An Evidence-based Update on Management of Patients With Rotator Cuff Tears: Nonoperative and Postoperative Rehabilitation

Brian G. Leggin, PT, DPT, OCS
Andrew F. Kuntz, MD
Martin J. Kelley, PT, DPT, OCS

OBJECTIVES OF THIS SESSION

- Nonoperative Management of Rotator Cuff Tears
- Surgical Decision Making and Management
- Postoperative Rehabilitation

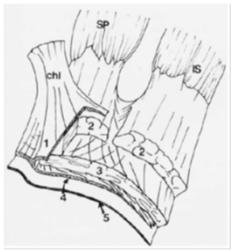
OBJECTIVES

OBJECTIVES

- Functional Anatomy and Biomechanics
- Pathophysiology of Rotator Cuff Disease
- Examination
- Nonoperative management

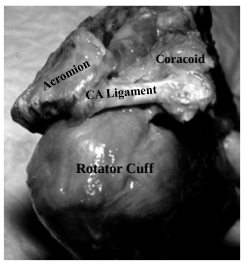
- 5 histologic layers
  1. large arterioles
  2. large bundles of tendon fibers
  3. smaller collagen bundles
  4. loose CT
  5. shoulder capsule

Clark, JBJS 1992



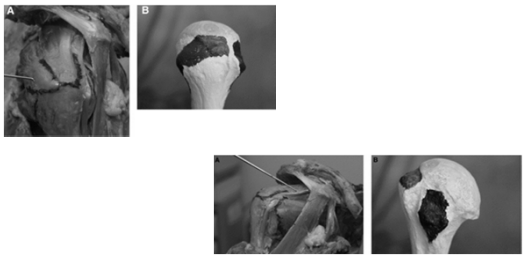
Shoulder Articulations
Subacromial Interface

- Elements
  - Coracoacromial Arch
  - Rotator Cuff
- Interface
  - Bursa



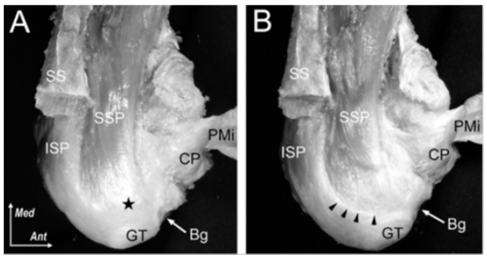
ROTATOR CUFF INSERTION

Curtis, *Arthroscopy*, 2006



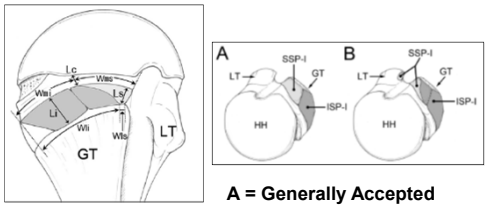
ROTATOR CUFF INSERTION

Mochizuki, *JBJS,* 2008



ROTATOR CUFF INSERTION

Mochizuki, *JBJS,* 2008



A = Generally Accepted
B = New Findings

Shoulder Girdle Musculature

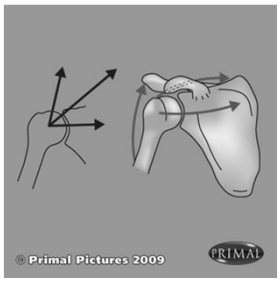
Rotator Cuff

Force Couples

- **Subscapularis**
- **Posterior Cuff**
  - **Infraspinatus**
  - **Teres Minor**
- **Humeral Head Centralizer**

Shoulder Girdle Musculature

Rotator Cuff



Rotator Cuff Disease

Natural History

- **One of the most prevalent musculoskeletal disorders**
- **Clinical presentation varies widely**
- **Some patients present with minimal impairments and functional limitations**
- **Others present with profound impairments and loss of function**

Rotator Cuff Disease
Natural History

- Rotator Cuff Tears in Asymptomatic Patients
  - Overall
    - Complete = 14%
    - Partial = 20%
  - Results by Age
    - >60 = 28% FT – 26% PT
    - 40-60 = 4% FT – 24% PT
    - <40 = 0% FT – 4% PT

Rotator Cuff Disease
Natural History

- Yamaguchi, *JBJS*, 2006
- Presence of rotator cuff disease highly correlated to age
- Average age:
  - No rotator cuff tear = 48.7 years
  - Unilateral rotator cuff tear = 58.7 years
  - Bilateral rotator cuff tear = 67.8 years
- 50% likelihood of bilateral tear after 66 years

Rotator Cuff Disease
Natural History

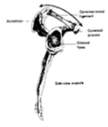
- Asymptomatic tears become symptomatic = 50%
  - Increase in pain common
- Tear Progression
  - 50% symptomatic patients
  - 22% asymptomatic patients

Rotator Cuff Disease
Mechanism of Injury

- Extrinsic Factors
  - "impingement"
    - Primary
    - Secondary
    - Internal
  - Tensile Overload
  - GH Instability
  - Trauma
- Intrinsic Factors
  - Changes in Cuff Vascularity
  - Metabolic Changes

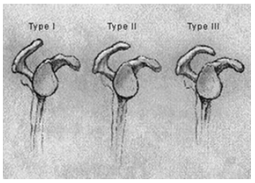
Rotator Cuff Disease
Primary Extrinsic Impingement

- Coracoacromial Arch
  - Acromion
    - Acromial Morphology
    - Anteroinferior osteophyte
  - CA Ligament
    - Thickens with age
  - Coracoid
- AC Joint
  - Inferior Osteophyte

