THE MANAGEMENT of SLAP & BICEPS TENDON INJURIES in the OVERHEAD ATHLETE

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  - Orthopaedic Learning Center BOD
  - MLB Medical Advisory Committee
  - MLB Elbow Research Study Group
  - AOSSM Vice-President, Board of Directors

Shoulder Injury in the Athlete

History
- 27 y.o. RHD MLB pitcher
- Chronic, progressive right shoulder pain while throwing
- Worsened acutely
- Pain is deep and post
- Unable to throw

Exam
- 30 deg. less ABD, FF
- 25 deg. less INT ROT
- + Hawkin's Test
- + O’ Brien’s & DLS Tests
- + mild-mod supraspinatus weakness
Diagnosis: SLAP Tear

Shoulder Injury in the Athlete

... a need to repair!
• clinical evaluation broadened
• surgical techniques evolved
• early reports suggested G/E results
(Yoneda, 1991; Savioe, 1992; Pagnani, 1995; Snyder, 2003; Cole, 2010; Brox, 2012)

SLAP Tear in the Overhead Athlete . . .

Look more closely at existing data . . .

- Small study populations
- Heterogeneous groups
- Inconsistent follow up
- Minimal assessment of Return to Pre-injury Level of Play
More recent data is less optimistic . . .

- Persistent pain and stiffness (Weber, 2007; Franceschi, 2008)
- Difficulty returning to preinjury level (Cohen, 2012)

“Leave it alone?”

Less optimistic results due to . . .

- Diagnostic Uncertainty
  Is it what we think?
- Equivocal Indications
  Should we fix it?
- Early Surgical Techniques
  How do we fix it?
- Narrow Postop Rehab
  How do we rehab it?
- Imprecise Scoring Assessment
  How do we determine success?
SLAP Tear in the Overhead Athlete

IS IT WHAT WE THINK? ... Diagnostic Uncertainty

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Physical Exam - “SLAP” Tests

- Clunk Test (Andrews)
- Resisted Supination Ext Rot Test (Andrews)
- Crank Test (Liu)
- Biceps Load Test I and II (Kim)
- Anterior Slide Test (Kibler)
- Mayo Shear Test (O’ Driscoll)
- Active Compression Test (O’ Brien)
- Relocation Test (Jobe)
- Forced Shoulder Abd and Elbow Flex (Nakagawa)
- Modified Dynamic Labral Shear Test (Kibler)

“No single test or combination of tests reliably predicts a SLAP”
McFarland, AJSM, 2002; Stetson, AJSM, 2002; Snyder, AJSM 2003; Kuhn, 2003; Parentis, AJSM, 2006

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Imaging – MR

- With or without enhancement?
- Asymptomatic changes exist in the superior labrum with age and in certain populations like overhead athletes
- Does not precisely define pathology

Ricchetti, JSES, 2013
Connolly, JBJS, 2013
Reuss, JSES, 2006
Waldt, AJR, 2004

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SLAP Tears: Imaging Pearls
- Contrast undercutting the superior labrum at and/or posterior to the biceps root >2mm
- Detachment of superior labrum from glenoid
- Irregular borders of sublabral recess anterior to biceps anchor
- Peri-labral cyst formation

SLAP Tears: Arthroscopy Pearls
Need to Assess:
- Labral-Glenoid interface
- Tissue quality
- Presence of exposed non-articular glenoid
- Mobility of labrum

IS IT WHAT WE THINK?
. . . Diagnostic evaluation of SLAP tears may often be ambiguous
SLAP Tear in the Overhead Athlete

SHOULD WE FIX IT?

... Equivocal Indications

Superior Labrum is Important for the Overhead Athlete!

- Biceps attachment site
- Deepens glenoid
- Distributes contact pressure between humerus & glenoid
  - Washer Effect
- Attachment site for glenohumeral ligaments & capsule
- Pressure sensor for proprioception

Harryman, 1992
Pagnani, 1995
Lee, 2005
Veeger, 2007
Lee, 2008
Kibler, 2011
Predictable Series of Events in Throwers

- Progressive Osseous changes
- Scapular and Cuff weakness
- Post. Soft Tissue contracture
- Post-sup. Instability in ABD and EXT ROT.
- Peel-back mechanism occurs
- SLAP, Biceps & Post-Sup Cuff Injury occur

General population is not routinely exposed to this “cascade of events” ... but throwers are!

