

## Scapular Stabilization in the Overhead Athlete



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## COI Disclosure Information Tim L. Uhl PhD PT ATC FNATA

Leadership position/advisory role for: **ASSET Past-President**

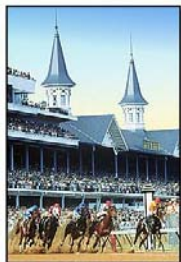
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Other remuneration from: **Lexington Clinic funds PhD Student**

## Greetings Commonwealth of Kentucky



## Affiliations



American Society of Shoulder  
 Elbow Therapists ([www.asset-usa.org](http://www.asset-usa.org))



UNIVERSITY OF KENTUCKY  
 CENTER FOR  
 MUSCLE BIOLOGY



American Shoulder and Elbow Surgeons  
 ([www.ases-assm.org](http://www.ases-assm.org))



## Objectives

1. Participants will be able to conduct an assessment of scapular stability in overhead athlete with the knowledge of normal adaptations for overhead throwing athletes.
2. Participants will have knowledge to recommend interventions to improve scapular stability or mobility to reduce deficits identified during examination.

## Outline

1. Functional Anatomy: Biomechanics
2. Incidence
3. Assessment integrated into standard Examination
4. Repositioning
5. Interpretation
6. Intervention

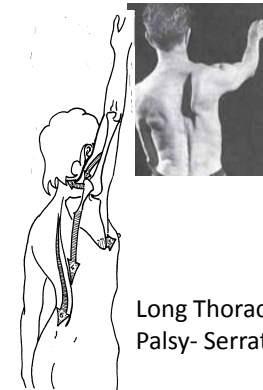
## Assessment of Scapular Dyskinesis

- Scapular motion is critical for normal motion and function of upper extremity
  - Inman JBJS 1944
- Share our approach to Scapular Assessment and how to incorporate it into shoulder examination
- Explain the interpretation of the clinical tests / findings in order to assimilated in clinical treatments



## Function: Appreciate Normal Motor Control and Kinematics before can identify Abnormal

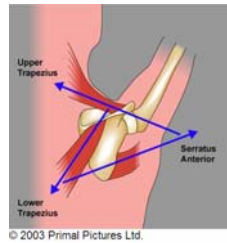
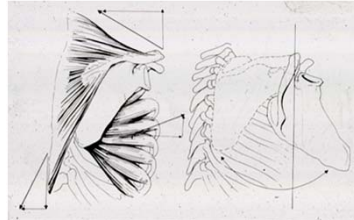
- The ability to lift arm is dependent on proximal stability
  - Joint integrity
  - Scapular motion & musculature
  - Spine motion & musculature



Long Thoracic Nerve  
Palsy- Serratus Anterior

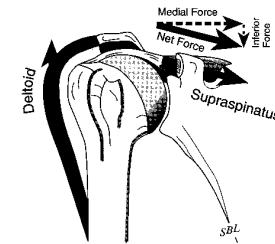
## Scapular Force Couple

- **Arm Elevation**
  - Upper trapezius
  - Serratus anterior
  - Lower trapezius
- **Understand normal motion allows recognition of abnormal motion**

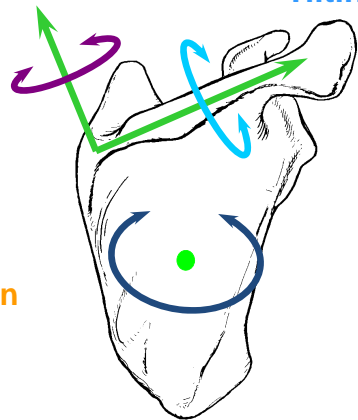
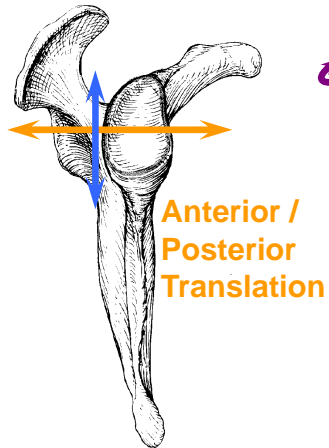


## Normal Force Couples in the Shoulder

- **Scapulohumeral force couples provide for the tremendous mobility in the upper extremity**
  - Inman JBJS 1944
- **Deltoid elevates humerus**
- **Cuff function to compress & stabilize the head**
  - Lee CORR 2002
  - Yanagawa J Biom Eng 2008