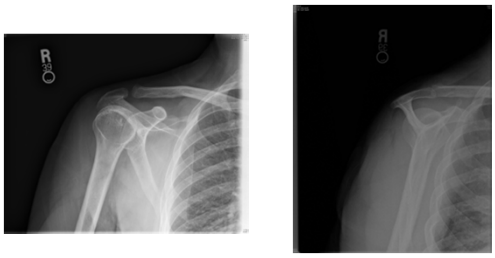


Rotator Cuff Disease
Primary Extrinsic Impingement

- Acromial Morphology
  - Type I: flat = 17%
  - Type II: curved = 43%
  - Type III: hooked = 40%
- Specimens with RTC Tears
  - 73% had Type III Acromion



Radiology
AP View and Scapular 'Y' View

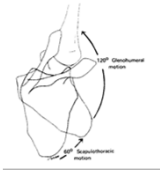


Role of Acromial Spur

- Ogawa, JSES, 2005
- Cadaveric study of 1029 shoulders
- Small spurs were associated with advancing age
- Morphologic change to the rotator cuff may enhance spur growth
- IE: "chicken or egg?"

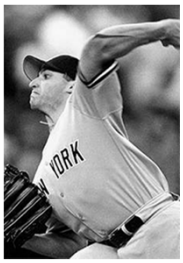
Rotator Cuff Disease
Secondary External Impingement

- Rotator cuff dysfunction from secondary source causes impingement
  - Physiologic subacromial space narrowing
    - Scapulothoracic dysfunction
    - Instability
    - Neurologic
- Typically <35 years old
- ⊕ Impingement signs
- ∅ Plain radiographs



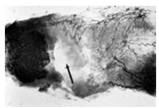
Rotator Cuff Disease
Internal Impingement

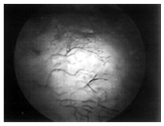
- Rare!
- Repetitive microtrauma
- Overhead athletes
- Late cocking phase
- Posterior rotator cuff impinges against the posterior-superior glenoid



Rotator Cuff Disease
Intrinsic Factors (vascular)

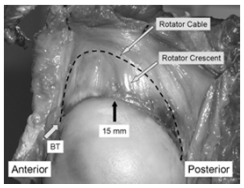
- Vascularity of distal supraspinatus tendon
  - Relative hypovascular zone prone to failure
  - "Critical zone"
    - Articular surface (undersurface)
    - 1 cm proximal to rotator cuff insertion
    - Hypovascularity mediated by arm position
  - Never proven!
    - Hypovascularity as direct cause





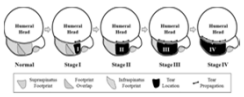
Location of Rotator Cuff Tear
Kim, et al, *JBJS,* 2010

- Ultrasound on 360 shoulders with rotator cuff tears
- Mean distance from biceps tendon to anterior tear margin = 7.8 mm
- Most commonly torn location = 15-16 mm posterior to biceps tendon



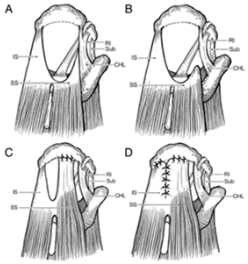
Rotator Cuff Tear Stage
Oh, et al, *JBJS, 2011*

- Set up testing system in cadavers
- Supraspinatus tear ↑'d ER ROM and ↓'d abd capability
- Adding half of infraspinatus changed humeral kinematics
- Pec major and lats kicked in as tear progressed