Nonoperative Treatment is an appropriate option . . .

Edwards, Ahmad, Levine et al AJSM, 2010
Fedoriw, Ramkumar, Lintner et al AJSM, 2014

Nonoperative Treatment of SLAP Tears

- 39 patients with clinically documented SLAP
- Patient-derived Validated Scores: SF-36, VAS, ASES, SST, EuroQol
- Nonoperative Pt Group (19 pts) –
  - All with improvements in pain, function and quality of life
  - Return to Play: 74% overall, 66% of overhead athletes

“A trial of nonoperative treatment should be considered in patients with a SLAP tear”

Edwards, Ahmad, Levine et al AJSM, 2010
Return to Play After Treatment of SLAP Tears in Pro Baseball Players

- 68 players with clinically documented SLAP
- "Return to Play" (RTP) vs. "Return to Prior Performance" (RPP)
  - 21 pitchers successful nonop: 40% RTP; 22% RPP
  - 27 pitchers required operative tx: 48% RTP; 7% RPP

Fedoriw, Ramkumar, Lintner et al. AJSM, 2014

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SLAP Tear in the Overhead Athlete...

Indications for operative treatment:
- overhead athlete
- persistent symptoms
- consistent exam
- consistent imaging
- failure of nonop tx

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SHOULD WE FIX IT?

. . . Equivocal Indications
. . . Asymptomatic?
. . . Symptomatic, Rehabable?
. . . Symptomatic, Surgical?
HOW DO WE FIX THAT?

... Early operative techniques may have been too constraining

General Principles of Surgical Treatment
- Arthroscopic Assessment
- Debride vs Repair
- Implant Selection
- Arthroscopic Approach
- Implant Location
- Concomitant Pathology

Overconstraining the biceps!
**Arthroscopic Evaluation**

**Superior Labrum**

- Meniscoid (Snyder, 1998)
- Labral-Articular Interface (Huber, 1997)
- Mobile Superior Labrum (Davidson, 2004)
- “Peel-back” (Burkhart, 1998; Andrews, 2004)

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**Debride vs Repair**

**Repair if . . .**

- Good quality tissue
- Hemorrhage/granulation tissue at interface
- Exposed non-articular glenoid
- Lift off >3-5mm
- “Peel-back” in overhead athlete

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**IMPLANT SELECTION**

- Material (metallic vs bioabsorbable vs biocomposite)
- Load to Failure
- Fatigue Properties
- Creep of Bioabsorbables
- Incidence of Inflammatory Response
- Size of Drill Hole
- Ease of Insertion
- Ease of Suture Sliding
- Suture Type (braided vs enhanced; permanent vs absorbable)

Barber, JAANA, 2003
Gerber, JAANA, 2003
**ARTHROSCOPIC APPROACH**

Arthroscopic fixation of SLAP Lesions through the Mid-Lateral Trans-Muscular Portal: An Anatomic Study

Ciccotti, Kuri, Leland et al, Arthroscopy, 2010

**IMPLANT LOCATION**

DiRaimondo et al, AJSM, 2004
Morgan et al, Arthroscopy, 2008
Yoo et al, JSES, 2008

**SLAP Repair in the Overhead Athlete**

23 yo LHD Minor League Pitcher

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CONCOMITANT PATHOLOGY

- Snyder – 43% with biceps and rotator cuff tearing
  - 15% with instability
- Maffet – 48% with biceps and rotator cuff tearing
  - 20% with instability
- Pagnani – 18% with biceps and rotator cuff tearing

. . . Especially the biceps!

BICEPS INJURY IN THE OVERHEAD ATHLETE

Biceps Injury . . .