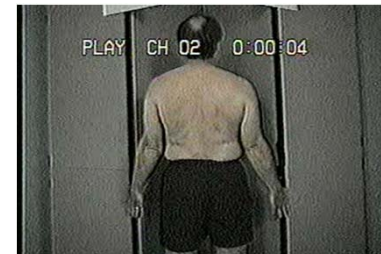
Superior/Inferior Translation   Internal / External Rotation   Ant / Post Tilting



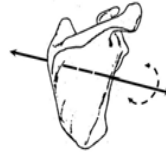
Up / Down Rotation

## Normal Clinical Observation

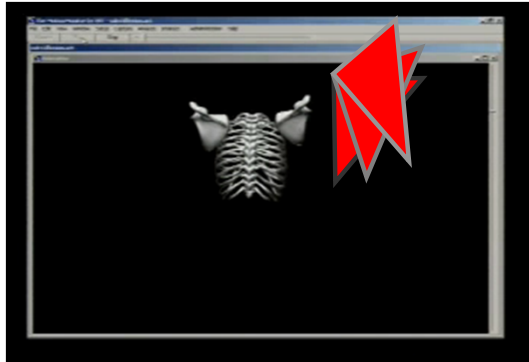
- **Normal Scapulohumeral Rhythm**
- **Scapula smoothly rotates upward during elevation with minimal motion in first 60° and rotates smoothly downward during lowering with the medial border remaining flush with thorax**
  - Kibler J Sh Elb Surg 2002
  - McClure J Ath Train 2009



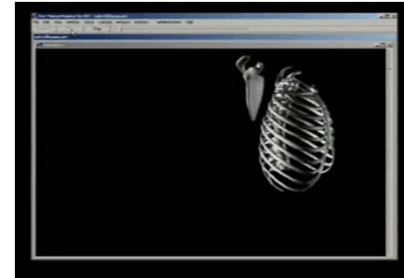
## Scapular Upward Rotation



Resting Position  $2^{\circ} \pm 5^{\circ}$   
 Normal Range  $50^{\circ} \pm 5^{\circ}$



## Scapular External Rotation

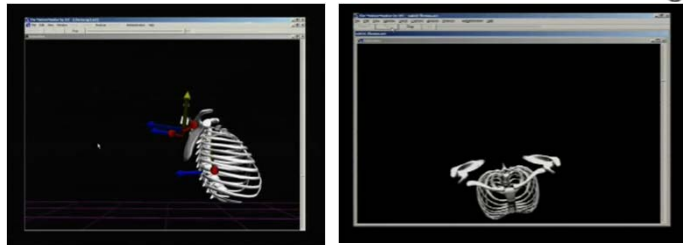


Resting Position  $-30^{\circ} \pm 15^{\circ}$   
 Normal Range  $25^{\circ} \pm 10^{\circ}$



Loss of Scapular Ext. Rot.

## Scapular Posterior Tilting



Resting Position  $-8^{\circ} \pm 5^{\circ}$   
 Normal Range  $30^{\circ} \pm 15^{\circ}$

## Decreased Posterior Tilt

- Increased Anterior Tilt
- Scapular Dysrhythmia
  - McClure J Ath Train 2009



## Shoulder and Elbow Tendonopathy is Common

- 11.2/1000 patients presenting to primary care MD with shoulder pain
  - van der Windt DA et al., *Annals Rheum Dis* 1995
- Collegiate Baseball, Softball, and Volleyball 3<sup>rd</sup> most common shoulder injury
  - Dick et al., *J Athl Train.* 2007
  - Marshall et al., *J Athl Train.* 2007
  - Agel J et al., *J Athl Train.* 2007
- Lateral epicondylalgia has a prevalence of 1-2% in general population
  - Shiri R et al., *Am J Epidemiol.* 2006
- In elite junior tennis players as high as 12%
  - Winge et al., *Int J Sports Med* 1989

## Scapular Dyskinesia is Common

- The dominant side scapula appears to be more internally rotated and anteriorly tilted in 43 healthy college athletes
  - Oyama JAT 2009
- 76% of 56 participants had at least one plane of scapular asymmetry
  - Uhl Arthroscopy 2009
- Observation of dyskinesia does not necessarily indicate injury but in the presence of symptoms should be a trigger to further investigate causes

## Incidence of Scapular Dyskinesia

- Dyskinesia - Impairment of voluntary movement resulting in fragmentary movements.
  - Dorland's Medical Dictionary
- Scapular Dyskinesia is intimately involved with glenohumeral derangement
  - 64% Instability
  - 100% Impingement
  - Warner, CORR 1992



## Clinical Assessment of Scapula In Context of Comprehensive Assessment

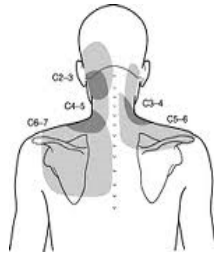
- History
- Observation
  - Posture
  - Scapular assessment
    - Static position
    - Dynamic motion
    - Scapular Repositioning
- Function
  - ROM
  - Strength
  - Special Tests
- Palpation
- Neurological
  - Frisch's Systematic Musculoskeletal Examination 1994



What is wrong with this young man's shoulder?