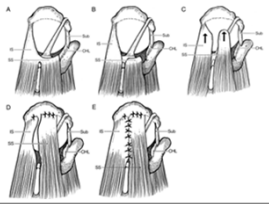
LONGITUDINAL SHAPED

- Lo & Burkart, *AJSM*, 2003



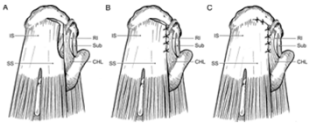
CRESCENT SHAPED

Lo & Burkhart, *AJSM*, 2003



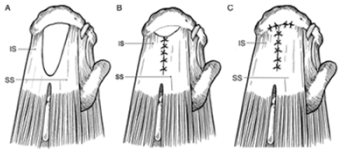
L-SHAPED

- Lo & Burkart, *AJSM*, 2003

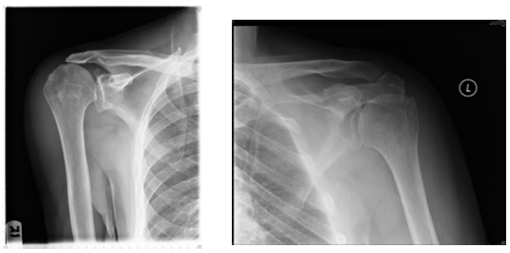


U-SHAPED

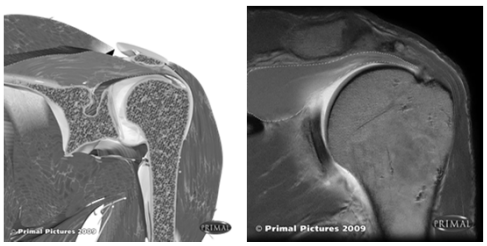
- Lo & Burkart, *AJSM*, 2003



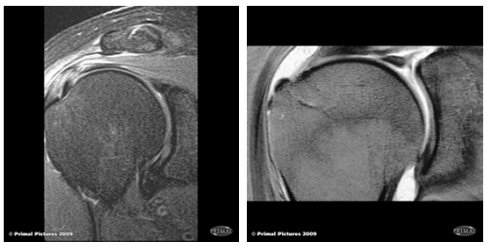
Radiology
Humeral Head Migration



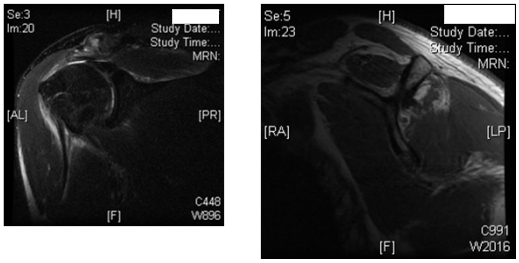
Radiology
MRI



Radiology
MRI



Radiology
MRI



Classification

- **Rotator Cuff Disease**
  - **(aka: impingment, tendonitis, bursitis, tendonopathy)**
  - **Rotator Cuff – No Tear**
- **Rotator Cuff Tear (greatest diameter)**
  - **≤ 1 cm = small tear**
  - **1-3 cm = medium tear**
  - **3-5 cm = large tear**
  - **> 5 cm = massive tear**

Cofield 1985

MASSIVE ROTATOR CUFF TEAR

- **Tear > 5 cm in diameter**
  - **Cofield 1985**
- **Detachment of at least two entire tendons from tuberosities**
  - **Patte, 1983 – Gerber, 2000**

ROTATOR CUFF DISEASE
History

- **Rotator Cuff Signs and Symptoms**
  - **> 40 years of age – not always symptoms**
  - **Pain – lateral shoulder to insertion of deltoid**
  - **Pain with reaching overhead and/or behind back**
  - **Pain at night**
  - **Weakness or decreased ER Strength**
  - **Decreased IR ROM**
- **Pre-existing RTC symptoms followed by acute trauma indicative of acute extension of degenerative RTC**

CLINICAL SIGNS

Clinical presentation of large and massive rotator cuff tears
- Pain (especially at night)
- Trauma/Chronic
- Atrophy
- PROM > AROM
- Impingement sign
- Weakness of FF & ER
- ER lag sign

PHYSICAL EXAMINATION

- Neer
- Hawkins
- Supraspinatus
  - Empty can

PHYSICAL EXAMINATION

- Lag signs
- External Rotation
  - 20° abd.
  - 90° abd. – isolates infraspinatus
- Subscapularis
  - Lift off
  - Belly press

Shoulder Exam

Lift Off Test

Belly Press Test

- Isolates subscapularis
- Useful in patients who lack IR ROM
- Place hand on belly and hold elbow away from body
- Positive if patient cannot maintain elbow or hand position

RANGE OF MOTION

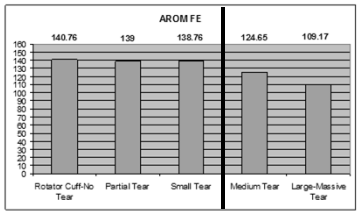
- **American Shoulder and Elbow Surgeons**
  - Forward Elevation
  - External Rotation at 0
  - External Rotation at 90°
  - Internal Rotation up back
    - *IR at 90°

JSES 1994

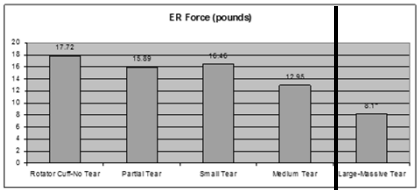
Strength / Muscle Force

- ***Internal and External Rotation*** **with arm at side, elbow flexed to 90°**
- ***Forward elevation*** **in plane of the scapula at 45°, elbow flexed to 90°**

Leggin, et al JSES 1996

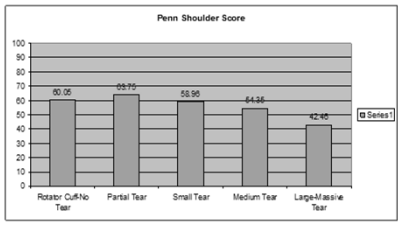


- **Rotator Cuff-No Tear/Partial/Small Tear significantly different than Medium and Large-Massive Tears**



- **RC-NT significantly different than medium and large-massive**
- **Partial, Small, and Medium tear different than large-massive**

TOTAL SCORE



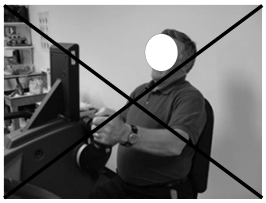
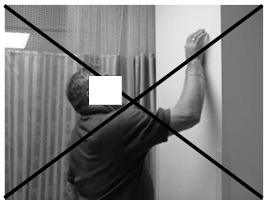
Rehab Principles

- **Rotator Cuff-No Tear and Tears ≤ 3 cm**
  - pain relief with modalities
  - rest from painful activity
  - patient education
  - restore normal length of capsuloligamentous complex
  - Improve rotator cuff, deltoid, scapular muscle strength and coordination

Clinical Implication

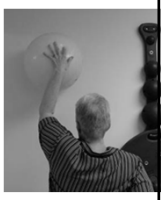
- Pain relief and rest play a large role in managing rotator cuff disease


WHAT DO WE NOT DO??

SWISS BALL ROLL





MODALITIES

- Heat
- Ice
- NSAID's
- Cortisone injection

RESTORE TISSUE LENGTH
Posterior Capsule

- Emphasize low load, repeated stretch
- 10 repetitions
- 10-20 second hold
- 3-4 times daily

PHASE II ROM

- Extension
- Internal rotation
- Cross body adduction



STRETCHING

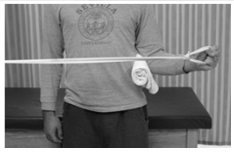


STRENGTHENING

- Thera-band resistance
  - Yellow……2 lbs.
  - Red……..3 lbs.
  - Green…….4 lbs.
  - Blue……..5 lbs.
  - Black……..6 lbs.
  - Silver……..8 lbs.

