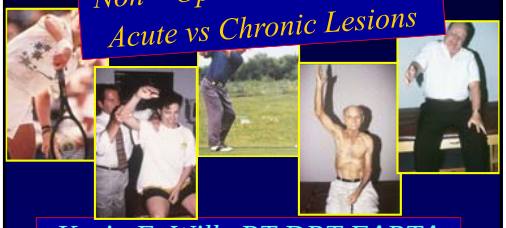
Rotator Cuff Lesions

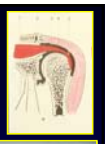
Non – Operative Treatment
Acute vs Chronic Lesions



Kevin E. Wilk, PT,DPT,FAPTA

Classification & Treatment of Rotator Cuff Lesions

Rotator Cuff Lesions
Introduction



- Commonly seen pathology
- Wide spectrum of severity:
  - mild impingement ⟷ progressive failure
  - *impingement* ⟷ *full thickness tears*
- Rotator cuff failure is usually progressive process
- Numerous contributing factors
- Rehabilitation programs must vary significantly

The treatment plan – non-operative

ROTATOR CUFF PATHOLOGY
Classification

- ✓ Primary compressive cuff
- ✓ Primary tensile overload
- ✓ Primary internal impingement
- ✓ Rotator cuff failure / tear
- ✓ Calcific tendonitis
- ✓ PASTA lesions
- ✓ PAINT lesions
- ✓ Secondary compressive primary hypermobility
- ✓ Secondary internal impingement primary hypermobility
- ✓ Secondary tensile overload primary hypermobility

ROTATOR CUFF PATHOLOGY
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- ✓ PAINT lesions
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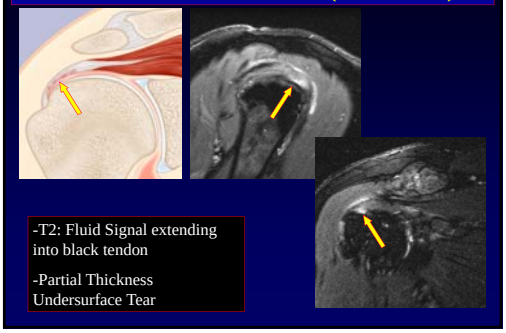
- ✓ Secondary internal impingement primary hypermobility
- ✓ Secondary tensile overload primary hypermobility

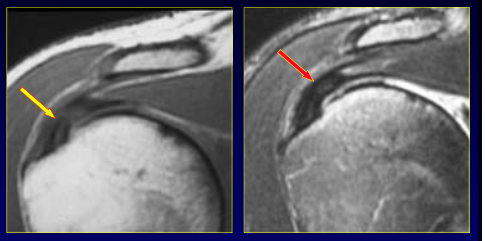
Partial Thickness Tear (Articular)



-T2: Fluid Signal extending into black tendon

-Partial Thickness Undersurface Tear

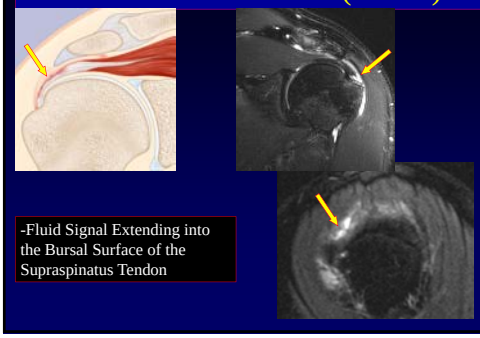
Tendonopathy



-Increased T1-signal; thickened/ attritional changes (thinned)

-Intermediate T2-signal (No Fluid Signal)

Partial Thickness Tear (Bursal)

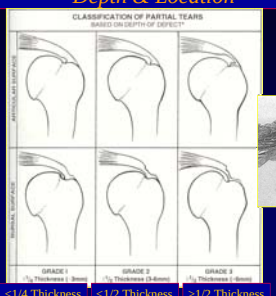


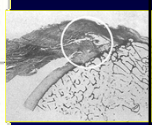
-Fluid Signal Extending into the Bursal Surface of the Supraspinatus Tendon

Partial Tear Classification
Depth & Location

Articular

Bursal

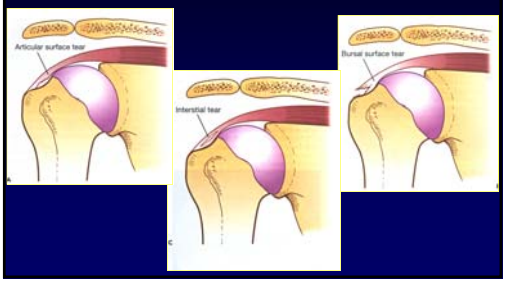




Ellman 1987

<1/4 Thickness | <1/2 Thickness | >1/2 Thickness

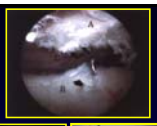
Partial Rotator Cuff Tears
Classification



Pasta Lesions

P - partial
A – articular sided
S - supraspinatus
T - tendon
A - avulsion

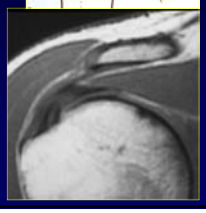
ROTATOR CUFF FAILURE



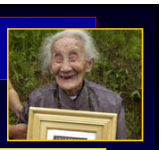
- Wide spectrum of severity
  full thickness ⟷ *partial thickness*
- 70% of tears occur in sedentary individuals
  Neer: Clin Orthop '83
- Tears occur > 40 yo (50-60)
- Gradual weakening → failure
  Hawkins: JBJS '87

Paint Lesions

P - partial
A – articular side
IN - interestial
T - tear



ROTATOR CUFF
Causes of Failure



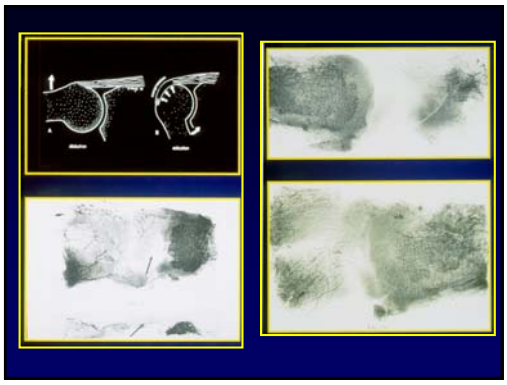
Tendon weakened by combination of factors

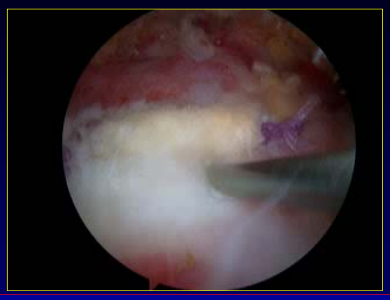
- ✓ Age
- ✓ Repeated microtrauma
- ✓ Disuse - attrition
- ✓ Steroid injection (repeated)
- ✓ Impingement
- ✓ Hypovascularity
- ✓ Tendons poor oxygen uptake 7.5 lower than muscles
- ✓ Major trauma

Usually gradual weakening - failure

ROTATOR CUFF VASCULARITY
Rathbun, MacNab:JBJS 1966

- RTC vascularity, position dependent
- Shoulder adduction less BF
- Shoulder abduction less BF
- *"Winging out of cuff"*
- *BF & shoulder position*



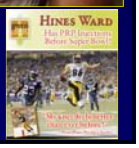


PRP – Platelet-rich Plasma

Rotator Cuff Anatomy
Microvascularity

- *Codman '34 –* avascular region of cuff
  "critical zone"
- *Lindbloom et al: '39* – hypovascularity
  "critical zone"
- *Rothman CORR: '65* – undervascular in critical zone
- *Rathbun: JBJS '66* - decreased vascularity
  "position dependent"

Platelet Rich Plasma
Overview - PRP



- Autologous blood therapy
- Uses patient's own blood components to stimulate healing response
- PRP – enhance body's own healing response
- Uses platelets which have growth factors
- Used to treat *"injured tissues"*

Rotator Cuff Anatomy
Microvascularity

- *Moseley et al: JBJS '63* – not less blood flow
  "rich in anastomoses"
- *Swiontkowski CORR: '87* – utilized laser doppler
  substantial blood flow in zone position no effect on BF
- *Iannotti: JBJS '89* - laser doppler study
  "significant BF in the critical area"
- *Brewer: AJSM '79* - hypovascularity
  "effects of age on vascularity"

Platelet Rich Plasma
Overview - PRP

- Withdraw autologous blood sample
- Add anticoagulant
- Centrifugation twice
  - » 1st remove RBC's
  - » 2nd separate platelet poor plasma from platelet rich plasma
- Extract PRP
  - » 4-8x whole blood concentration
- Add calcuim & thrombin to activate platelets
- Relatively quick & easy

Los Angeles Times | SPORTS

LOCAL U.S. WORLD BUSINESS SPORTS ENTERTAINMENT HEALTH STYLE TRAVEL OPINION

Kobe Bryant goes to Germany for treatment on his knee

By Mike Bresnahan

October 3, 2013 | 2:17 p.m.

Kobe Bryant is going to Germany for an innovative knee procedure, people with knowledge of the situation said Thursday.

Bryant should return in a few days and the procedure was not related to the torn Achilles' tendon he sustained last April.

Lakers Coach Mike D'Antoni declined to provide much insight, other than to say the procedure was planned and not a "big deal."

"He knew he had time because he's not getting on the court yet," D'Antoni said Thursday. "I don't think it caught anybody by surprise. Instead of doing it in August, he's doing it now. There's no concern whatsoever."