## History

- Location of pain
  - Medial border scapular pain is a common referral location for cervical joint dysfunction
- Mechanism of injury
  - Motor vehicle accidents or forceful eccentric load
  - Prolonged past Intervention failure
  - Palpate for peri-scapular muscular defects
  - Scapular muscle detachment
    - Kibler J Sh Elbow Surg 2014



<http://www.google.com/search?q=cervical+spine+referred+pain+pattern>



<http://myimpossiblemedicaljourney.blogspot.com/2013/02/scapular-pain-validation.html>

## Slouched Thoracic Posture Reduces Motion & Strength in Healthy

- Shoulder abduction ROM
  - Erect:  $158 \pm 11^\circ$
  - Slouched:  $134 \pm 14^\circ$
  - Loss of  $24^\circ$
- Scapular Kinematics
- Upward rotation:
  - Erect:  $43 \pm 8^\circ$
  - Slouched:  $38 \pm 7^\circ$
  - Loss of  $6^\circ$
- Posterior tilt
  - Erect:  $45 \pm 7^\circ$
  - Slouched:  $41 \pm 7^\circ$
  - Loss of  $4^\circ$ 
    - Kebaetse et al. Arch Phy Med Rehab 1999



## Observation Static Posture: Forward Head Rounded Shoulder

- Cited as a potential cause of shoulder and neck pain
  - Kamkar et al., JOSPT 1993
- Comparison of posture between patients with and without shoulder symptoms find no relationship with pain or impingement
  - Greenfield et al., JOSPT 1995
  - Lewis et al., JSES 2005



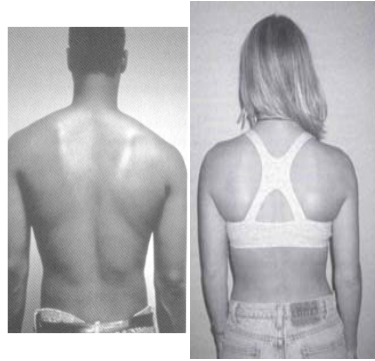
## Double Square Technique to Measure Shoulder Posture

- Differences between sides
  - Dominant side more forward
    - Peterson, JOSPT 1997
- Posture measured this way can provide objective measure of improvement
  - Klumper, JSR 2006
  - Lynch, BJSM 2010



## Static Scapular Assessment

- Observational descriptions of static positions
  - Downward Rotation
  - Depression
  - Abduction
  - Winging and tilting syndrome
    - [Sahrmann Diagnosis and Treatment of Movement Impairment Syndromes](#) 1999



## Thrower's Shoulder are Different

- Healthy
- Compared to non-throwers
  - ~ 7° more UR
  - ~7-10° more IR
  - ~7-10° more Scapular retraction above 90°
  - = PT & Scapular elevation
    - [Myers Am J Sports Med](#) 2005
- Internal Impingement Throwers vs. healthy throwers
  - = UR, IR, Protraction
  - ↑ Clavicular Elevation
  - ↑ Posterior Tilt ~5°
    - [Laudner JOSPT](#) 2006
- Expect to see scapular variations when evaluating an overhead athlete



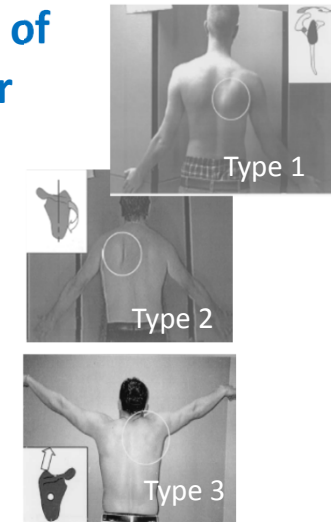
## Clinical Assessment of Dynamic Shoulder Motion

- Patients often present with normal looking mobility
- **A complete shoulder examination requires posterior inspection**



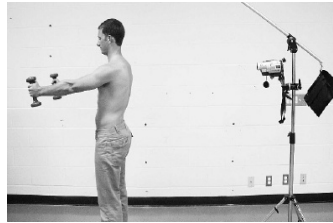
## Clinical Assessment of Dynamic Shoulder Motion