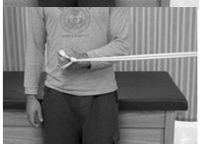
PHASE I STRENGTHENING

- External Rotation
- Internal Rotation
- Extension

PHASE I STRENGTHENING

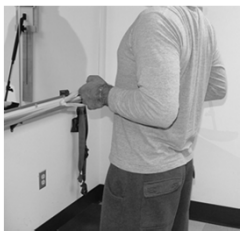
- Internal Rotation


PHASE I STRENGTHENING

- Extension


PHASE I SCAPULAR MUSCLE STRENGTHENING



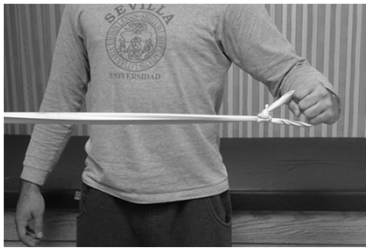

MANUAL RESISTANCE


PHASE II STRENGTHENING

- *<u>begin when at green for all Phase I exercises</u>
- Forward elevation below shoulder level
- Abduction to 45°
- External rotation at 45° supported

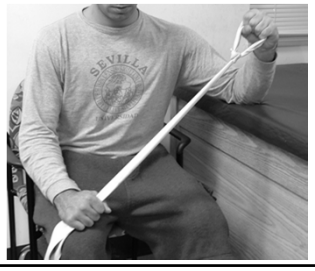
PHASE II STRENGTHENING

- Abduction to 45°



PHASE II STRENGTHENING

- External rotation at 45° supported



MANUAL RESISTANCE

ELEVATION and ER THROUGH RANGE

MANUAL RESISTANCE

ALTERNATING ISOMETRIC D2 and D1

McClure, et al, *Physical Therapy,* 2004

- Determine the effect of a 6-week exercise program on:
  - Impairments
    - ROM, strength, 3D scapular kinematics
  - Function/Disability
    - Penn Shoulder Score, SF-36
- Patients with shoulder impingement syndrome

McClure, et al

- N = 39
- Followed 1 time per week for 6 visits
- Improved:
  - Symptoms (pain, satisfaction)
  - Impairment (strength, ROM)
  - Function (shoulder score, SF-36)
    - PSS increased from 63 to 86
  - ? Scapular Kinematics (scap post tilt & ER)

Lombardi, *Arthritis & Rheumatism*, 2008

- Randomized controlled trial
- Progressive resistance vs. no exercise
- Resistance group demonstrated improved pain and function vs. control group

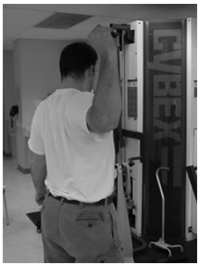
Cummins, *JSES*, 2009

- 100 patients received injection and therapy
- ASES score improved from 56 to 95
- Pain decreased from 4.8 to 0.6
- 79% did not undergo surgery
- 30% of those who did not have surgery continued to have some pain

Holmgren, BMJ, 2012

- 102 patients
- Randomized to specific exercise vs. control – non-specific
- Specific exercise
  - > improvement in Constant Score
  - < patient chose surgery (20% vs. 63%)

Horizontal Abduction with ER & Scap retraction



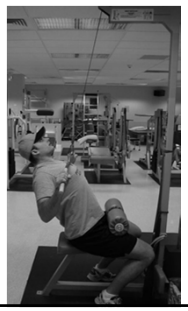
FOREHAND

BACKHAND

DYNAMIC HUG

SERRATUS ANTERIOR

PHASE III - IV STRENGTHENING



OUTCOME OF ROTATOR CUFF ≤ 3 cm

11.5 visits

PENN SHOULDER SCORE

IE = 58.04

DC = 82.92

Rotator Cuff Tears Rehabilitation Principles

- **Rehabilitation of medium (> 3cm) and large-massive cuff tears**
  - **Restore PROM**
  - **Initiate Cuff Strengthening (manual resistance)**
  - **Need to train remaining muscles to centralize humeral head to allow elevation**
  - **Emphasize subscapularis and deltoid**

RESTORE PROM

- **Many patients have limited FE and IR**
- **Phase I ROM**
  - **Supine FE & ER with stick**
- **Phase II ROM**
  - **Extension with stick**
  - **Cross body adduction**
  - **Internal rotation**

PHASE II ROM

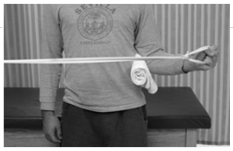
- Extension
- Internal rotation
- Cross body adduction

Rotator Cuff Strength

- Provide manual resistance to ER/IR

Rotator Cuff Strength

- Phase I
  - ER
  - IR
  - Extension



Large – Massive Rotator Cuff Tears

- Proximal humeral migration correlates with cuff tear size
  - Keener, *JBJS*, 2009
- Stable glenohumeral abduction without excessive humeral migration requires significantly greater forces of subscapularis
  - Hansen, *JBJS*, 2008

Hawkes, JOR, 2012

- Compared healthy vs. massive rotator cuff patients
- Increased activity of latissimus dorsi and teres major

Graichen, J of Biomechanics, 2005

- Adducting muscle activity led to significant increase of subacromial space
- No difference in scapulo-humeral rhythm between abducting and adducting muscle activity