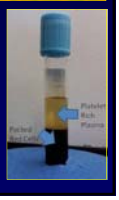
Platelet Rich Plasma
Overview - PRP

REVIEW ARTICLE

Sports Med Arthrosc Rev 2013

The Basic Science of Platelet-rich Plasma (PRP): What Clinicians Need to Know

Steven P. Arnoczky, DVM and Shahin Shehani-Rad, MD, MS†*



KOBE BRYANT

Why Did Kobe Go to Germany?

An aging star and the new procedure that could revolutionize sports medicine

BY JONAH LEHRER ON APRIL 16...

By nearly every metric in years. Not only is l also performing abo and rebounds. (As always, Kob

Consider the Regenokine approach, a patented method developed by Dr. Peter Wehling, a spinal surgeon in Düsseldorf, Germany. The procedure begins with the removal of a small cup of blood from a patient, which is then incubated at a slightly elevated temperature.

Does PRP work?

PubMed article search: 6,047

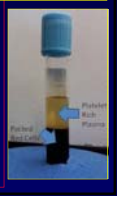
Significant difference	No difference
✓ Peerbooms, AJSM, 2010	✗ Silva, KSSTA, 2009
✓ Kon, KSSTA, 2010	✗ De Vos, JAMA, 2010
✓ Filardo, KSSTA, 2010	✗ Vogrin, ESR, 2010
✓ Radice, Arthroscopy, 2010	✗ Creaney, BJSM, 2011
✓ Wang-Saegusa, AOTS, 2011	✗ De Jonge, AJSM, 2011
✓ Thanasas, AJSM, 2011	✗ Schepull, AJSM, 2011
✓ Gosens, AJSM, 2011	

50% 50%

Dragoo J: 2014

Platelet Rich Plasma
Overview - PRP

- *Gosens et al: AJSM '11*
  - » PRP vs corticosteroid injection
  - » DBRCT:lateral epiconydlitis (2 yrs f/u)
  - » PRP group better: pain & function
- *Peerboons et al: AJSM '10*
  - » PRP vs corticosteroid injection
  - » DBRCT : lateral epicondylitis (1 yr f/u)
  - » PRP group better
- *Mishra et al: AJSM '06*
- *Thansas et al: AJSM '11*
- *Hechtman et al: Orthopaedics '11*



Scenario 2: PRP for Tendinopathy

RCT study	Diagnosis	Parameters	Results
Vetrano *AJSM, 2013*	Patellar tendinopathy	VISA-P, VAS, Blazina	Significant difference in VAS, VISA at 6 months, all parameters at 12 mos (vs. ESWT)
Dragoo *AJSM, 2014*	Patellar tendinopathy	VISA, VAS, Tenger, Lysholm, SF-12	VISA scores improved significantly @ 12wks but not significant @26wks. Lysholm scores did not improve. (vs. dry needling).
Schepull *AJSM, 2011 **	Achilles tendon rupture	Achilles Tendon Total Rupture Score, Heel Raise Index	No difference
de Jonge *BJSM, 2011*	Achilles tendinopathy	Pain scores, VISA-A	No difference
de Vos *JAMA, 2010*	Achilles tendinopathy	Pain scores, VISA-A	No difference
Krogh *AJSM, 2013*	Elbow tendinopathy	PRTEE	No difference @ 3 mos (vs. steroid vs. saline)
Creaney *BJSM, 2011*	Elbow tendinopathy	PRTEE	No difference (vs. autologous blood)
Thanasas *AJSM, 2011*	Elbow tendinopathy	VAS, Liverpool	Significant difference in VAS @ 6 wks (vs. autologous blood)
Peerbooms *AJSM, 2010* **Gosens** *AJSM, 2011*	Elbow tendinopathy	VAS, DASH	↑in VAS & DASH Significant difference (vs. corticosteroid)

Dragoo J: 2014

RCT: Intra-articular LP-PRP injections

Level of evidence	Author	Diagnosis	PRP Formulation	Parameters	Results
Double-blind RCT (n=78)	**Patel** *AJSM, 2013*	Bilateral Knee OA (Ahlback radiographic grade)	Single-spin-leukocyte-poor, RBC-poor	WOMAC, VAS	Significant difference (vs. saline)
Double-blind RCT (n=109)	**Filardo** *BMC Musculoskel Disord, 2012*	Knee OA (KL grade ≤ 3)	Double spin–leukocyte-rich, RBC-poor	IKDC, EQ-VAS, Tegner, KOOS	No difference (vs. HA)
RCT (n=120)	**Cerza** AJSM, 2012	Knee OA (KL grade ≤ 3)	Arthrex ACP-leukocyte-poor, RBC-poor	WOMAC	Significant difference (vs. baseline and HA)
Double-blind RCT (n=176)	**Sanchez** *Arthroscopy, 2012*	Knee OA (Ahlback radiographic grade)	PRGF– leukocyte-poor, RBC-poor	Knee pain, WOMAC,	Significant difference (vs. HA)
Prospective cohort (n=120)	**Spakova** *Am J Phys Med Rehab, 2012*	Knee OA (KL grades 1-3)	Triple spin–leukocyte-poor, RBC-poor	WOMAC, Numeric Rating Scale (pain)	Significant difference (vs. HA)
Prospective cohort (n=144)	**Filardo** *KSSTA, 2012*	Knee OA (KL grades 1-3)	PRGF vs. leukocyte-rich double-spin	IKDC, EQ-VAS, Tegner	More pain/swelling with PRP

Dragoo J: 2014

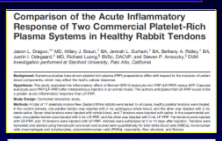
FAST Procedure
Overview

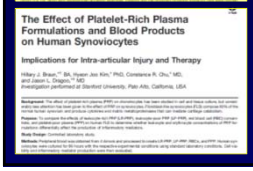
- ✓**FAST** Procedure
  - ✓*Focused Aspiration Soft Tissue*
- ✓Precutaneous removal of diseased soft tissue
- ✓Tenex Health
- ✓ Ultrasound guided, 18 gauge needle technique

Platelet Rich Plasma
Literature - PRP

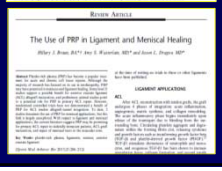

Platelet-Rich Plasma as a Treatment for Patellar Tendinopathy

A Double-Blind, Randomized Controlled Trial


Comparison of the Acute Inflammatory Response of Two Commercial Platelet-Rich Plasma Systems in Healthy Rabbit Tendons


The Effect of Platelet-Rich Plasma Formulations and Blood Products on Human Synoviocytes

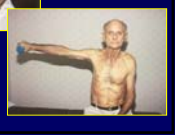
Implications for Intra-articular Injury and Therapy

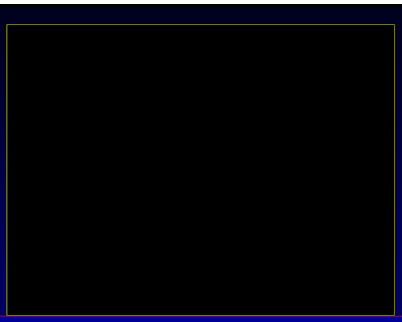

The Use of PRP in Ligament and Meniscal Healing

ROTATOR CUFF
Cuff Failures

- 71 healthy, asymptomatic shoulders
- Age 18 -85, arthrography
- 13 (18%) + Arthrogram
- Symptom free & no previous history

Pettersson: ASES '89





Mesenchymal Stem Cells

Yamagucchi et al: JSES '01

- Natural history of asymptomatic rotator cuff tears over a 5 year period (sonogram)
- 45 patients (22 males), unilateral symptoms & *contralateral asymptomatic cuff tear*
- Mean age 69 yrs (52-85)
- ✓*51% previously asymptomatic became symptomatic - within (3 yrs)*
- ✓ 9/45 had progression of tear (20%)
- ✓ None had a decrease in tear size

Kuhn et al: JSES '13

- Effectiveness of physical therapy in the Rx of atraumatic full thickness rotator cuff tears: a multi center study
- 452 patients – evaluated at 6 & 12 weeks & then phone interview at 1 & 2 yrs post
- Assessed ASES score, Western Ontario, single

✓ *PT successful in 75% of cases*

✓ *25% patients went on to have surgery – if elected to have surgery occurred 6-12 wks*

Rotator Cuff
Function

✓ Dynamic stability
- ➢ centers / compresses humeral head

✓ Steers humeral head

✓ Movement (ER, IR & elevation)

✓ *"Fine tuner"*

Rotator Cuff ⟷ *Compressive Cuff*

Rotator Cuff Tears
Age Related Prevalence

- Rotator Cuff Tears in Asymptomatic Shoulders

Tempelhof, Rupp, Seil: JSES '99

✓ Overall incidence 23% (n=411)

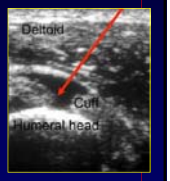
✓ 50-59 yr old: 13%

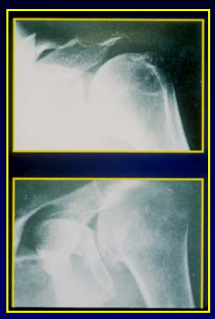
✓ 60-69 yr old: 20%

✓ 70-79 yr old: 31%

✓ 80> : 51%

✓ "normal" degenerative attrition





Rotator Cuff Tears
Age Related Prevalence

- Rotator Cuff Tears in Asymptomatic Shoulders

Minagawa, Yamamoto, Itoi, et al: J Orthop '13

✓ Overall incidence 22% (n=664)