- 4 categories of relative asymmetry during motion
- Inter- & Intra-rater (independent) reliability was moderate (k=.42 to .49)
  - [Kibler et al., JSES](#) 2001



## Scapular Dyskinesia Test of Independent Scapular Motion

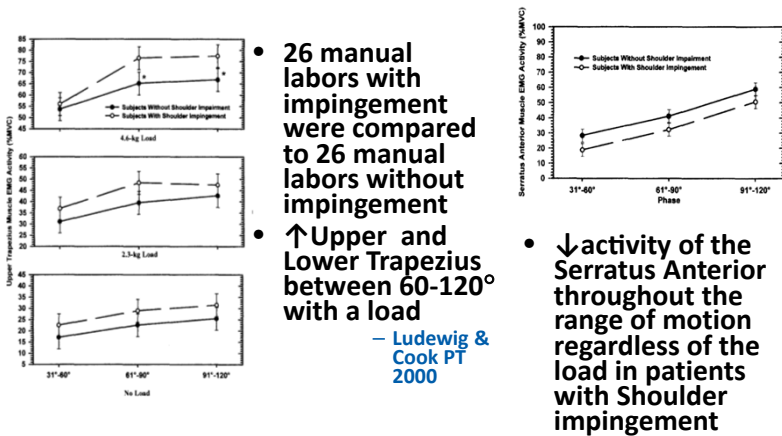
- 142 Athletes were examined
- Added load ( 3 or 5 lbs)
- Dyskinesia
  - Dysrhythmia – not smooth
  - Winging – medial border displaced
- Each scapula was categorized
  - Normal
  - Subtle
  - Obvious
- 75-82% percent agreement between raters
  - Kappa = .5 - .6
  - McClure et al., JAT 2009



## Dynamic Scapular Assessment

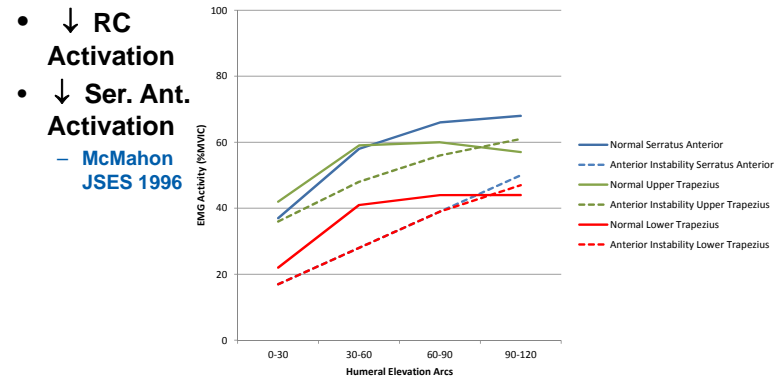
- Scapular Dykiniesis Test – 2 categories
  - Obvious / Normal
  - McClure et al., J Ath. Train 2009
- Kiblers' Scapular Assessment – 2 categories
  - Yes / No
  - Uhl et al., Arthroscopy 2009
- Presence of Scapular Dyskinesia was not directly related to shoulder pain
- International Classification of Function
  - Body Functions
    - Impairments (ROM, Strength, Motor Control, Scapular Dyskinesia)
  - Body Structures
  - Activities and Participation

## Scapular Muscle Alterations in Patients with Shoulder Impingement



- 26 manual labors with impingement were compared to 26 manual labors without impingement
- ↑Upper and Lower Trapezius between 60-120° with a load
- Ludwig & Cook PT 2000
- ↓activity of the Serratus Anterior throughout the range of motion regardless of the load in patients with Shoulder impingement

## Scapular Muscle Activation in Anterior Instability during Scaption



- ↓ RC Activation
- ↓ Ser. Ant. Activation
- McMahon JSES 1996





Healthy

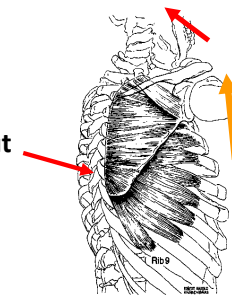
Swimmer  
with MDI

## Scapular Dyskinesia Assessment

- Scapulohumeral Rhythm is necessary for normal function
- Scapular moves 3 dimensionally
- Alterations can be observed
  - Motor Control issues
    - Scapular muscular activation are altered
  - Mobility Issues
    - Glenohumeral derangement
  - Neurological Issues
    - Spinal Accessory
    - Long Thoracic

## Repositioning the Scapula to Alter Symptoms

- Many impingement tests drive the humerus into the scapula to reproduce symptoms
  - Painful arc
  - Neer Impingement
- Would moving the scapula out of the way of the humerus alter symptoms
  - 1. Scapular Assistance Test
  - 2. Scapular Retraction Test
- Similar to distraction test for cervical radicular symptoms