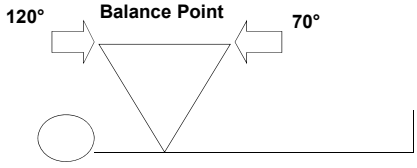
Large-Massive Rotator Cuff Tears

- Kelly, *JSES*, 2005
- 18 subjects:
  - 6 normals
  - 6 symptomatic 2 tendon cuff tears
  - 6 asymptomatic cuff tears
- EMG activity of 12 muscles during 10 functional tasks

Kelly, *JSES*, 2005

- All cuff tear patients had increased muscle activation during all tasks vs. normals
- Asymptomatic patients > subscapularis and deltoid activity
- Symptomatic patients = increased activity of torn rotator cuff and upper trapezius

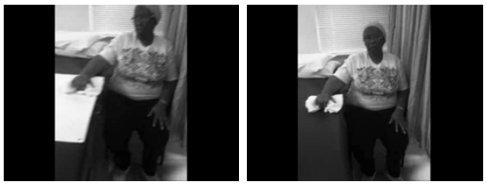
Rotator Cuff Tears Rehabilitation Principles



*Restore the balance point

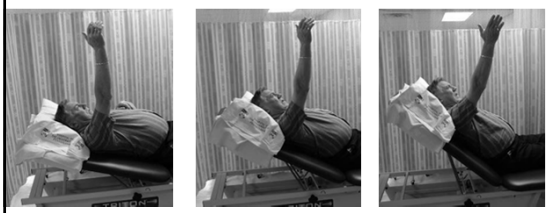
Rotator Cuff Tears Rehabilitation Principles

- Supine active forward elevation
- Gradually introduce gravity
- Add weighted ball and/or elastic resistance
- Emphasize internal rotation strength

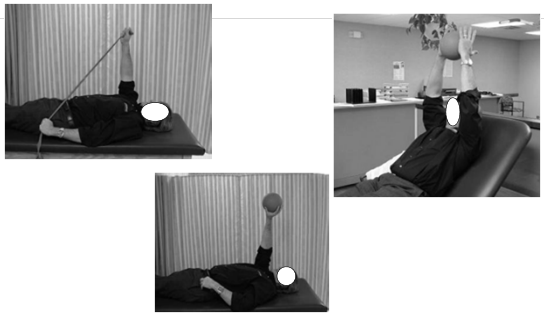


SUPINE ELEVATION PROGRESSION

SUPINE ELEVATION PROGRESSION



SUPINE ELEVATION



ELEVATION PROGRESSION

Row

Levy, *JSES*, 2008

- 17 patients with irreparable massive tears
- Constant score increased from 26 to 60
- FE ROM increased from 40 to 160

Ainsworth, *Musc Care*, 2006

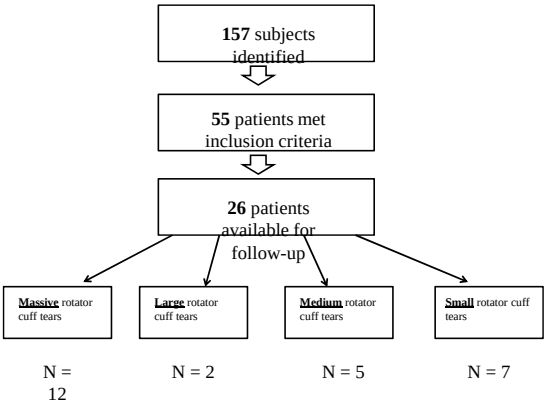
- 10 patients with massive cuff tears
- All demonstrated improvement in Oxford Shoulder Disability Questionnaire

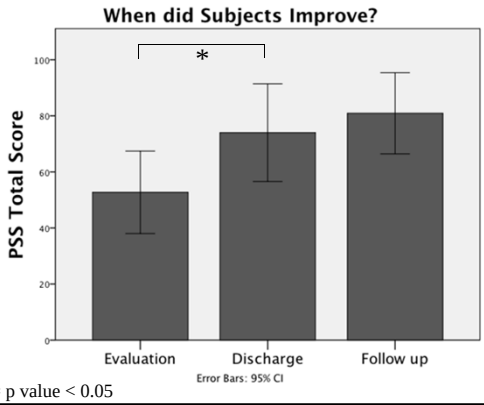
OUTCOME

12.83 visits

PENN SHOULDER SCORE

– IE = 41.42
– DC = 77.75





* = p value < 0.05

FUTURE

- **Long term study of impact of exercise and therapy on rotator cuff disease**
- **Compare results to operative treatment**

Thank You!!

Current Concepts in Rotator Cuff Repair

American Physical Therapy Association
2013 Combined Sections Meeting
San Diego, CA

Andrew F. Kuntz, MD
Assistant Professor
Department of Orthopaedic Surgery
University of Pennsylvania
Philadelphia, PA

Disclosures

I have no potential conflicts with this presentation

Objectives

- Review the pathogenesis and natural history of cuff disease
- Identify a "tear at risk"
- Review latest surgical techniques used in rotator cuff repair
- Review potential targets and new technology to augment a cuff repair

Recent Advancements

- Better understanding of the natural history of cuff disease
- Improved surgical techniques
- Orthobiologics
- Rehabilitation concepts

Prevalence of Rotator Cuff Tears

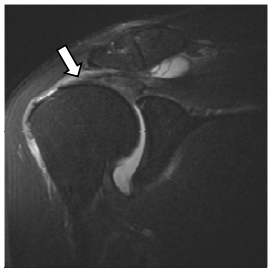
- Cadaver studies:
  Full Thickness Tear
  5% - 40%
- Age related
  - 6%, age < 60
  - 30%, age > 60
- Partial thickness tears more common