SLAP & BICEPS INJURY IN THE OVERHEAD ATHLETE

Clinical Utility of Traditional and New Tests in the Diagnosis of Biceps Tendon Injuries and SLAP Lesions

- 325 consecutive patients with shoulder pain underwent standardized clinical evaluation (6 traditional and 2 new tests)
- Clinical exam correlated with surgical findings
- Sensitivity, specificity, accuracy, +/- predictive value, and +/- likelihood ratio were calculated

Kibler, Sciaccia, Hester et al, 2009
Superior Labrum – Modified DLS

Modified DLS Test was most accurate (0.84) and highest + likelihood ratio (31.57)

Modified DLS & O’Brien’s together provided best prediction

Kibler, Sciascia, Hester et al, 2009

Biceps – Upper Cut

Upper Cut Test was most accurate (.077) and highest + likelihood ratio (3.38)

Upper Cut & Speed’s Tests together high clinical prediction

Kibler, Sciascia, Hester et al, 2009

ARTHROSCOPIC CLUES

BICEPS
- Erythema
- Hemorrhage
- Fiber disruption
- Longitudinal splits
- Pull biceps into joint
Biceps Injury in the Overhead Athlete

Operative Treatment Technique Options
- Biceps Debridement
- Biceps Tenotomy
- Biceps Tenodesis (Arthroscopic/Open)
  - Intra-artic Soft Tissue
  - Supra-Pect
  - Sub-Pect

Can the Biceps/Superior Labrum be torn TOO much to repair? . . . should we tenodese? . . . for just failed SLAP Repair?
(Walch, 2010; Hawkins, 2011; Romeo, 2014)

SLAP Repair + Biceps Debridement
SLAP Repair + Biceps Tenodesis
SLAP Repair + Biceps Tenotomy
Biceps Tenodesis/Tenotomy Alone
(?Primary SLAP vs. Failed SLAP Repair)
SLAP & Biceps Injury in the Overhead Athlete

General Principles of Operative Treatment
- Assess superior labral tear
- Assess biceps tendon
- Tenodese biceps
  - Variety of Techniques (Subpect)
  - +/- Repair SLAP tear
  - ...? poorer results in throwers with SLAP Repair and Biceps Tenodesis (Erickson, Romeo et al, 2017)

DEBATE CONTINUES
- Type of implants
  - Suture vs. knotless
- Number of implants
  - 1 vs. 2 vs. 3/more
- Location of implants
  - Ant + post vs. only post to biceps
- Suture type
  - Absorbable/nonabsorbable/enhanced
- Suture placement
  - Simple vs. mattress
- Concomitant Pathology...especially the biceps method of treatment
  - ...there’s no final word yet!

SLAP Tear in the Overhead Athlete

HOW DO WE FIX THAT?
...operative techniques are more precise...but the SLAP vs. Biceps debate continues
SLAP Tear in the Overhead Athlete

HOW DO WE REHAB IT POSTOP?

... Previously, narrow postop rehab focused primarily on glenohumeral joint

SLAP Tear in the Overhead Athlete

SCAPULA  Shoulder ROM

CORE

Hip and Legs

...Kinetic Chain...

Treatment of the Throwing Shoulder

- **Short Toss/Long Toss/Mound Programs**
  - Tossing – progressive from 30’ to 180’
  - Mound – fastballs first with increasing effort; then off-speed pitches
  - Focus on technique throughout

Fleisig et al, J Ortho Sports Phy Ther 2011
Reinold et al, J Ortho Sports Phy Ther 2002
Slenker et al, AJSM 2014
Treatment of the Throwing Shoulder

Fielding Programs
- Grounders & Fly Balls to player
- Full Fielding
- Rehab Starts
  - 5 inning
  - 7 innings
  - 9 innings
- Return to Play

Fleisig et al, J Ortho Sports Phy Ther 2011
Reinold et al, J Ortho Sports Phy Ther 2002
Slenker et al, AJSM 2014

Treatment of the Throwing Shoulder

Hitting Programs
- Dry Swings
- Hitting off tee
- Front Toss
- Live Hitting
- Batting Practice
- Return to Play

Fleisig et al, J Ortho Sports Phy Ther 2011
Reinold et al, J Ortho Sports Phy Ther 2002
Slenker et al, AJSM 2014

SLAP Tear in the Overhead Athlete

Return to Play After Type II SLAP Lesion Repairs in Athletes (Sayde, Cohen, Cicotti et al, CORR, 2012)
- Systematic Review – 1950 to 2010
- 506 patients with Type II SLAP Repair
- Minimum 2 yr follow-up
- 83% G/E subjectively
- 63% overhead athletes return to prior level
- Tremendous variation in surgical technique, postop rehab and outcome assessment
SLAP Tear in the Overhead Athlete

Deficiencies in Pitching Biomechanics in Baseball Players with History of SLAP Repair
(Loughlin, Fleisig, Cain, Dugas et al, AJSM, 2014)

- 65 pitchers:
  - 13 collegiate and pro after successful SLAP Repair
  - 52 healthy controls
- 3-D Motion Analysis while throwing fastballs
- SLAP Repair with less shoulder horizontal add, shoulder ext rot, and forward trunk tilt
- Authors recommend postop rehab focused on correcting above noted deficiencies

HOW DO WE REHAB IT POSTOP?