## Logic of Reposition comes from Malposition

- Clinician is presented with shoulder pain and malposition of the humerus
- Rx – is reposition the humerus to reduce pain

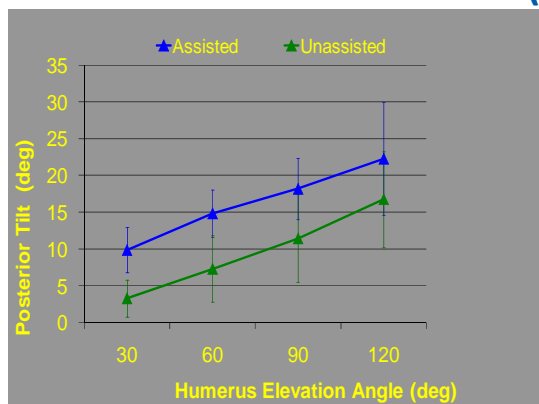


## Malposition

- Clinician is presented with shoulder pain and malposition of the scapula
- Rx – is reposition the scapula to reduce pain



## Kinematic Study of SAT Results of Posterior Tilt (n=16)



$7^{\circ} \pm 1^{\circ}$   
increase  
at every  
phase on  
average  
( $p < .001$ )

Pain reduced  
by 1 level in 9  
symptomatic  
patients  
( $p = .02$ )

## Sub-Acromial Space

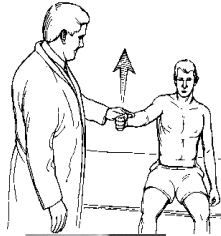
- Ultrasound assessment during Scapular Assistance Test
- Significantly increased space at 45 & 90° of Scaption
  - 1.2 mm distance from anterior acromion to humeral head
  - 3-4° of increased posterior tilt
  - 7° of increased upward rotation

– Seitz JSES 2012

## Scapular Retraction Test (SRT)

- Perform provocative test to assess arm elevation strength
- Repeat test with patient actively retracting the scapula and clinician manually stabilizing scapular medial border toward the thorax then retest strength
- (+) Test – Improved strength and /or pain reduction
- Interpretation - to differentiate between true and apparent rotator cuff weakness in patients with shoulder pain

– Kibler & McMullen JAAOS 2003



## Retraction Test

- Increase in strength in retracted position
  - 24% in injured
  - 13% in controls
- No change in pain
- Apparent cuff weakness may be arising from poor scapular control
  - Kibler et al., AJSM 2006
- Scapular Reposition Test – only manual support
- 98 overhead athletes with impingement signs
  - 46 had pain reduction of at least 1pt
  - <30% had strength increase with SRT
    - Tate et al. JOSPT 2008



## Results- Kinematics (Relative Change from Rest)

Kibler JOSPT 2009

	Not Stab.	Stab	Change	p
UR	15.7±6.4°	15±9°	0	NS
IR	8.1±9.3°	-7±10°	-8.9°	.002
PT	5±5°	16.6±7°	11.6°	.001
Prot.	2.6±	-2.6±	-5.3	.005
Elev.	8.9±11°	-5.8±27°	-14	.006

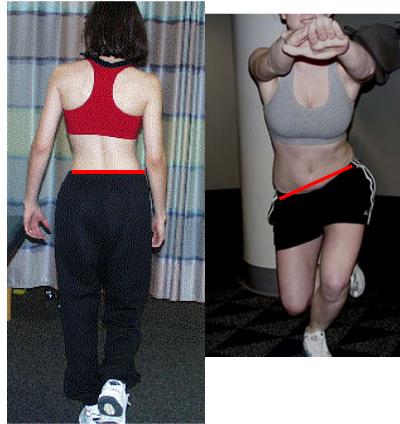
## Be careful of the Myopic View

- Without proximal control distal movement are compensating for a poor foundation
- Breakdown along the kinetic chain can
  - Increase demand on upper extremity musculature
  - Change the biomechanical stresses
  - Diminish performance
- 47% of 199 overhead throwing athletes with elbow pain had poor single leg squat control
  - Kibler et al., AOSSM abstract 2009



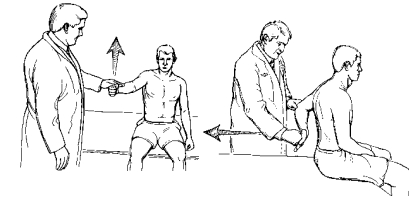
## Functional Assessment of Core Stability