Neer 1983, Matsen 2004, Lehman 1995, Yamanaka 1987

Prevalence of Rotator Cuff Tears

Sher et al., JBJS, 1995

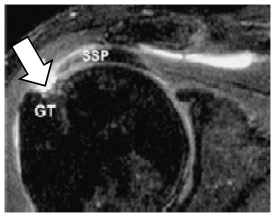
- MRI, asymptomatic
- Overall: 35%
  - 15% full thickness
  - 20% partial thickness
- Age dependent
  - >60: 28% full, 26% part
  - 40-60: 4% full, 24% part
  - <40: 0% full, 4% part



Prevalence of Rotator Cuff Tears

Yamaguchi et al., JSES, 2001

- Unilateral shoulder pain
- Bilateral ultrasound
- Age relationship for tears
  - No tear – 48.7 y/o
  - Unilateral tear – 58.7 y/o
  - Bilateral tear – 67.8 y/o
  - 50% likelihood of bilateral tear after age 66 if present with painful tear



Risk Factors for Rotator Cuff Tear

- Genetics
  - ↑ incidence of tears in 2nd and 3rd degree relatives (Tashjian et al., JBJS, 2009)
- Smoking
  - ↑ prevalence of tear (Baumgarten et al., CORR, 2010)
  - ↑ tear size (Carbone et al., JSES, 2012)
- Hypercholesterolemia
  - ↑ serum lipids in patients with rotator cuff tears (Abboud & Kim, CORR, 2010)
  - ↓ tendon biomechanical properties (Beason et al., JOR, 2011)

The Dilemma

VARIATION IN ORTHOPAEDIC SURGEONS' PERCEPTIONS ABOUT THE INDICATIONS FOR ROTATOR CUFF SURGERY

- Treatment is not standardized
- Orthopaedic surgeons lack agreement on physical therapy, steroid injections, surgical decision
- No clear guidelines to dictate if, when, and how a rotator cuff tear should be fixed

Natural History of Rotator Cuff Tears

- Understanding of the natural history may help guide treatment
- How do you study the natural history?
  - Symptomatic → natural history often interrupted by treatment
  - Asymptomatic → model for investigating etiology of:
    - Pain
    - Tear prevalence
    - Tear progression

Natural History of Rotator Cuff Tears

Natural history of asymptomatic rotator cuff tears: A longitudinal analysis of asymptomatic tears detected sonographically

Ken Yamaguchi, MD,[a] A. Marc Tetro, MD, FRCS(C),[a] Oren Blam, MD,[a] Bradley A. Evanoff, MD,[b] Sharlene A. Teefey, MD,[c] and William D. Middleton, MD[c] St Louis, Mo

- 45 patients w/ asymptomatic full thickness tears
- 5 years follow-up: ultrasound, questionnaire, exam
- Asymptomatic → symptomatic: 51% at 2.8 years
- ↑ pain, ↓ function in symptomatic group
- Tear Progression:
  - Asymptomatic: 22%
  - Symptomatic: 50%
  - None had tear healing

Natural History of Rotator Cuff Tears

Symptomatic Progression of Asymptomatic Rotator Cuff Tears

A Prospective Study of Clinical and Sonographic Variables

- Asymptomatic, full thickness tears
- 50% patients became symptomatic
  - Initial tear size (AP dimension) larger
  - Tear progression more common
- Conclusions:
  - Larger tears more likely to become symptomatic
  - Development of pain correlates with tear enlargement
  - Symptom development should prompt evaluation

Natural History of Rotator Cuff Tears

- Maman et al., JBJS-A, 2009
  - 33 pts., symptomatic full thickness tear
  - 52% tear progression
    - More likely after 18 months
    - Age > 60 and initial fatty infiltration correlated with progression
- Safran et al., AJSM, 2011
  - 51 pts, <60 y/o, symptomatic full thickness tear
  - 49% tear progression
    - Pain only factor that correlated with progression
- Conclusion: Significant rate (~50%) of tear progression

Natural History of Rotator Cuff Tears

Evolution of Nonoperatively Treated Symptomatic Isolated Full-Thickness Supraspinatus Tears

Sandro F. Fucentese, MD, Andreas L. von Roll, MD, Christian W.A. Pfirrmann, MD, Christian Gerber, MD, and Bernhard Jost, MD

Investigation performed at the Department of Orthopedics and Division of Radiology, University Hospital Balgrist, Zurich, Switzerland

- 24 patients, <65 y/o
- Supraspinatus tear (<1.6 cm)
- All refused surgery
- Average follow-up: 42 months
- MRI follow-up
  - Smaller tear: 9 pts (includes no tear identified in 2 pts)
  - No change: 9 pts
  - Increased size: 6 pts
- 17 very satisfied / satisfied
- No change in ROM
- No ↑ fatty atrophy beyond state 2
- Tear progression did not affect reparability
- Conclusion: Small, full thickness tears have lower risk for tear progression

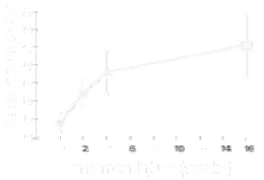
Tear Size – Does it Matter

Harryman et al., JBJS-A, 1991

- Ultrasound follow-up of open rotator cuff repair
- 105 shoulders, avg 5 year f/u
- Rate of recurrent tear
  - Supraspinatus only tear: 20% recurrence
  - Two tendon tear: 45% recurrence
  - Three tendon tear: 65% recurrence
- Most patients satisfied (even with recurrent defect)
- Function and satisfaction correlated with repair intregrity

Timing – Early vs. Late Repair

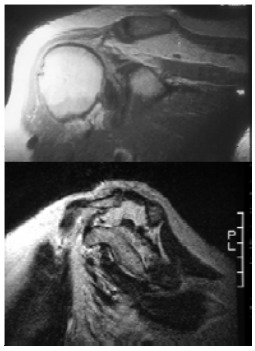
- Rapid increase in repair tension with time
  (Gimbel et al., CORR, 2004)
- Improved function with early (<3 wks) repair
  (Bassett et al., CORR, 1983)
- No difference in outcomes if repaired w/in 3 months
  (Bjornsson et al., Acta Orthop, 2011)



	Group 1 3 wks	Group 2 3-6 wks	Group 3 6-12 wks
Elevation	168	126	129
Pain relief	Satis.	Satis.	Satis.