✓ 20-40 yr old: 0%

✓ 50-59 yr old: 10%

✓ 60-69 yr old: 15%

✓ 70-79 yr old: 26%

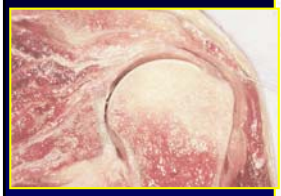
✓ 80> : 36%

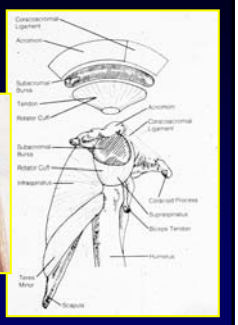
✓ Asymptomatic tears: 65% & symptomatic tears: 34%

✓ More tears in males than females

Biomechanics of the Impingement Syndrome

Subacromial Space





Shoulder Impingement
Compressive Cuff Disease - Neer

- Failure under *"compressive loads"* as cuff impinges upon coracoacromial arch
- Hallmark: *"extra-articular"* superior surface tears (outside in lesion)
  - » Subacromial erosion
  - » Gradual cuff rotator failure
  - » Progressive cuff failure

Excursion of the Rotator Cuff Under the Acromion

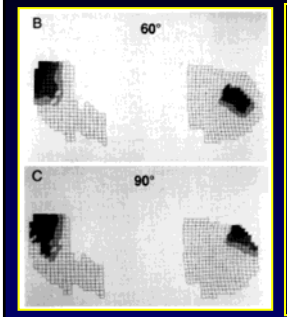
Patterns of Subacromial Contact*

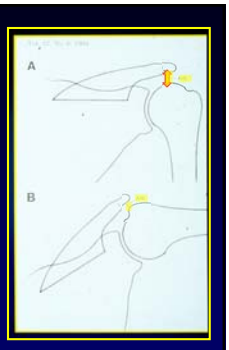
Evan L. Flatow, †‡ MD, Louis J. Soslowsky,§ PhD, Jonathan B. Ticker,† MD, Robert J. Pawluk,† MS, Matthew Hepler,† MD, Jon Ark,† MD, Van L. Mow,‡ PhD, and Louis U. Bigliani,† MD

From the †Orthopaedic Research Laboratory, New York Orthopaedic Hospital, Columbia-Presbyterian Medical Center, New York, New York, and the §Orthopaedic Research Laboratories, the University of Michigan, Ann Arbor, Michigan*

TABLE 3
Measurements of anteroposterior radiographs*

Arm position (deg)	AHI (mm)	Acromion to greater tuberosity (mm)
0	11.1 ± 1.4	33.1 ± 4.9
60	8.1 ± 2.1	11.8 ± 4.7
70	7.5 ± 2.0	9.1 ± 3.4
80	6.8 ± 2.3	6.6 ± 1.9
90	5.7 ± 2.4	5.8 ± 2.4
100	4.9 ± 2.2	7.1 ± 3.1
110	4.7 ± 2.1	9.4 ± 3.6
120	4.8 ± 2.5	11.7 ± 3.7

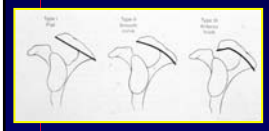


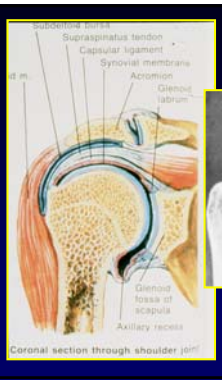


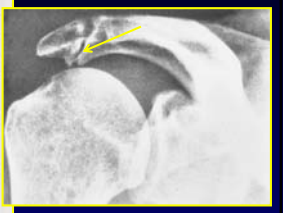
Subacromial Impingement
Overview

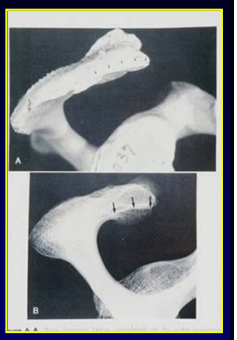
Factors contributing to impingement

Structural ⟷ *Functional*









ACROMIAL SHAPE
Bigliani, Orthop Trans 1986

Type I: Flat

Type II: Curved

Type III: Hooked

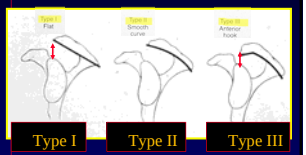


Table I Acromial morphologic condition by age groups

Decade	Type I (%)	Type II (%)	Type III (%)
21-30	32	37	31
31-40	27	44	29
41-50	37	33	30
51-60	31	52	17
61-70	33	44	23
Total population	32	42	26

Nicholson et al: JSES '96

Compressive Cuff Disease
Structional Factors

- *Bursae:*
  - » Inflammation –
  - » Thickening
- *Rotator cuff tendon*
  - » Tendinitis
  - » Thickening
  - » Partial thickness tears
- *Humeral Head*
  - » Congenital abnormalities
  - » Fracture malunion
- *Acromioclavicular Joint:*
  - » Joint abnormalities
  - » Sprains
  - » Degenerative spurs
- *Acromion:*
  - » Abnormal shape
  - » Spurs
  - » Os Acromiale - unfused
  - » Malunion of fracture
  - » Nonunion of fracture

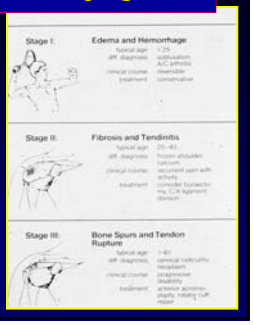
IMPINGEMENT TREATMENT
Overview – Possible Pathomechanics

- Glenohumeral capsular hypomobility
  - » capsular tightness
  - » asymmetrical tightness
- Glenohumeral joint hypermobility
  - » rotator cuff weakness (ER/IR)
  - » muscular imbalance
- Scapular abnormalities
  - » Scapular position - posture
  - » scapular hypermobility
  - » Anterior scapular tilting

Compressive Cuff Disease
Functional Factors

- *Rotator Cuff:*
  - » Weakness
  - » Inflammation
  - » Imbalance
  - » Poor dynamic stab
- *Capsular:*
  - » Hypomobility
  - » Hypermobility
- *Scapular Factors:*
  - » Postural adaptations
  - » Position
  - » Restriction in motion
  - » Neuromuscular control
  - » Paralysis
  - » Fascroscapularhumeral Muscular Dystrophy

Stages of Subacromial Impingement



Subacromial Impingement
Functional Factors-Secondary

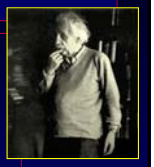
- Capsular Hypomobility
- Capsular Hypermobility
- Inadequate rotator cuff strength
  - » Poor dynamic stabilization
- Scapular position

Treatment Variations

Same Rx Approach ??

Acute Onset ⟷ ***Chronic Lesion***

Rehab Compressive Cuff Disease
Treatment Philosophy



- *Accurate & differential diagnosis*
- Identify all causative factors
- *Identify all involved structures*
- Treatment sequentially & systematically – prioritize
- Progressive & functional rehab
- *Caution against overaggressive activities early in rehab progress*

Rehab Compressive Cuff Pain
Acute Episode

- ✓Diminish inflammation & pain
- ✓Restore or maintain ROM
- ✓Improve or maintain proper posture
- ✓Emphasize cuff & scapular strengthening
- ✓Gradual restoration of activities
- ✓Avoidance of specific activities

Rehab Compressive Cuff Disease
Acute Phase - Goals

- ✓Normalize motion
- ✓Diminish pain - inflammation
- ✓Re-establish baseline dynamic stability
- ✓Patient education, activity modification
- ✓Correct postural adaptations

Rehab Compressive Cuff Disease
Treatment Formula

- *Acute Phase:*
  - ✓ *Postural corrections*
  - ✓ *Activation exercises*
  - ✓ *Calm inflamed tissue down*
  - ✓ *GH joint stability/mobility – "balance"*
- *Subacute Phase:*
  - ✓ *Restoring balance (muscle, capsule)*
  - ✓ *Improving strength with proper activation*
  - ✓ *Maintaining posture during activities*
- *Chronic Phase:*
  - ✓ *Endurance*
  - ✓ *Maximizing functional activities*

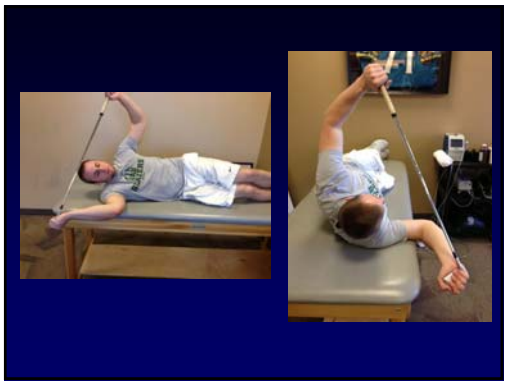
Rehab Compressive Cuff Disease
Normalizing Motion

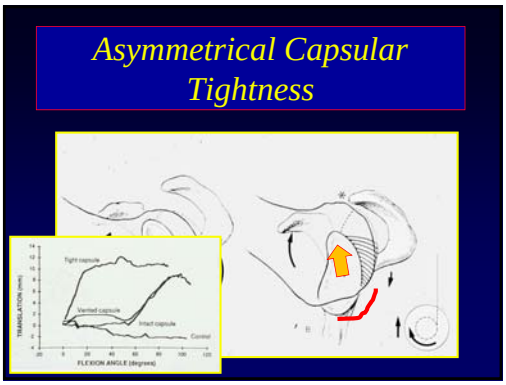
"Reverse capsular pattern"
Wilk & Andrews Orthop 1994
- » Inferior capsular tightness
- » Possibly posterior capsular tightness

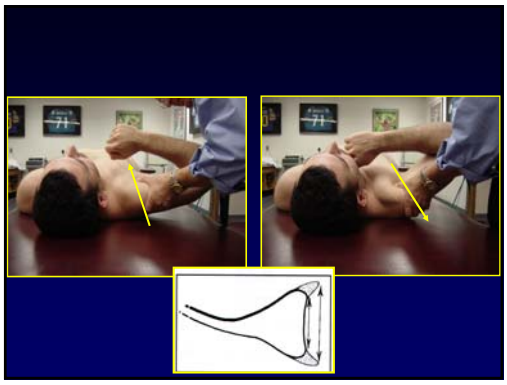
- Joint mobilization
- Physiologic stretching
- CR, HR stretches
- AAROM, PROM, capsular stretches

Assess postural adaptations to improve motion


Always Supine ??