- **Single leg balance**
  - Trendelenberg
- **SLS squat**
  - Frontal plane control
    - Hip
    - Knee
- **Interpretation**
  - Poor - basic mat program that develops local muscle activation
  - Good - incorporate with distal extremity rehabilitation



## Muscle Testing

- **Rotator Cuff**
  - Thumb up
  - Lift Off
  - External Rotation
    - Kelly et al., Am J Sports Med 1996
- **Scapular Muscle Test**
  - Isolated Upper & Lower Trapezius
  - Testing motions for
    - Serratus
    - Rhomboids & Middle Trapezius
      - Michener Phys Ther 2005



## Shoulder Mobility

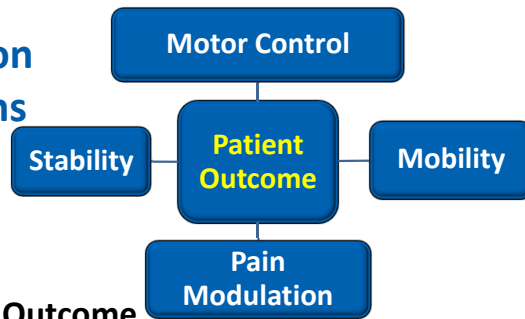
- **Isolate glenohumeral motion**
- **Stabilize scapula improves reliability**
  - Awan, Arch Phy Med Rehab 2002
- **Throwing athlete internal rotation deficit is common**
  - Wilk AJSM 2011
  - Kibler Clinics Sports Med 1988
- **Loss of IR and TROM is predictive of injury**
  - Wilk AJSM 2011
  - Shanley AJSM 2011
- **Horizontal Adduction deficit is present in pathological shoulder**
  - Myers, AJSM 2006
- **Improves as symptoms improved during rehabilitation**
  - Tyler, AJSM 2010



## Assessment to Intervention

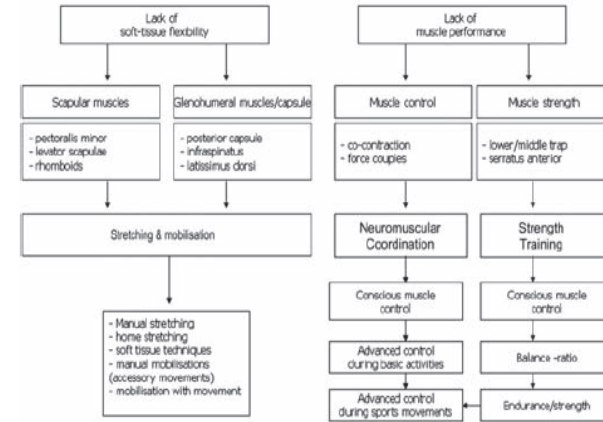
- **History**
- **Observation**
  - Static
  - Dynamic
- **Function**
  - Mobility – ROM – End Feel
  - Motor – Control – Strength
- **Palpation**
- **Neurological**
  - Spinal lesion
  - EMG/NCV if necessary
- **Level of Irritability**
  - Less is more
- **Demand level**
  - What is patient's expectation
- **Time of season**
- **Impairments identified in exam**
  - Prioritize problems
  - Could I alter symptoms during active motion
    - Scapula
    - Humeral

## Rehabilitation Interventions



- Goal is Patient Outcome
- Is it a mobility problem
- Is it a stability (motor control) issue
- Where is pain coming from?

## Scapular Rehabilitation Algorithm



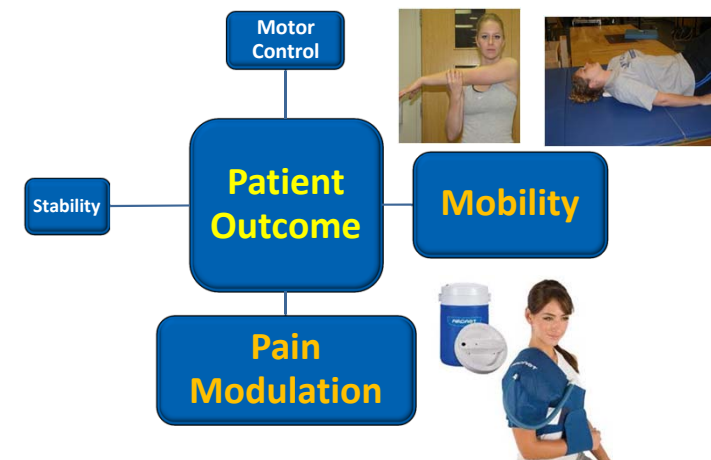
Ellenbecker & Cools Br J Sports Med 2010