Tear Progression and Repair Outcome

- Irreversible Changes
  - Retraction with adhesion
  - Muscle atrophy and fatty infiltration
  - Degenerative changes of the glenohumeral joint
- All are poor prognostic factors



Operative vs. Non-Operative Treatment

Risks **Benefits**

Surgery and Non-Op Outcomes
vs.
Tear Progression / Irreversible Change

Operative vs. Non-Operative Treatment

- Group I (low risk w/ conservative approach)
  - Non-operative treatment
- Group II (high risk w/ conservative approach)
  - "Tear at risk"
  - Maximize healing potential
    - Consider early surgical intervention
    - Best repair possible (double vs. single row)
    - Address risk factors (smoking, hypercholesterolemia, NSAIDs)
    - Slow post-op rehab protocol
- Group III (irreversible changes)
  - Non-operative treatment
  - Perform least invasive surgery when necessary

Operative vs. Non-Operative Treatment

Box 1
Treatment algorithm for rotator cuff disease

- Group I—initial nonoperative treatment
  - Tendonitis
  - Partial-thickness tears (except maybe larger bursal-sided tears)
  - Maybe small (<1 cm) full-thickness tears
- Group II—consider early surgical repair
  - All acute tears full-thickness (except maybe small [<1 cm] tears)
  - All chronic full-thickness tears in a young (<65) age group (except maybe small [<1 cm] tears)
- Group III—initial nonoperative treatment
  - All chronic full-thickness tears in an older (>65 or 70) age group
  - Irreparable tears (based on tear size, retraction, muscle quality, and migration)

Tashjian, Clin Sports Med, 2012

Operative vs. Non-Operative Treatment



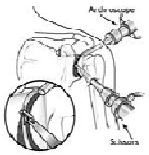
Rotator Cuff Repair

- Approach
  - Open
  - Arthroscopic
- Biologics
  - PRP
  - Patch Augmentation
- Post-operative Rehabilitation
  - Early vs. Delayed

Approach – Open vs. Arthroscopic

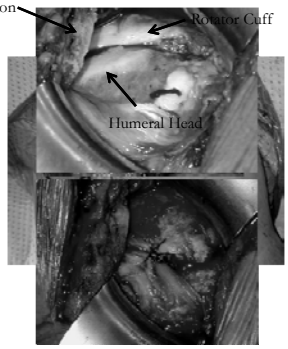


versus



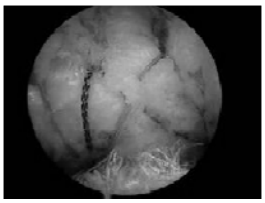
Open Rotator Cuff Repair

- Principles (Neer, 1972)
  - Open superior approach
  - Subperiosteal anterior deltoid take-down
  - Coracoacromial ligament excision
  - Anterior acromioplasty
  - Cuff mobilization
  - Cuff repair to bone through tunnels
  - Early (immediate) passive motion



Arthroscopic Rotator Cuff Repair

- Increasingly more common
  - ↑ 600%, 1996 – 2006
  - Open RCR ↑ 34% during same time perior



Arthroscopic Rotator Cuff Repair

Potential Advantages

- ↓ deltoid morbidity
- Concurrently address intra-articular pathology
- Better cuff mobilization and visualization
- Better patient acceptance

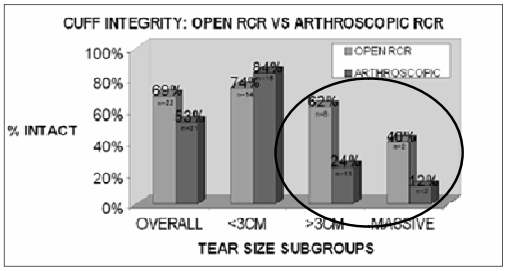
Potential Disadvantages

- More expensive
- Smaller cuff repair footprint
  - Surface area available for healing
  - Double row may help
- Technically demanding
  - May be volume dependent

Arthroscopic Rotator Cuff Repair

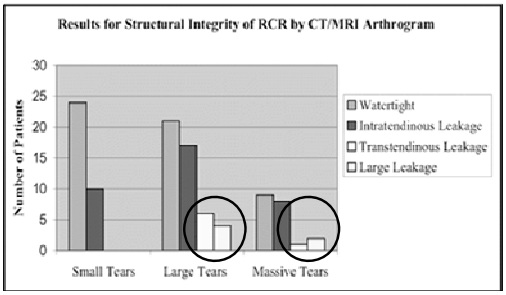
- Anchor Type
  - Single/Double/Triple – loaded
  - Metal/Plastic/Bio
- Repair Configuration
  - Single-Row
  - Double-Row
  - Trans-osseous