Asymmetrical Capsular Tightness
Tight capsule
Vented capsule
Intact capsule
Control
TRANSLATION (mm)
FLEXION ANGLE (degrees)



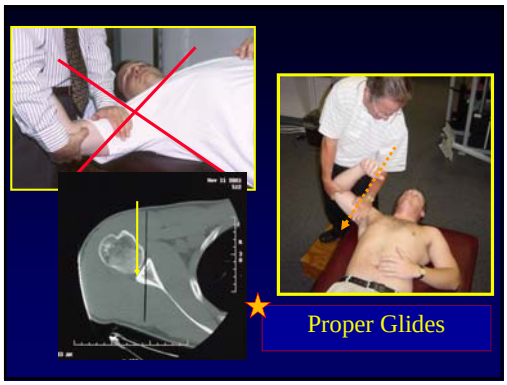
McClure, Bialker, Neff et al: PT '04

- Shoulder function in people with shoulder impingement before & after 6 week exercise program
- 59 patients with impingement syndrome
- 39 patients Rx with 6 week program @ 6wks & 6 mos.
- Pain, satisfaction, function, strength, ROM & 3D scapular kinematics were assessed

✓ *Improvement in all areas (ROM, strength, pain & function)*

✓ *No difference in scapular kinematics*

✓ "relatively simple exercise program with pt education"



Proper Glides

Kuhn: JSES '09

- Effectiveness of exercise in the treatment of rotator cuff impingement
- Systematic review of 11 randomized controlled trials & studies

✓ *Data demonstrated exercise has statistical & clinically significant effects on pain & improving function but not ROM or strength*

✓ *Manual therapy augmented the effects of exercise*

✓ *No difference b/t home & supervised program*

Bang, Deyle: JOSPT '00

- Compared two PT treatment approaches for the treatment of shoulder impingement – *prospective randomized clinical trial*
- 50 patients (30 male) with diagnosis of shoulder impingement syndrome were prospective randomized into 2 groups
  - *Group I: exercise grp: (flexibility & strengthening exercises*
  - *Group II: manual Rx grp:(same program but addition of manual therapy*
- Intervention was 6 times over 3 weeks
- Testers were blinded, assessed on strength, ROM, pain (VAS), functional assessment questionnaire

✓ *Results: both groups improved*

✓ *However, manual Rx group stat sign improvement over other group regarding pain and strength*

Rehab Compressive Cuff Disease

Baseline Dynamic Stability

- Emphasis: posterior rotator cuff & scapular muscles
- Initially, co-contraction (RS) "*balance of forces*"
- *Isometrics if painful - Isotonics if not painful*

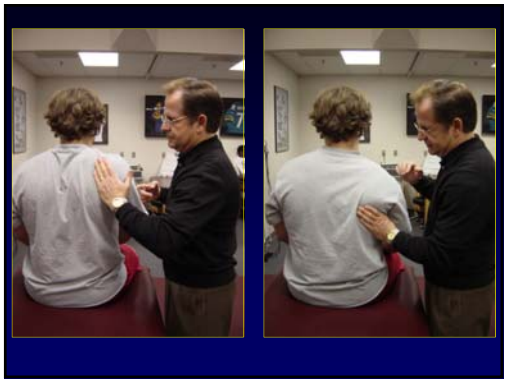
Rehab Compressive Cuff Disease

Baseline Dynamic Stability

- Initial strengthening program – *focus on posterior shoulder structures*
- *posterior shoulder dominant program*
  - ✓ER strengthening
  - ✓scapular muscles
    - ✓retractors
    - ✓depressors
    - ✓*protractors (?)*

Stackhouse et al: JSES '12

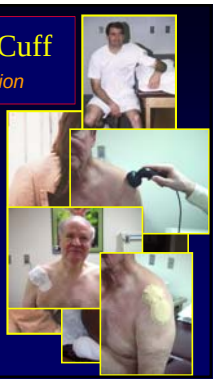
- 17 healthy adults asymptomatic were tested
- Isolated ER force HHD
- Tested pre injection then after painful injection (1.5mL 5% hypertonic saline) into subacromial space
- ✓*After painful injection ER force decreased by 32% and EMG by 23%*



Rehab Compressive Cuff

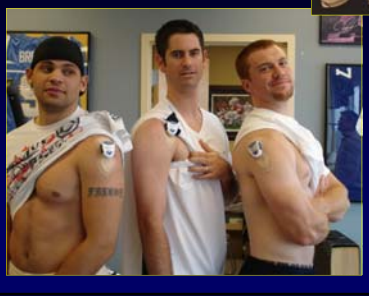
Diminish Pain / Inflammation

- ***Pain ≒ Inflammation***
- Modalities, ice, heat, ultrasound, iontophoresis *(patch)*
- Biomechanical factors
- Avoidance program
- NSAID's (?)



Iontophoresis

Hybresis



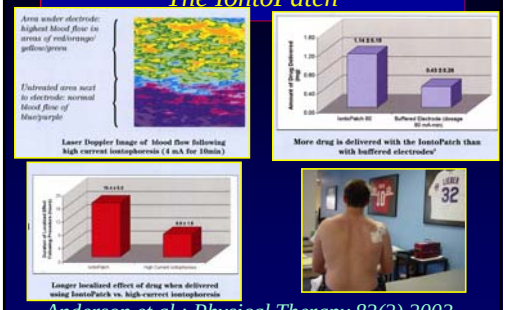
Supraspinatus Tendonitis

Tendonosis

- Similar subjective complaints
- *Pain present at rest*
- Often associated with biceps tendonosis
- *Treatment significantly different then paratendonoitis*
- Tendon degeneration-- attritional tear
- Tendon failure – poor healing response

Localized Area ⟷ Diffuse Area

The IontoPatch



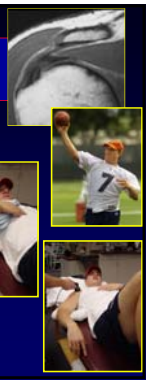
Anderson et al : Physical Therapy 83(2) 2003

Supraspinatus Tendonitis

Tendonosis Rx

- Promote tendon healing – *↑circulation*
- Heat & ultrasound: No Ice
- Stretch musculotendinitis unit
- No NSAIDs
- Eccentric muscle training
- Transverse massage, soft tissue
- Cuff strengthening program
- Gradually increased applied loads

Key- stimulus for collagen synthesis



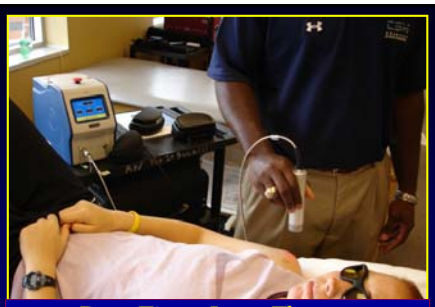
Supraspinatus Tendonitis

Peritendinitis Rx

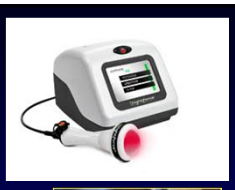
- *Treatment of rotator cuff tendonitis*
- Active rest
- Ice, modalities
  - » Iontophoresis"patch"
  - » NSAID
  - » Injection ??
- Avoidance ??
- Enhance posterior flexibility
- Improve dynamic stabilization
- Gradually increase applied loads

Key – Diminish soft tissue inflammation

Deep Tissue Laser Therapy

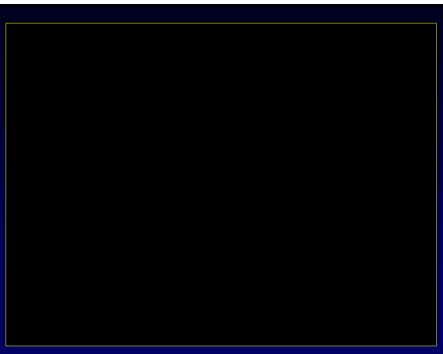


Deep Tissue Laser Therapy



1994

2014



Then & Now

Laser Therapy

How does it work -Benefits

- Light from laser penetrates into tissue, where light energy is converted into chemical energy (First law of Photo Chemistry)
- *Mitochondrion stimulated to produce more energy (ATP) and repair damaged tissue* (Kreb's Cycle / Electron Transport Chain)
- *Production of up to 700% more nitrous oxide for vasodilation* of capillaries compared to 0% from placebo or continuous wave lasers

- **Decreases** / eliminates pain
- **Reduces** inflammation
- **Promotes** new blood vessels and tissue growth
- **Faster** wound healing and closure
- **Stimulation** of osteoblasts

J Ath Trn '13

Does Phototherapy Enhance Skeletal Muscle Contractile Function and Postexercise Recovery? A Systematic Review

Paul A. Borsa, PhD, ATC, FACSM*; Kelly A. Larkin, PhD, CAT(C)*; Jerry M. True, DC, FIACN†

*Department of Applied Physiology and Kinesiology, University of Florida, Gainesville; †Harmony Healing Arts Center, Stuart, FL

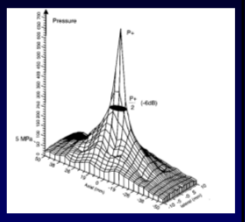
Clinical Implications

Skeletal muscle fatigue is a new avenue for research in phototherapy. The traditional use of phototherapy in clinical settings has been directed toward treating injured tissue to control pain and enhance healing. However, new paradigms for clinical practice are expanding the traditional model for phototherapy in clinical situations. We provided an in-depth look at the effects of phototherapy administered pre-exercise on limiting the extent of exercise-induced fatigue and muscle damage and on facilitating postexercise recovery. Our review is novel because we examined phototherapy from a proactive standpoint as an ergogenic aid to therapeutic exercise and prophylaxis to exercise-induced muscle damage.