## Scenario

- Tennis player presents with acute tendonopathy of rotator cuff 2° due to increased activity level over last 5 days
- Limited ROM in ER and IR
- Weak and painful ABD & ER
- Scapular dyskinesis



## Rehabilitation Plan



## Mobility Interventions

- Need to re-establish mobility or lengthen tight tissues
  - Pectoralis Minor/Major
  - Posterior Shoulder Tightness
  - Cervical / Thoracic spinal joint mobility



### Stretching Matrix

Anterior			
Home	Towel Roll	1 arm doorway	2 arm doorway
Clinic	Massage/ Manual	Contract/Relax	Manual w/ trunk
Posterior			
Home	Cross body	Cross body stabilized	Sleeper stretch
Clinic	Massage/ Manual	Contract/Relax	Active stretch
Cervical/Thoracic			
Home	Supine AROM	Sitting AROM	Manual overpressure
Clinic	PROM and Massage	Contract Relax	Mobilization
Inferior*			
Home	Towel slides	Doorway slides	
Clinic	Massage/ Manual	Contract/Relax	Active stretch

### Address Mobility: Anterior Structures



- Watch for leaning
- Emphasize stepping

- Watch for Neurological Symptoms

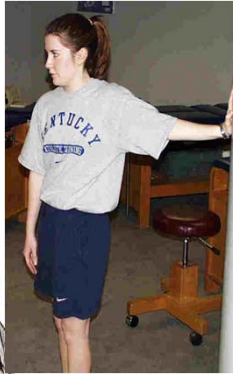
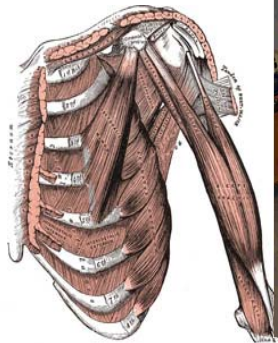
### Address Mobility & Motor Control: Anterior Structures

- Encourage Cervical Retraction and Scapular Retractors
  - Prevent irritation
  - Activation of scapular muscles may facilitates reciprocal inhibition of tight anterior musculature



## Address Mobility: Anterior Structures

- Other muscles attach to the coracoid
  - Short head of the biceps
  - Coracobrachialis
- Constantly check for scapular position & neurological Sx's



## Addressing Posterior Shoulder Tightness and Scapular Stability



- Stabilizing scapula with overpressure
- Integrate massage to teres minor/latissimus dorsi
  - Trigger point release



## Stretching the Posterior Tissues

- Adaptive changes can occur shortening posterior cuff/capsule
  - Kibler et al., Clin Sports Med 1988
- Cross body adduction with scapula stable and humerus internally rotating
- Cross body adduction increases IR motion by 20°
  - McClure et al., CSM 2005
- Hold Stretch 30 seconds (No Pain)
  - Bandy et al., Phy Ther 1994
- Considers variations in arm position and stabilizing scapula



## Spinal Mobilization Options

- Various techniques can be applied
- Consider patient level of irritability
  - Contraindications
- Great description & videos online through JOSPT
  - Tate et al., JOSPT 2010



## Scenario

- Elite Volleyball player with chronic tendonopathy of rotator cuff for last year
- Pain dramatically increases in the third set
- No AROM or PROM limitations
- Weak and painful Flexion & ER
- Scapular dyskinesis
  - (+) Scapular Retraction Test
- Start of the season



## Motor Control: Strengthening

- Continuum of functional exercises based on irritability
  - Isometric Low row
  - Prone extension at 0°
  - Side-lying External Rotation
  - Rowing incorporating contralateral hip extension
  - Prone horizontal abduction at 90°
- Scapular control and pain response



## Fundamental Program

- Side-lying
  - Elevation
  - ER
- Prone
  - Horizontal Abduction with ER
  - Extension
- Result improved SPADI score by ~20 points in 6 weeks
- Effectively reduced UT during active elevation



Scapular Muscle Rehabilitation Exercises in Overhead Athletes With Impingement Symptoms

Effect of a 6-Week Training Program on Muscle Recruitment and Functional Outcome

Kristof De Mey,<sup>1</sup> PT, Lieven Danneels,<sup>1</sup> PT, PhD, Barbara Cagnie,<sup>1</sup> PT, PhD, and Ann M. Cools,<sup>1</sup> PT, PhD  
Investigation performed at Ghent University Hospital, Department of Rehabilitation Sciences and Physiotherapy, Ghent, Belgium