... Postop rehab should focus on entire athlete – Kinetic Chain!

HOW DO WE DETERMINE SUCCESS?

... Previously, our postop scoring assessment has been imprecise
SLAP Tear in the Overhead Athlete

SLAP Injury...

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SLAP Tear in the Overhead Athlete

Results of Arthroscopic Repair of Type II SLAP Lesions in Overhead Athletes Return to Preinjury Playing Level
Brian Neuman MD, Brittany Boisvert MD, Brian Reiter MD, Kevin Lawson BS, Michael Cicotti MD, Steven Cohen MD

- 30 overhead athletes with isolated Type II SLAP
- Avg ASES Score (0-100): 87.1
- Avg KJOC Score (0-100): 71.6
- ASES focuses on ADL's and may give a falsely elevated success rate
- The KJOC score better examines the demands of elite overhead athletes
- The outcome measures that we use impact our perception of success

AJSM, 2011

SLAP & Biceps Injury in the Overhead Athlete

SLAP & Biceps Tear...

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Thomas Jefferson University
SLAP Tear in the Overhead Athlete

**Research Data**
- Electromyographic
- Biomechanical

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**Postop Restoration of UE Motion & Neuromusc. Control During the Overhand Pitch: Evaluation of Tenodesis & Repair for SLAP Tears**
(Charmers, Bush-Joseph, Romeo et al, AJSM, 2014)

- 18 pitchers:
  - 6 S/P successful SLAP Repair; 5 S/P successful Subpect Biceps Tenodesis; 7 controls
  - Surface EMG & Motion Analysis while pitching
  - No differences in majority of pitching kinematics
  - **SLAP Repairs had altered thoracic rotation and lead knee flexion at front foot contact**

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**Role of the Superior Labrum After Biceps Tenodesis in Glenohumeral Stability**
(Strauss, Provencher, Bush-Joseph, Romeo et al, JSES, 2014)

- 20 cadaveric shoulders tested for translations:
  - At baseline
  - After creating Ant SLAP(10) and Post SLAP(10)
  - After Biceps Tenodesis (20) and SLAP Repair (20)
  - Biceps Tenodesis showed no significant improvement in stability compared to SLAP Tear
  - SLAP Repair restored Posterior and ABD/Max ER translations, but not Ant translation
  - Authors recommend biceps tenodesis as possible tx of SLAP Tear, but caution in throwers because of its inability to restore translational stability
SLAP Tear in the Overhead Athlete

Research Data

- Electromyographic
- Biomechanical
- Clinical

SLAP & Biceps Injury in the Overhead Athlete

Arthroscopic Treatment of Isolated Type II SLAP Lesions: Biceps Tenodesis as an Alternative to Reinsertion
Boileau et al, AJSM 2009

- 25 patients surgically treated for an isolated Type II SLAP tear
- Group 1: 10 pts with SLAP repair (avg age=37)
  Group 2: 15 pts with Tenodesis (avg age=52)
- Outcome: Repair – 40% satisfied
  Tenodesis – 93% satisfied
- Return to Play: Repair – 20%
  Tenodesis – 87%

SLAP & Biceps Injury in the Overhead Athlete

Superior Labral Anterior-Posterior (SLAP) Tears in the Military
Provencher et al, Sports Health 2016

- PubMed, Embase and MEDLINE database review from 1985 thru 2016
- Increased risk for SLAP tears in military personnel
- In high-demand, military pts under 36yrs, SLAP Repair is supported
**SLAP & Biceps Injury in the Overhead Athlete**