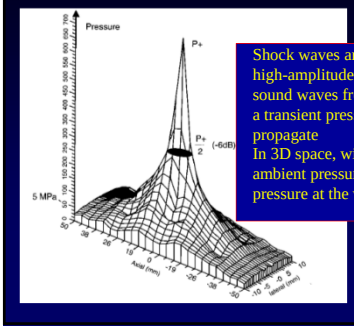
Phototherapy appears to be a viable treatment modality for skeletal muscle. It is safe, easy to administer, and noninvasive and has no known side effects and few reported contraindications. Study outcomes consistently demonstrated ergogenic and prophylactic benefits to skeletal muscle after a treatment dose of phototherapy. Positive outcomes occurred when phototherapy was administered pre-exercise and postexercise. Investigators could conclude that exposing skeletal muscle to single-diode and multidiode laser or multidiode LED therapy positively affects physical performance by delaying the onset of fatigue, reducing the fatigue response, improving postexercise recovery, and protecting cells from exercise-induced damage. The results we discussed may directly affect how phototherapeutic

Acoustic Pulse (shockwave)

- Shock waves are single-impulse with high-amplitude and short-length sound waves from
- a transient pressure disturbance that propagate
- In 3D space, with a sudden rise from ambient pressure to its maximum pressure at the wave front.



Acoustic Pulse (shockwave)



Shock waves are single-impulse with high-amplitude and short-length sound waves from
a transient pressure disturbance that propagate
In 3D space, with a sudden rise from ambient pressure to its maximum pressure at the wave front.

Shock Wave Therapy
Piezo Wave

Shock Wave Therapy
Mechanisms of Action

- MyACT employs the natural mechanisms, by which cells "convert" mechanical forces into cellular biochemical events
- Compression exerts a mechanical stress on cells resulting in heightened expression of proangiogenic genes such as eNOS (endothelial nitric oxide synthase), VEGF (Vascular Endothelial Growth Factor), CXCL5, CCL2, CCR2 (Chemokines and receptors), and proangiogenic proteins of VEGF and vWF
- Promotes increased circulation and pain relief

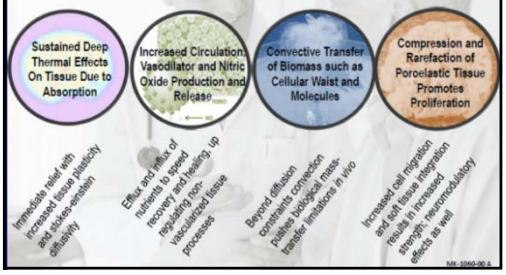
Shock Wave Therapy
Piezo Wave


Mechanics rules cell biology


Augmentation of Tendon-to-Bone Healing

Physiological effects of ultrasound

sam® optimizes ultrasound-based bio modification—it's physics



Shock Wave Therapy
Piezo Wave

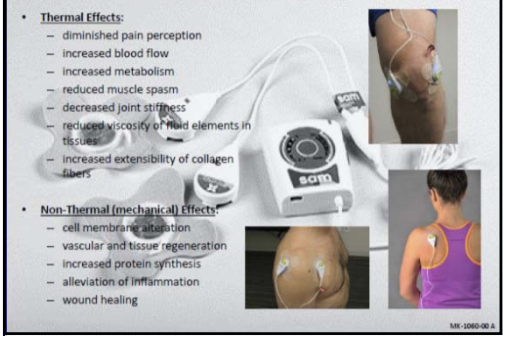

Extracorporeal Shock Wave Therapy in the Treatment of Chronic Tendinopathies


Extracorporeal shock-wave-induced expression of fabricin in tendons and septa

Ultrasounds Therapeutic Effects

- Thermal Effects:
  - diminished pain perception
  - increased blood flow
  - increased metabolism
  - reduced muscle spasm
  - decreased joint stiffness
  - reduced viscosity of fluid elements in tissues
  - increased extensibility of collagen fibers
- Non-Thermal (mechanical) Effects:
  - cell membrane alteration
  - vascular and tissue regeneration
  - increased protein synthesis
  - alleviation of inflammation
  - wound healing

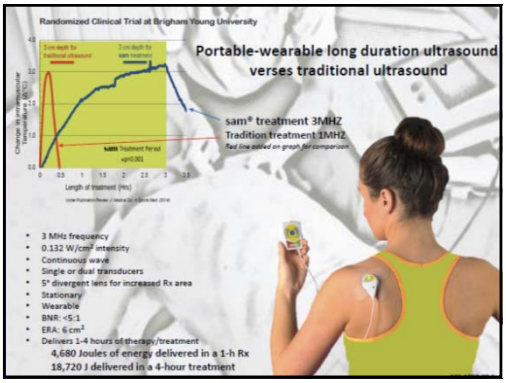
Applicator Placement



Low Intensity Therapeutic UltraSound (LITUS)

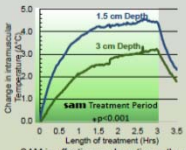
Randomized Clinical Trial at Brigham Young University

Portable-wearable long duration ultrasound verses traditional ultrasound



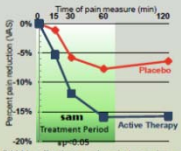
- 3 MHz frequency
- 0.132 W/cm² intensity
- Continuous wave
- Single or dual transducers
- 5° divergent lens for increased Rx area
- Stationary
- Wearable
- BNR: <5:1
- ERA: 6 cm²
- Delivers 1-4 hours of therapy/treatment
  - 4,680 Joules of energy delivered in a 1-h Rx
  - 18,720 J delivered in a 4-hour treatment

Clinically proven, **sam**® penetrates deeply for effective therapy….



SAM is effective on deep tissue therapy

Published: J. Medical Sci. in Sports and Med. (2014)



SAM is effective on chronic trapezius myalgia

Published: J. Ultrasound in Med. Bio (2013)

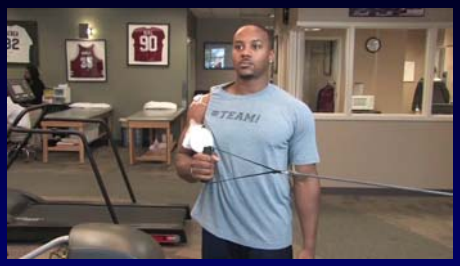
Wearable long duration ultrasound therapy pilot study in rotator cuff tendinopathy
Proceedings of Meetings on Acoustics of the Acoustical Society of America, June, 2013

Design and evaluation of a wearable self-applied therapeutic ultrasound device for chronic myofascial pain
Journal of Ultrasound in Medicine and Biology, August 2013

Pocket-sized ultrasonic surgical and rehabilitation solutions: From the lab bench to clinical trials
Journal of the Acoustical Society of America, March 2010

Treatment of mild to moderate knee osteoarthritis with long duration, low intensity therapeutic ultrasound
American Institute of Ultrasound in Medicine Annual Meeting, March 2014

MX-1060-00 A



Clinically proven, **sam**® penetrates deeply for effective therapy….