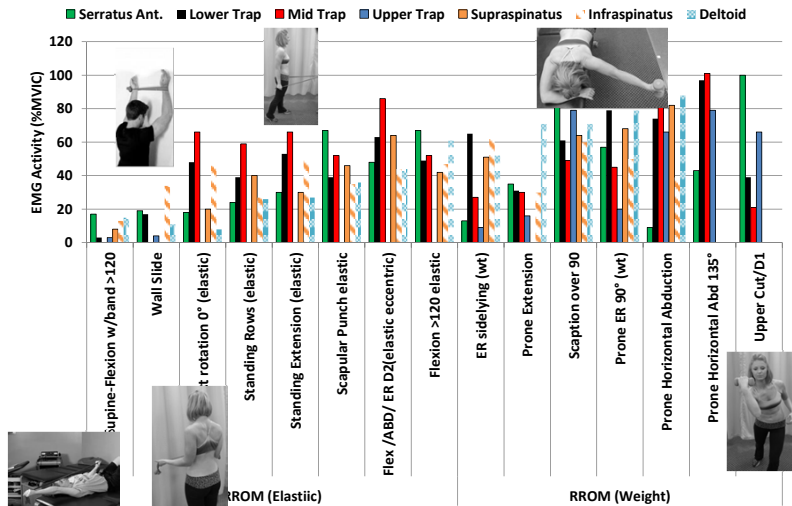


## Conscious Control Increases Motor Activity

- Visual, Auditory, & Kinesthetic cueing of scapular orientation
  - Increased Scapular Muscular Recruitment by 7-10% in Sidelying ER & Prone Extension
  - No alteration of UT/LT muscle ratios occurred
    - DeMey et al., JOSPT, 2013
- Auditory & Kinesthetic cueing of scapular of scapular retraction during PHA
  - Increased lower trapezius activation over written instructions by 10-15%
    - Seitz, J Electromyography Kines 2014

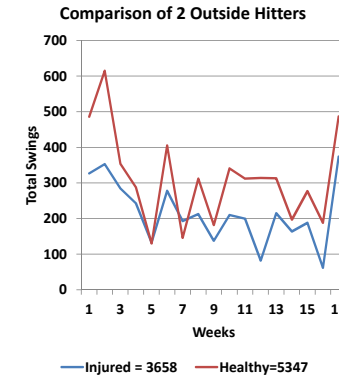


## Exercise Continuum



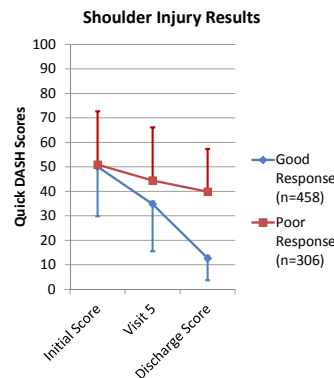
## Managing Volume of Swings

- Volleyball athlete was determined to have SLAP lesion prior to season with chronic shoulder pain
- Alternated days of overhead swings throughout the season
- Participated in all game sets (n=118)
- Attempted most attacks (n=1010) had 21.5% kill rate



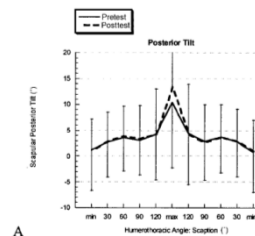
## Early Changes Predict Outcomes

- Analysis of 107 patients with sub-acromial impingement signs revealed 2 primary predictors
  - For every 10% improvement in the first 5 visits (2 wks) increase the chance of a good outcome by 20%
  - Scapular retraction exercises given in first 5 visits increased the chance of good outcome by 4 fold



## Altering Scapular Kinematics is Difficult

- 6 wk intervention on patients clinically with Impingement Syndrome
  - Posture
  - Shoulder Flexibility
  - Rotator Cuff Strengthening
- Improved
  - Strength ↑ 15-25%
  - Function ↑ 20 points
  - IR and ER ↑ 20%
- No Change
  - Posture
  - Scapular Kinematics
- Dependent Measures
  - Scapular Kinematics
  - Posture
  - Strength
  - Function



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## Summary

- **Functional Anatomy: Biomechanics - Know and understand normal to recognize abnormal**
  - Variations of normal among athletes
- **Incidence - Common**
- **Assessment integrated into standard Examination – Easily**
  - Keep it simple
- **Repositioning– Reduction of pain indicates scapular position/motion is a factor in shoulder pain**
- **Interpretation – Impairment that may need to be incorporated into treatment intervention**
- **Intervention – Keep it patient centered**
  - Mobility issue
  - Motor Control issue
  - Modulate pain with exercise selected

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**KENTUCKY**

College of Health Sciences



see blue.



“The sun shines bright on  
my old Kentucky home...”