**Return to Play after Biceps Tenodesis in Major League Baseball Players**
Chalmers, Erickson, Verma, Romeo, OJSM 2017

- 17 professional baseball players with SLAP Tears underwent Biceps Tenodesis
- 12 pitchers; 5 position players
- Overall 35% (6/17) Returned to Play
- 80% (4/5) position players RTP
- 16% (2/12) pitchers RTP

**SLAP Tear in the Overhead Athlete**

**HOW DO WE DETERMINE SUCCESS?**

... thrower specific scoring allows a more accurate assessment of return to pre-injury play

**SLAP Tear in the Overhead Athlete**

... should we leave it alone?
... or fix it?
... or consider tenodesis?
Shoulder Injury in the Athlete

History
- 27 y.o. RHD MLB pitcher
- Chronic, progressive right shoulder pain while throwing
- Worsened acutely
- Pain is deep and post
- Unable to throw

Exam
- 30 deg. less ABD, FF
- 25 deg. less INT ROT
- + Hawkin’s Test
- + O’ Brien’s & DLS Tests
- + Upper Cut Test
- Cork-screwing with Single-leg Squat Test

Diagnosis: SLAP Tear + Biceps Injury

Treatment
- Nonoperative
  - No throwing x 6wks
  - Correct Kinetic Chain deficits
  - Progressive Tossing Program
  - But pain persisted
- Scope
  - Both SLAP + Biceps
  - SLAP Repair + SPBT
“Success is going from failure to failure without a loss of enthusiasm”

Winston Churchill

Leave it alone if . . .
- Clinically ambiguous
- Soft Indications
- Older patient
- Non-athlete
- Non-throwing, recreational athlete
- Some throwing athletes

Fix it if . . .
- Clinically straightforward
- Traumatic/repetitive micro-traumatic history
- Positive exam and imaging
- Clear-cut Indications
- High level overhead/throwing athlete
- Failed nonop tx

. . . SLAP Repair should not be abandoned in this population . . .
. . . but this may very well be a small percentage of SLAP tears overall!
**Tenodese it if . . .**

- Clinically significant biceps tendon symptoms
- Positive biceps tendon findings on exam
- Significant biceps tendon damage on imaging and arthroscopy
- Complex, degenerative superior labral tear
- Failed nonop tx
- ? Recurrent SLAP Tear in overhead athlete

. . . but this may very well be a small percentage of SLAP tears in throwers!

**SLAP & Biceps Injury in the Overhead Athlete**

- Is it what we think?
- Should we fix it?
- How do we fix it?
- How do we rehab it?
- How do we define success?

**Optimize results by . . .**

- Diagnostic Precision
- Specific Indications
- Nonconstraining Surgical Techniques
- Broad Postop Rehab
- Precise Outcome Assessment

...continued research...
THANK YOU.

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SLAP Tear in the Overhead Athlete
ARThROSCOPIC CLUES

SLAP
- Hemorrhage
- Granulation tissue
- Exposed non-articular glenoid
- Lift off >3-5mm
- “Peel-back” in overhead athlete

SLAP Tear in the Overhead Athlete

Clinical Utility of Traditional and New Tests in the Diagnosis of Biceps Tendon Injuries and SLAP Lesions
- 325 consecutive patients with shoulder pain underwent standardized clinical evaluation (6 traditional and 2 new tests)
- Clinical exam correlated with surgical findings
- Sensitivity, specificity, accuracy, +/- predictive value, and +/- likelihood ratio were calculated
  
  Kibler, Sciascia, Hester et al, 2009

BICEPS
- Speed’s
- Yergason’s
- Belly Press
- Bear Hug
- Upper Cut

... assess the scapula!

SLAP
- Anterior Slide
- Jobe
- Apprehension/Relocation
- O’Brien’s Active Compression
- Dynamic Labral Shear
- Modified DLS
**SLAP Tear in the Overhead Athlete**

**Superior Labrum – Modified DLS**

*Modified DLS Test* was most accurate (0.84) and highest + likelihood ratio (31.37).