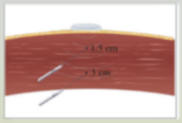
Pilot Clinical Studies of Long Duration, Low Intensity Therapeutic Ultrasound for Osteoarthritis

Matthew D Langer PhD, Vanessa Levine, Rebecca Taggart, George K Lewis PhD
ZetrOZ, Inc.
Trumbull, CT, USA
mlanger@zetroz.com
Lyndon Hernandez MD, MPH
Department of Gastroenterology
Medical College of Wisconsin
Milwaukee, WI

Ralph Ortiz, DO
Medical Pain Consultants
Freeville, NY

Kick Off OA Study Spring of 2014

Dr Ralph Ortiz, Medical Pain Consultants, Ithaca NY
80 Patients
NIH Grant $397,000



Intramuscular Heating And Bio-Regulatory Effects Produced By Long Duration LITUS
International Society for Therapeutic Ultrasound April 3, 2014

Justin H. Rigby, David O. Draper, Rebecca M. Taggart, Kelly L. Stratton, George K. Lewis Jr.
Brigham Young University, Provo, UT and ZetrOZ Inc., Trumbull, CT

Sponsor: J Ty Hopkins, FACSM, Brigham Young University, Provo, UT

MX-1060-00 A

Rehab Compressive Cuff Disease

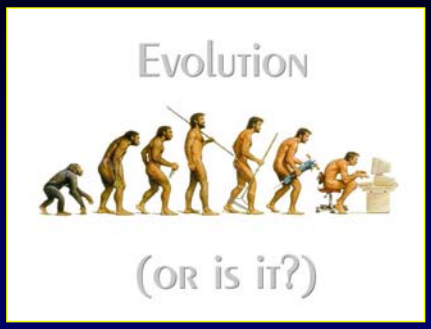
*Patient Education - **Posture***

- ✓ **Postural adaptations**
- Posture modification
- Activity modification
- Don't smoke – promote healing…
- Pathomechanics of impingement
- Compliance

Postural Correction

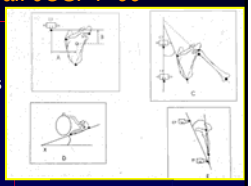
Borich, Bright, Lorello, et al: JOSPT 36(12) 926-934, 2006

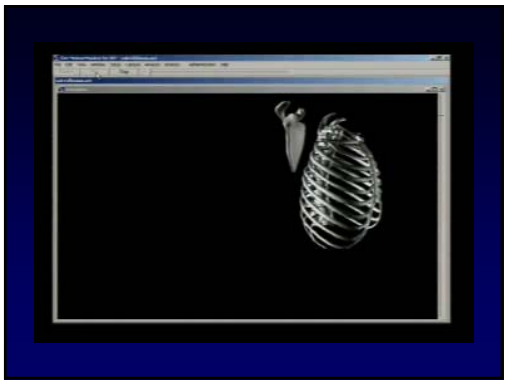
- Scapular angular position assessment at end range internal rotation
- 3- dimensional scapular assessment
- 23 subjects were analyzed
- *IR ROM deficit group exhibited significantly greater scapular anterior tilt (9 deg) compared to control group*

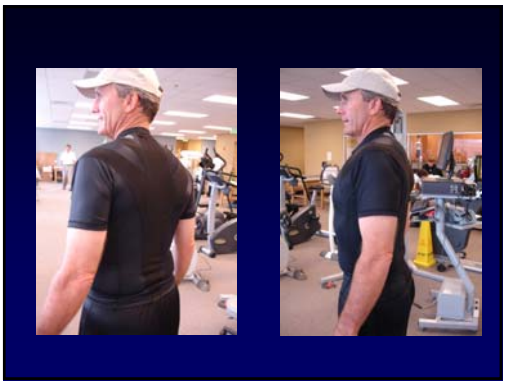


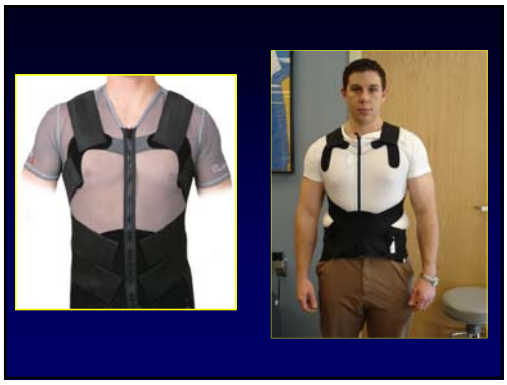
Lukasiewicz et al: JOSPT '99

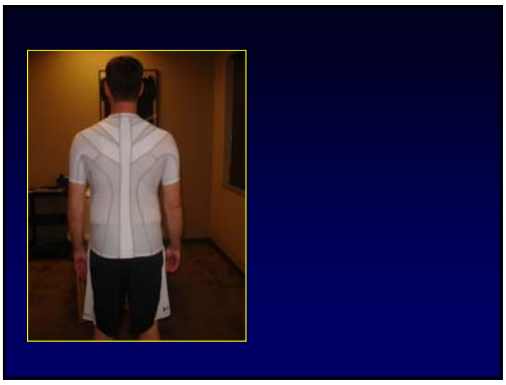
- Analyze scapular position and orientation in subject w/ impingement & normals
- 3D electromechanical devices in 3 planes
- During arm elevation: posterior tilting, upward rotation, protraction
- *Impingement subjects: greater scapula elevation & less posterior tilting**

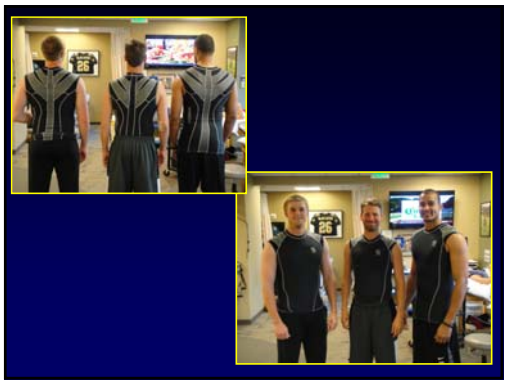


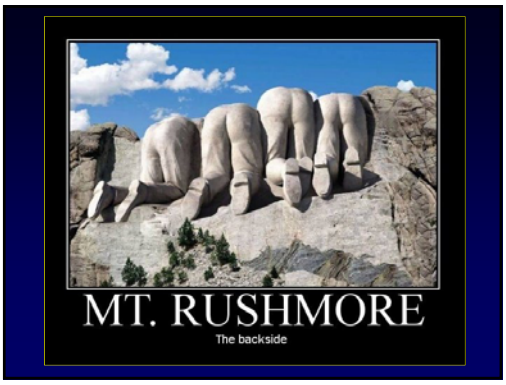











MT. RUSHMORE
The backside


Scapular Assistance & Retraction Maneuver
Kibler: AJSM '06
McClure: JOSPT '12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Seitz, McClure,Finucane et al: JOSPT '12

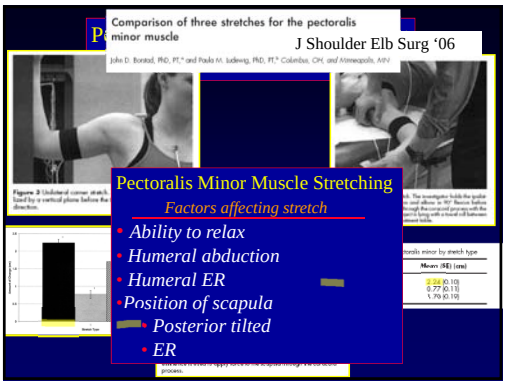
- Scapular assistance test
- 42 Subjects: 21 with SAIS & 21 controls
- 3D motion analysis at 0, 45 & 90 deg elevation

✓ *Increase in posterior tilt at all angles*

✓ *Acromiohumeral distance improved at 45 &90*

"more subacriomal space"

✓ *No change in isometric strength*



Best Stretch for Pectoralis Minor

Pectoralis Minor Muscle Stretching

Overview

Borstad & Ludewig: JSES '06

- Comparison of 3 stretching techniques:
- Each technique different
- Unilateral self stretch (1st)
- Supine manual stretch (2nd)
- Seated manual stretch (3rd)

Muraki et al: Phys Ther '09

- Comparison of 3 stretching techniques cadaveric study:
- Scapular retraction at 30 deg flexion best

IMPINGEMENT TREATMENT

Keys to Treatment - Early Phase

- ✓Normalize motion
- ✓Capsular mobility *(balance)*
- ✓Establish dynamic stability*(ER/IR)*
- ✓*Diminish pain &/or inflammation***
- ✓Postural correction & patient education

IMPINGEMENT TREATMENT

Intermediate Phase - Goals

- ✓Full non-painful ROM - capsular
- ✓Improve strength, endurance
- ✓Promote dynamic stability
- ✓Maintain correct posture

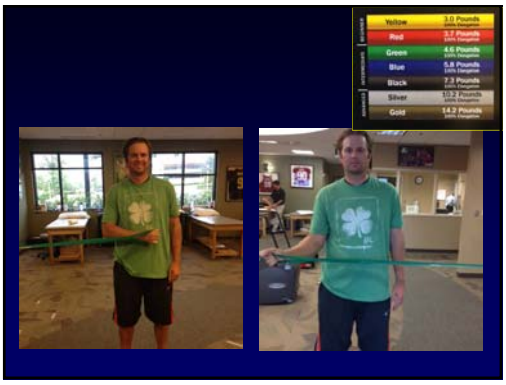
IMPINGEMENT TREATMENT

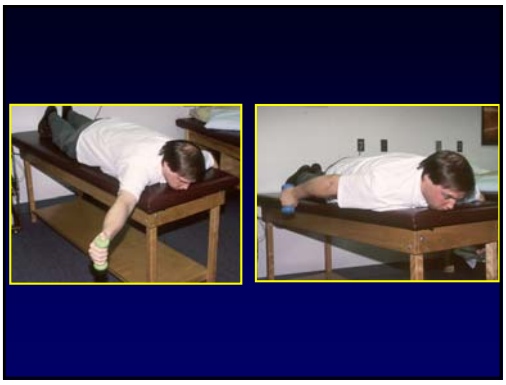
Intermediate Phase - Exercises

- Continue stretching and flexibility exercises
- Initiate complete shoulder program
  - ✓Deltoid, supraspinatus
  - ✓ER & scapular muscle training
  - ✓Adjust work levels
  - ✓Emphasize eccentrics
  - ✓Endurance program
- Continue dynamic stabilization drills


ASMI


ASMI
ER !!