Outcomes – Open vs. Arthroscopic



Bishop et al., JSES, 2006

Outcomes



Lafosse et al., JBJS, 2007

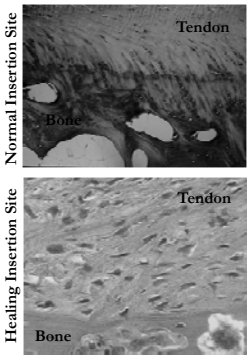
Outcomes – Open vs. Arthroscopic

- Multiple studies demonstrate equivalent results
  - Functional improvement: 75-95%
  - Pain relief: 85-100%
- Need to consider:
  - Surgeon experience
  - Case by case basis
- Open repair
  - Chronic, massive tears in a young patient
  - Revisions (Especially following failed arthroscopic repair)
- Arthroscopic repair
  - Reasonable most other times

Biology in Rotator Cuff Repair

The Problem

- Repair site heals slowly
- Delayed return to activities
- Relatively high failure rate
- When cuff repairs heal, healing occurs by reactive scar formation



Biologics in Rotator Cuff Repair

Structure
Composition
Organization
} Do not return to normal following repair

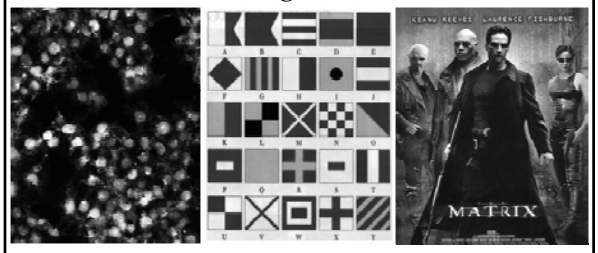
Goals of orthobiologics for cuff repair

Reestablish the natural bone-tendon interface

Improve biomechanical properties

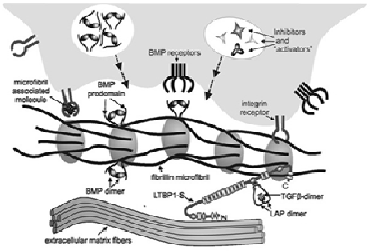
Biologics – Key Components

Cells **Signals** **Matrix**



Biologics – Key Components

- Temporal
- Spatial
- Dosage



Biologics in Rotator cuff Repair

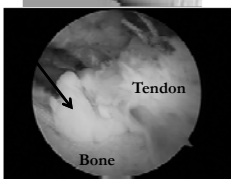
- Matrix metalloproteinases / inhibitors
- Angiogenic cytokines
- Growth factors
- Platelet rich plasma
- Stem cells
- Anabolic-androgenic steroids
- Extracellular matrix scaffolds
- Biomimetic scaffolds
- Gene therapy

Platelet Rich Plasma (PRP)

Platelet-derived growth factors released from activated platelets following injury initiate and drive the early (bFGF, PDGF, IGF) and later (EGF, VEGF, TGF-b, IGF) stages of healing in bone and soft tissue

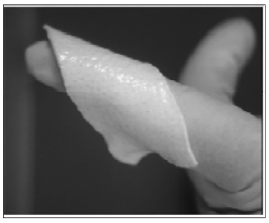
PRP in Rotator Cuff Repair

- Derived from patient's blood
- Concentrate platelets
- Numerous clinical studies fail to consistently demonstrate improved outcomes following rotator cuff repair



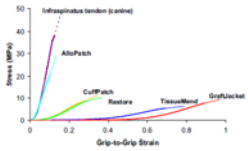
Scaffolds in Rotator Cuff Repair

- GraftJacket (Wright)
  Human Dermis
- TissueMend (Stryker)
  Bovine Dermis
- ZimmerCollagen
  Porcine Dermis
- CuffPatch (Arthrotek)
  Porcine SIS
- Restore (Depuy)
  Poricine SIS
- OrthoADAPT (Pegasus)
  Equine Pericardium



ECM Scaffolds in Rotator Cuff Repair

- Disparity of structural and material properties
- No clearly defined indications for clinical use
- Augment repairs at higher risk of failure
  - Chronic and large tears
- Interposition?



From Aurora et al., JSES, 2007

Post-Operative Immobilization

- History of immobilization following rotator cuff repair
  - Increase in shoulder stiffness transient (McLaughlin 1944, Debeyre 1965, Nixon 1975, Post 1978)
- Treatment lost popularity based in part on detrimental effects in flexor tendon studies
- Passive motion (PM) of the hand flexor tendons:
  - Studied in dogs and humans
  - Resulted in improved range of motion (ROM) and decreased stiffness (Gelberman 1982)

Post-Operative Immobilization

- Passive motion in shoulder:
  - Effect on ROM and stiffness not well studied
  - Small # of studies investigated PM following cuff repair without immobilization
    - Better ROM, but not better shoulder score (Raab 1996)
    - No difference in shoulder score, pain, strength or ROM (Lastayo 1998)
  - No studies investigating effects on tendon to bone healing
- Animal model allows study of biomechanical properties, repair integrity, ROM, and stiffness

Post-Operative Immobilization

- In rat model, following rotator cuff injury and repair:
  - Tendon to bone healing improved with immobilization
  - Passive motion resulted in increased shoulder stiffness and decreased range of motion
  - Detrimental effects of immobilization transient

Post-Operative Immobilization

Cuff & Pupello, JSES, 2012

- 68 pts
- Supraspinatus repair
- Early (POD 2) vs. Delayed (6 wks) ROM
- No difference in:
  - ROM
  - Satisfaction
- Healing (U/S)
  - 85% w/ early ROM
  - 91% w/ delayed ROM

Conclusions

- Etiology of rotator cuff tears multifactorial
- Rotator cuff tears progress
- Early surgical intervention for "tear at risk"
- Arthroscopic techniques improving
- Cuff repair techniques should aim to improve healing
- Biologics complicated, room for future improvement
- Slow early rehab

Thank You