve and Tie Arthroscopic Knot

Arthroscopic Repair

Final repair
? Acromioplasty

- Evaluate at time of diagnostic arthroscopy
- NOT routine in acute setting in young players
- Bursectomy and synovectomy

Arthroscopic Repair

- Tauro, 1998
  - 53 patients - 36 excellent, 13 good, 1 fair, 3 poor (UCLA)
  - Minimum of 2 years follow-up
- Gartsman, 2000
  - 73 shoulders
  - 90% good / excellent satisfaction, ASES score
  - VAS pain from 7.6 to 1.4
  - SF-36, Constant p<0.05

Arthroscopic Outcomes

Ball et al, AAOS, 2002

- 20 consecutive patients
- Chronic, retracted
- U/S
- “Excellent results”
- By the way … 90% disruption!
Advantages of Arthroscopy

- Access to glenohumeral joint
  - 76% pathology (Miller and Savoie)
- No detachment of deltoid
- Less soft tissue dissection
- Small incisions
- Less stiffness than mini-open
  - Nicholson, 2000

? Advantages of Arthroscopy

- Decreased post op pain (?)
- Earlier restoration of ROM (?)
  - Nottage, AAOS, 2001
  - Weber, AANA, 2001
- Faster rehab (?)
- Faster return to play (?)

Disadvantages of Arthroscopy for Football

- Difficult to use tendon gripping techniques
  - Mason-Allen (Gerber, 1994)
- ? Anchors as strong as tunnels
  - Hecker 1993
  - Reed 1996
  - Schlegel, Gill et al.
- Strength / integrity of repair
Mini-Open Approach

- ...What is it?!
- "Arthroscopically assisted"
- Extend lateral portal, skin flaps, split deltoid
- Indication (Blevins and Warren, 1995)
  - symptomatic tear with < 2 cm retraction
  - full thickness
  - 1 to 3 cm in length
  - good soft tissue

Mini-Open Results

- Park et al, 2000
  - 110 consecutive cases
  - 96% excellent or satisfactory results
  - Unsatisfactory results
    - 3 of 4 had A-C pain
- Cordasco, 2001
  - 65 patients at 2 - 7 years
  - SST 8.7 - 10.9
  - UCLA 17 - 33
  - Constant 75 - 95
  - 91% “successful”

Mini-Open Results

- Nicholson, 2001
  - 54 shoulders
  - 2.7 year f/u
  - ASES, SST, VAS all improved
  - 8 stiff, 6 requiring release
  - partial-thickness, bursal sided, young patients
- Remember, most will have thick deltoid
Open Repair

- Preserve the deltoid!
- Athletic activity limited until deltoid heals
- Deltoid pull-off is avoidable and catastrophic
- Best for 2 – 3 tendon tears

Open Repair in NFL:
Foulk et al, 2002

- 46 (90%) repaired, 1 debrided
  - 50% had acromioplasty despite traumatic etiology
  - 41 / 44 RTP at 20.8 weeks (16–30 weeks)
  - 41 / 41 had full use
  - 39 / 41 normal strength
  - 31 / 41 residual pain
- 3 ended careers

Complications
(Gill 2000, Post 1990)

- Hematoma
- Infection
- Axillary and suprascapular nerve lesions
- Rupture of deltoid origin
- Acromion fracture
- Brachial plexus palsies due to patient positioning
- Persistent pain
- Restricted ROM
- Reduced strength
- Re-rupture
Avoiding Complications

- Preserve deltoid
- Avoid excessive acromioplasty
- Mobilize tendon carefully (Warner, 1992)
  » tension free repair
- CA ligament - know if you can fix RTC
- Irrigate, “move along”

Arthroscopic Repair

- Tauro 1998
  » 49/53 G/E
- Gartsman 1998
  » 84% G/E
  » No long term studies

Arthroscopic Repair: Technical Issues

- Tear morphology
- Tendon mobilization
- Anchor placement
- Suture passage
- Knot tying / strength
- Bone quality
- Skill level
- Time
### Irreparable Tears

- Know pre-operatively, when possible
- Non-operative treatment
- Debridement alone
- Tendon transfers
  - Latissimus dorsi
  - Pectoralis major

### Rehabilitation Principles

- Phase I  Passive ROM
- Phase II  Active ROM
- Phase III  Resistive

- Remember…only 28% healing at 3 months!
  - Schlegel, Gill, 2002

### Rehabilitation Guidelines

- PROM before AROM  0-6 weeks
- AROM before strengthening  6-12 weeks
- Strengthening  12-24 weeks
- Return to play  24 weeks
- Maximize strength  …1 year!
What should we be doing in 2009?

Partial RTC Tears

- Tensile lesion on articular side of cuff
  - cuff tries to resist the ADD, IR, and GH distraction forces during deceleration
- Eccentric tensile overload
  - partial undersurface tear forms due to repetitive microtrauma in region of supraspinatus

Rotator Cuff

- Tenderness over supraspinatus and/or infraspinatus
- Gross weakness seldom present
  - especially in elite thrower
- Rx: rehab, rehab, rehab….
  - cuff strengthening
  - especially posterior eccentric exercises
Outcomes: Arthroscopic vs. Open

- Gartsman 1998
- Tauro 1998
- Stollsmeyer and Savoie 1998
- Weber, AANA, 2001

Indications: Arthroscopic vs. Open

- Expectations
  - Is minimally invasive approach important to player?
- Mechanical properties of cuff
- Surgeon’s experience
- Reported outcomes - ? Same
- Chief complaint
  - pain vs. strength / function

Arthroscopic Recommendations

- No valor in poor arthroscopic repair
- Anterolateral portal
- Mobilize cuff !!!
- Address delaminations
- Margin convergence if possible
- Horizontal mattress sutures
- ? Double row fixation technique
- ….lastly…..
Recommendations

• Do what you do best
• When in doubt, open it
• “Mini-open” ... so what?

If You Open…
Respect the Deltoid

Technical Points
(Gerber, 1998)

• Mason-Allen suture technique
• Cortical bone augmentation
• #3 Ethibond
• Tunnels 10mm distal to GT
  » 10mm apart (Caldwell, 1997)
Double Row Indications

- Tears > 2cm
- Contact athletes
- Overhead athletes
- Poor tendon quality
- Complex tear pattern

Lateral Anchor Preparation

Cortical Fixation
Tensioning

Tensioning

Suture Bridge / Double Row

Suture Bridge / Double Row

Important Factors

- Tear size
- Tissue quality
- Tendon mobility
- Bone quality
- ? Position played
- …Football...

Your repair is here!
My Recommendations for Contact Sports

<table>
<thead>
<tr>
<th>Arthroscopic</th>
<th>Open</th>
</tr>
</thead>
<tbody>
<tr>
<td>• &lt; 4-5 cm</td>
<td>• cuff avulsions</td>
</tr>
<tr>
<td>• acute</td>
<td>• chronic, retracted</td>
</tr>
<tr>
<td>• good quality tendon</td>
<td>• significant delamination</td>
</tr>
<tr>
<td>• minimal delamination</td>
<td>• weak more than pain</td>
</tr>
<tr>
<td>• pain more than weak</td>
<td></td>
</tr>
<tr>
<td>• little to moderate retraction</td>
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Future Study

- Treatment of massive cuff lesions
- Pre-operative assessment of reparability
- How to improve muscle function when fatty degeneration exists?
- Degeneration of the tendon itself
  - Scaffold?
  - PRP?
- Tendon transfers
- Return to play...

Thank you