Yellow
Red
Green
Blue
Black
Silver
Gold




LIVE UCKY

Scapular Muscle Training
Train the Scapular Daily

✓ *Isotonic table days*
- » Heavier weights
- » Isolated movements
- » Hypertrophy
- » Neuromuscular drills

✓ *Stability Ball days*
- » Lighter weights
- » Bilateral movts.
- » Combined movts
- » Trunk, core, …

Cools,et al : AJSM '07

- Rehabilitation of scapular muscle balances
- Which exercises to prescribe
- EMG activity, analysis of muscle ratios
- Trapez EMG activity (UT, MT, LT) *UT:LT MT:LT*
- *4 exercises were best:*
  - ✓ *Sidelying ER*
  - ✓ *Prone extension*
  - ✓ *Prone horz abduction ER*
  - ✓ *Sidelying forward flexion*
- ✓ *"consider these exercises when selecting scapular muscle ratios…"*

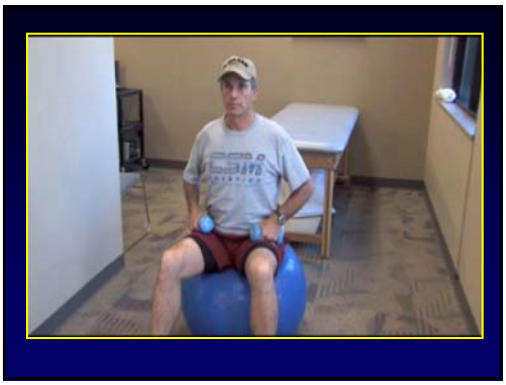
DeMey, …Cools: JOSPT '13

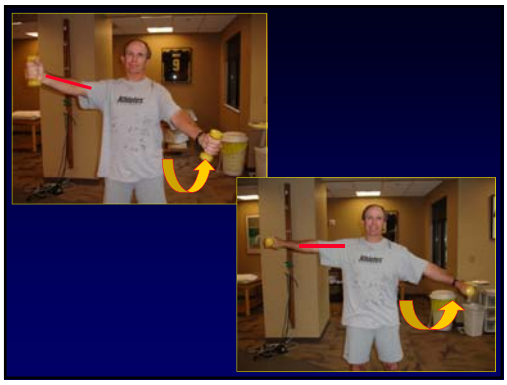
- 30 asymptomatic overhead athletes with scapular dyskinesis
- EMG analysis: UT/LT, UT/MT ratios
- 4 selected exercises performed with & without scapular correction
- 4 selected exercises:
  - ✓ Prone extension
  - ✓ Sidelying ER
  - ✓ Sidelying forward flexion
  - ✓ Prone horizontal abd with ER
- ✓ *Increased EMG ratios with side lying ER & prone extension*
- ✓ *No difference with side fwd flexion or prone horz abd*

Cools,Witvrouw,et al : AJSM '03

- Scapular muscle recruitment patterns (timing)
- Compared 39 overhead athletes with shoulder pain (impingement) to 30 painfree overhead athletes
- Performed sEMG to scapular & deltoid muscles – performed drop arm test
- ✓ *Significant slower muscle activation in MT,LT in painful grp. compared to control grp. (esp. LT)*
- ✓ *Painful grp. slower recruitment from deltoid to trapezius*

!!!






Sustained Holds
!!!

Sustained Holds

Sustained Holds

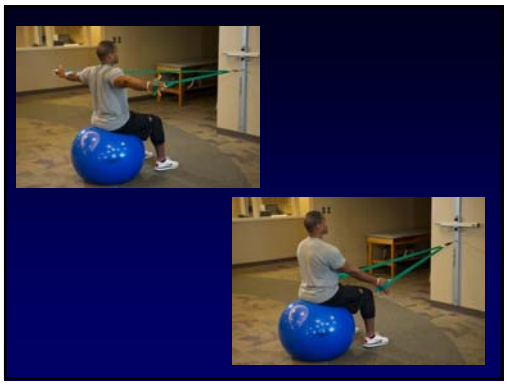
Reinold,Macrina, Wilk: J Athl Train '07

- EMG activity of suprspinatus & deltoid muscles during 3 common exercises
- 22 asymptomatic subjects (15 men)
- Fine wire EMG dominant shoulder
- Full can, empty can & prone full can
- Results: no sign diff in supraspinatus EMG

Middle Deltoid sign greater during EC & PFC

Posterior Deltoid: sign greater PFC & FC

Best exercise for supraspintus – standing full can



Best Exercises for Supraspinatus

- Standing full can
- Military press
- Prone full can
- Lateral raises
- Empty can ???

Supraspinatus muscle activity is important to normal shoulder function but not critical !!!

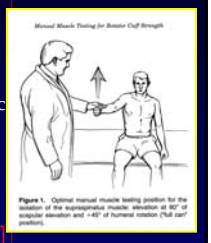
"Empty can"

"Full can"

MMT - Rotator Cuff

Kelly, et al AJSM 1996

- EMG analysis of shoulder muscles
- Supraspinatus, infraspinatus, subscapularis
- Tested 11 subjects, 29 isometric contractions
- Maximize neural activation of desired muscle
- Simultaneously minimize activation of synergist
- Optimal Position: "Full Can"

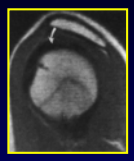


Greenfield, et al JOSPT '95

- Measured head, thoracic spine, scapular resting posture & ROM
- *Subjects asymptomatic vs. overuse injury*
- *Subjects with overuse injuries exhibited forward head posture & greater shoulder elevation*
- No significant difference in scapular resting position

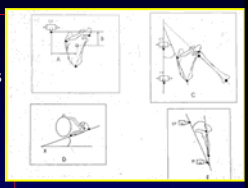
Solem - Bertoft: Clin Orthop '93

- Used MRI to determine effect of scapular retraction & protraction on acromial space
- Subjects supine & passively positional
- Protraction position sign reduced acromial angle, or anterior tilting of scapula



Lukasiewicz et al: JOSPT '99

- Analyze scapular position and orientation in subject w/ impingement & normals
- 3D electromechanical devices in 3 planes
- During arm elevation: posterior tilting, upward rotation, protraction
- *Impingement subjects: greater scapula elevation & less posterior tilting**



Warner, Micheli, et al: Clin Orthop '92

- Study scapular positions in 22 asymptomatic shoulders, 22 unstable & 7 impingement
- Analyze positions: arm at rest, elevated to 90^0
- *Impingement patients exhibited increased scapular elevation & winging*

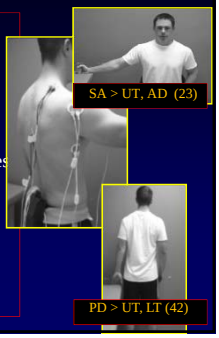
Best Exercises for Scapular Muscles

Lower Trapezius

- ✓ Prone horz abd at 105
  - *Ekstrom" 93*
  - *"prone full can"*
  - *Blackburn JAT '89*
- ✓ Table press down
  - *Wilk: NAJSPT '06*
- ✓ Wall push downs
  - *Wilk: NAJSPT '06*
- ✓ Scapular ER w/ Shlder ER
  - *Kibler: AJSM '08*

Kibler, Sciascia, Uhl: AJSM '08

- EMG analysis of specific scapular exercises in *"early phase"* rehab
- Studied: **SA, UT, LT,** Ant & Post Deltoid
- Performed: low row, inf glide, lawnmower, & robbery exercises
- Moderate EMG activity across all exercises
- SA highest during low row (30%)
- UT & LT were highest during lawnmower & robbery



SA > UT, AD (23)

PD > UT, LT (42)

Kibler et al: AJSM '08

LT > UT, SA (30)

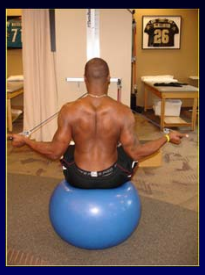
UT > LT, SA (31)

Kibler et al: AJSM '08

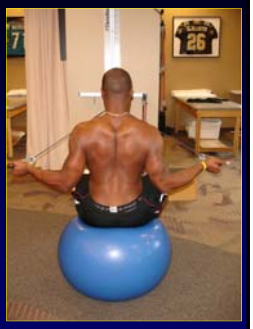
TABLE 2
Average Amplitude EMG Activity All Subjects (N = 39) by Exercises*

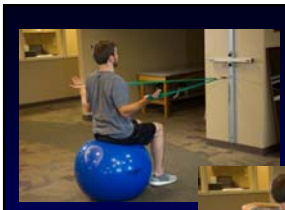
	Inferior Glide	Low Row	Lawnmower	Robbery
Upper trapezius	8.1 (5.9)	10.4 (8.1)	21.8 (15.7)	33.6 (16.7)
Lower trapezius	19.4 (26.6)	15.4 (11.6)	30.5 (19.2)	27.0 (20.8)
Serratus anterior	23.4 (19.6)	28.2 (20.8)	25.5 (21.4)	20.9 (16.8)
Anterior deltoid	4.6 (2.4)	16.6 (13.3)	8.5 (3.6)	7.4 (5.5)
Posterior deltoid	8.6 (6.0)	42.4 (23.2)	16.2 (10.6)	14.0 (9.2)
Differences between muscles	SA > UT, AD, PD LT = all others	PD > UT, LT, AD PD = SA SA > UT, LT	UT = LT = SA LT > AD, PD PD > AD	UT = LT = SA > AD UT = LT > PD

*Data are given in means (standard deviations). EMG, electromyography; RB, robbery; LM, lawnmower; SA, serratus anterior; UT, upper trapezius; AD, anterior deltoid; PD, posterior deltoid; LT, lower trapezius.