*Modified DLS & O’Brien’s* together provided best prediction

Kibler, Sciascia, Hester et al, 2009

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**SLAP Tear in the Overhead Athlete**

**Biceps – Upper Cut**

*Upper Cut Test* was most accurate (.077) and highest + likelihood ratio (3.38);

*Upper Cut & Speed’s* together fairly high clinical prediction

Kibler, Sciascia, Hester et al, 2009

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**Nonoperative Treatment of SLAP Tears**

- 39 patients with clinically documented SLAP
- Minimum 1 yr follow-up
- Patient-derived Validated Scores: SF-36, VAS, ASES, SST, EuroQol
- Nonoperative Pt Group (19 pts) – all with improvements in pain, function and quality of life
- Return to Play in Nonop Group – 71% of all athletes; 66% of overhead athletes
- “A trial of nonoperative treatment should be considered in patients with a SLAP tear”

Edwards, Ahmad, Levine et al AJSM, 2010
Return to Play After Treatment of SLAP Tears in Pro Baseball Players

- 68 players with clinically documented SLAP retrospectively reviewed
- “Return to Play” (RTP) vs “Return to Prior Performance” (RPP)
- 21 pitchers successful nonop: 40% RTP; 22% RPP
- 27 pitchers required operative tx: 48% RTP; 7% RPP

Fedoreiw, Ramkumar, Lintner et al  AJSM, 2014

SLAP Tear in the Overhead Athlete

Outcome of Type II SLAP Repairs in Elite Overhead Athletes
Brian Neri MD, Neal ElAttrache MD, K Owsley MD, Karen Mohr PhD, Lewis Yocum MD

- 23 overhead athletes with Type II SLAP tears
- 57% (13/23) returned to pain-free pre-injury level at final follow-up
- ASES Scoring: 96% G/E
- KJOC Scoring: 52% G/E

AJSM, 2011

SLAP & Biceps Injury in the Overhead Athlete

Biceps Tenotomy vs. Tenodesis: A Systematic Review of Outcomes
Slenker et al, Arthroscopy 2012

- PubMed search from 1950 to 2011 for articles documenting outcome after either Biceps Tenotomy or Tenodesis
- 16 articles, 1132 procedures (433 Tenodeses and 699 Tenotomies)
- Tenodesis: 74% G/E; 24% postop pain; 8% cosmetic deformity
- Tenotomy: 72% G/E; 19% postop pain; 13% cosmetic deformity
Efficacy of Biceps Tenodesis in the Treatment of Failed SLAP Repairs
McCormick, Nwachukwu, Provencer et al, AJSM 2014
- 42 active military patients with failed SLAP Repair retrospectively reviewed
- Minimum 2 yr follow-up
- ASES, SANE, WOSI all increased postop
- 34 pts (81%) returned to active duty

Surgical Treatment of Isolated Type II SLAP Lesions: Repair vs. Biceps Tenodesis
Elk et al, JSES 2013
- 25 patients surgically treated for an isolated Type II SLAP tear
- Group 1: 10 pts with SLAP repair (avg age=31)
  Group 2: 15 pts with Tenodesis (avg age=47)
- Outcome: Repair – Postop ASES Score 93.5
  Tenodesis – Postop ASES Score 93
- Return to Prior Level: Repair – 60%
  Tenodesis – 73%

Return to Play After Type II SLAP Lesion Repairs in Athletes
(Sayde, Cohen, Cicicotti et al, CORR, 2012)
- Systematic Review – 1950 to 2010
- 506 patients with Type II SLAP Repair
- Minimum 2 yr follow-up
- 83% G/E subjectively
- 63% overhead athletes return to prior level
- Tremendous variation in postop rehab
SLAP Tear in the Overhead Athlete

Outcome of Type II SLAP Repairs in Elite Overhead Athletes
Brian Neri MD, Neal ElAttrache MD, K Owsley MD, Karen Mohr PhD, Lewis Yocum MD

• 23 overhead athletes with Type II SLAP tears
• 57% (13/23) returned to pain-free pre-injury level at final follow-up
• Inability to return correlated with the presence of partial thickness cuff tear
• ASES Scoring: 96% G/E
• KJOC Scoring: 52% G/E

The Experts . . .

SLAP Tear in the Overhead Athlete

Inter and Intraobserver Variability in Diagnosis and Treatment of SLAP Tears
(Gobezie et al, AJSM, 2008)

73 EXPERT surgeons queried with video clips on diagnosis and proposed treatment of SLAP:
• Normal labrum – 66.7% correct
• Type I – 60.3% correct
• Type II – 51.9% correct
• Type III – 23.3% correct
• Type IV – 60.3% correct