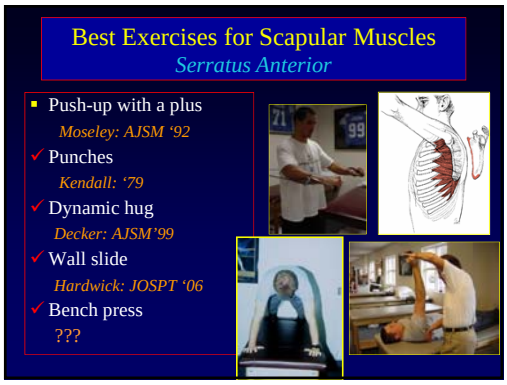


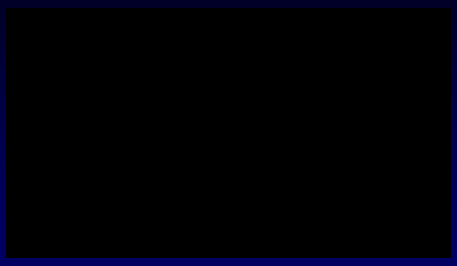
Lower Trapezius Exercises !!!






Wall Slide (high EMG 90°>)


Best Exercises for Scapular Muscles
Serratus Anterior
Push-up with a plus
Moseley: AJSM '92
✓ Punches
Kendall: '79
✓ Dynamic hug
Decker: AJSM'99
✓ Wall slide
Hardwick: JOSPT '06
✓ Bench press
???



Scapular Position – Protective for the GH Joint

IMPINGEMENT TREATMENT

Scapular Component

- Assess passive & active scapula mobility
- Examine scapular motion (active arm elevation & abduction)
- Analyze in phase of motion
- Analyze in force couples
- Pect minor flexibility / low trapez control
- Protraction / retraction strength
- *restore posterior scapula tilts !!*

IMPINGEMENT TREATMENT
Chronic Phase - Goals

- ✓Maintain capsular / muscular flexibility
- ✓Continue improvement in strength
- ✓Improve muscular endurance
- ✓Gradual return to sports / activities

IMPINGEMENT TREATMENT
Chronic Phase - Exercises

- Continue ROM &self capsular stretches
- *"Fundamental shoulder exercises"*
- Gradual return to sports
  - » Interval programs
  - » Stretching and strengthening

FUNDAMENTAL SHOULDER EXERCISES

This Needs An Update !!

- ROM exercises (flexion, ER, IR)
- Stretching, horizontal adduction (stabilize)
- ER/IR strengthening
- Sidelying ER
- Shoulder abduction to 90 degrees
- Scaption *"thumb up"*
- Prone horizontal abduction
- Prone rowing
- Biceps curls

Always have add-ons, modifications, tweak it !!

Based on Type of Patient

Subacromial Impingement Treatment
Keys to Treatment

- Gradual return to sports
- Interval sport programs
- Stretch / strengthen prior to play

"Fundamental shoulder exercise program"

"THE OFFICE" SHOULDER EXERCISES

- *Move ! … change positions frequently*
- Wall Stretches:
  - » Pectoralis major stretch
  - » Pec[illegible]or stretch
- Scap[illegible]uscle [illegible]aining
  - » Sc[illegible]on
  - » Low[illegible]as
  - » Shoulder extension
  - » Shoulder ER
- Chin Tucks
- Neck Stretches

Perform several times per day

- *Corner stretch*
- *Wall circles*
- *Chin Tucks*
- *Scalene stretches*

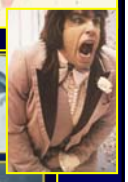
SHOULDER IMPINGEMENT

- ✓ *Glenohumeral hypomobility*
  - » capsular tightness
  - » asymmetrical tightness
- ✓ *Glenohumeral hypermobility*
  - » rotator cuff weakness
  - » muscular imbalances(ER/IR)
- ✓ *Scapular muscular abnormalities*
  - » Hypermobility
  - » Postural - anterior tilt

IMPINGEMNET TREATMENT

Keys to Treatment

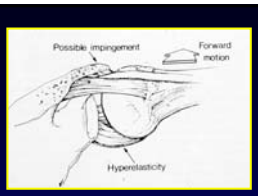
- ✓ *Correct asymmetrical capsular tightness – balance the capsule*
- ✓ Re-establish muscular balance
- ✓ Early avoidance of strenuous activities
- ✓ Normalize motion: especially capsular mobility
- ✓ *Improve ER, scapular muscle strength – Dynamic stabilization*
- ✓ Normalize posture, treat scapular control & position
- ✓ *Watch out for empty can exercises*
- ✓ *"Balance the Shoulder"*

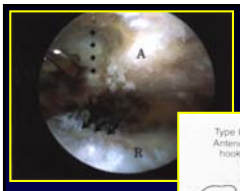


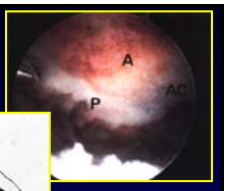
SECONDARY IMPINGEMENT

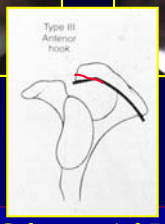
Pathophysiology

- Primary instability or hypermobility
- Humeral head displaces anteriorly and superiorly causing impingement
- Seen in overhead athletes
- *Key: differential diagnosis*
- *Rx: enhance dynamic stabilization*









Arthroscopic Subacromial Decompression

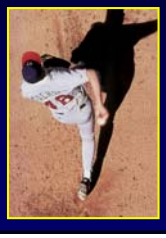
SECONDARY IMPINGEMENT

Due to Hypermobility

- *Treatment plan:*
  - » *Re-establish proper muscular ratios*
  - » *Dynamic stabilization*
  - » *Proprioception & neuromuscular control*
  - » *Correct biomechanics*

Functional Stability

Posterosuperior (Internal) Impingement


Internal Impingement
Overhead Athlete

- Occurs *during* abduction & excessive external rotation
- Late cocking during pitching
- Supraspinatus / Infraspinatus rubs on the posterosuperior glenoid rim & labrum
- *Results in fraying of cuff and glenoid labrum – pain !!*


Normal Condition/Adaptation ⟷ *Lesion*

*Is Internal Impingement **normal** in the overhead thrower???*

Internal Impingement
Introduction

- ✓ Occurs during abduction & excessive external rotation
- ✓ Late cocking during pitching
- ✓ Supraspinatus / Infraspinatus rubs on the posterosuperior glenoid rim & labrum
- ✓ *Results in fraying of cuff and glenoid labrum – inflammation*

Andrews: Tech Orthop'88
Walch: JSES '91
Jobe et al: JSES '93

Rehabilitation Guidelines for Internal Impingement Syndrome

Tomorrow !!!

Rehabilitation Internal Impingement

Differential Diagnosis – Clinical Exam

- Excessive ER
  Loss of IR GIRD
- Positive internal impingement sign *Meister: AJSM '00*
- Pain posteriorly palpation
- Anterior hyperlaxity (?)
- Subjective: pain with late cocking & acceleration. Can't get loose, loss of velocity, stiffness

TRAUMATIC IMPINGEMENT

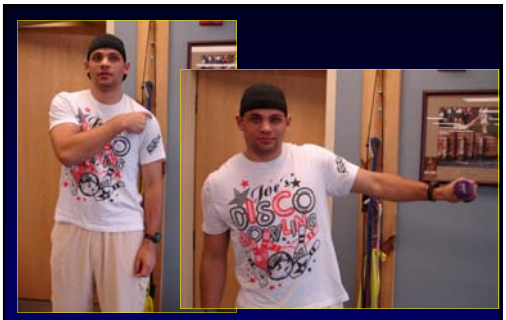
Pathophysiology

- Fall onto outstretched arm
- Arm is abducted and rotated
- Humeral head forced into acromion
- Tissue injury varies (age, force, etc.)
  - » Labrum, cuff tear, rotator cuff avulsion, &/or fracture

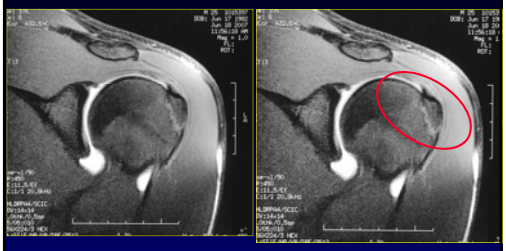
Traumatic Overload

Overview

- Forces on tissue exceed tissue strength
- Traumatic fall or during sports
- Accumulative traumas(throwing , etc.. then superimpose a fall or blow to shldr
- Associated lesions; SLAP tears, fractures, capsular injuries (dislocations),neurologic
- Tissue quality,age, extent of force determines pathology & degree of injury



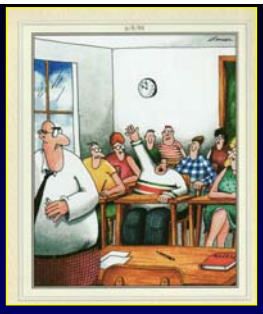
What's his lesion/problem ???



Calcific Tendinitis
Overview

- Unknown etiology
- Reactive calcification followed by spontaneous absorption
- Usually occurs in supraspinatus &/or infraspinatus tendon (vascularity issues)
- Overall incidence 3-20%
- Phases to calification – acute inflammation, calcification, absorption
- Treatment concepts – Rehab, barbotage

Calcific Tendinitis
Overview



"Kevin, may I be excused?
My brain is full."

IMPINGEMENT
Summary

- ✓ Numerous types of impingement
  - *subacromial (compressive)*
  - *internal (posterosuperior)*
  - *traumatic (overload)*
- ✓ *May be due to structural / functional*
- ✓ *factors (osseous ⟷ soft tissue)*
- ✓ Humeral head forced into acromion
- ✓ Rehabilitation base on causative factors: ***tailor the program to patient***

Evaluation ⟶ Treatment