Evidence Based Approach to Addressing Shoulder Pain Through Exercise: The Activation and Imbalance of the Upper Trapezius, Lower Trapezius, and the Serratus Anterior

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OBJECTIVES

1. ***Understand the role of the scapulothoracic force couple and the relationship to shoulder injury***
2. ***Identify evidence based exercises that restore muscular control and balance of the UT, SA, LT***
3. ***Implement these exercises in everyday rehabilitation practice***

Prevalence of Shoulder Pain

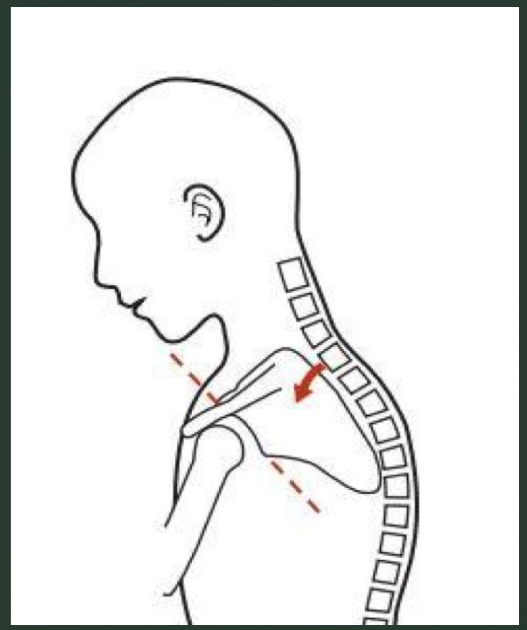
- Shoulder pain is a pervasive complaint associated with overhead athletes
- Interfering shoulder pain has been reported in up to 87% of swimmers at some point throughout their career (Pink et al. 2000, Madsen et al. 2011)
- Incidence of shoulder injuries in overhead athletes occur 1.8/1000 hours (Asker et al. 2017)

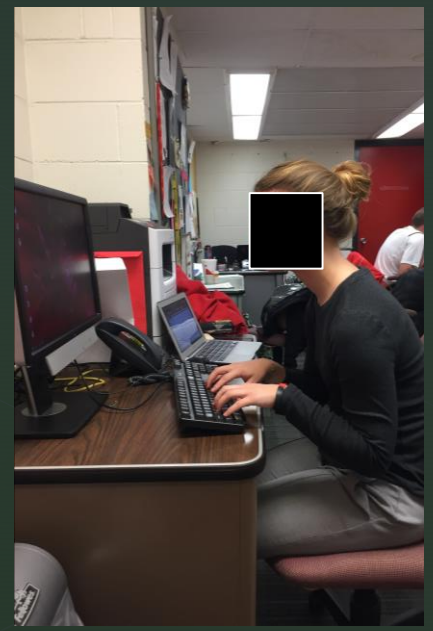
Prevalence of Shoulder Pain

- Shoulder pain is also one of the most common complaints among the general population
  - It is the third most common musculoskeletal complaint in orthopedic practice (Garving et al. 2013)
  - 60% of the population complain of shoulder pain at some point in their life (Cools et al. 2013)

Long periods or sitting and computer use can lead to altered scapular resting position resulting in shoulder and neck pain

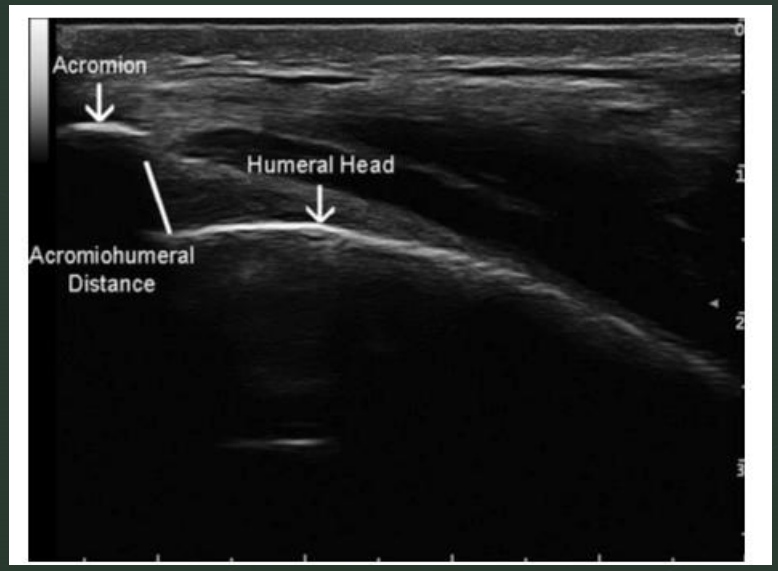
Cools et al. 2013





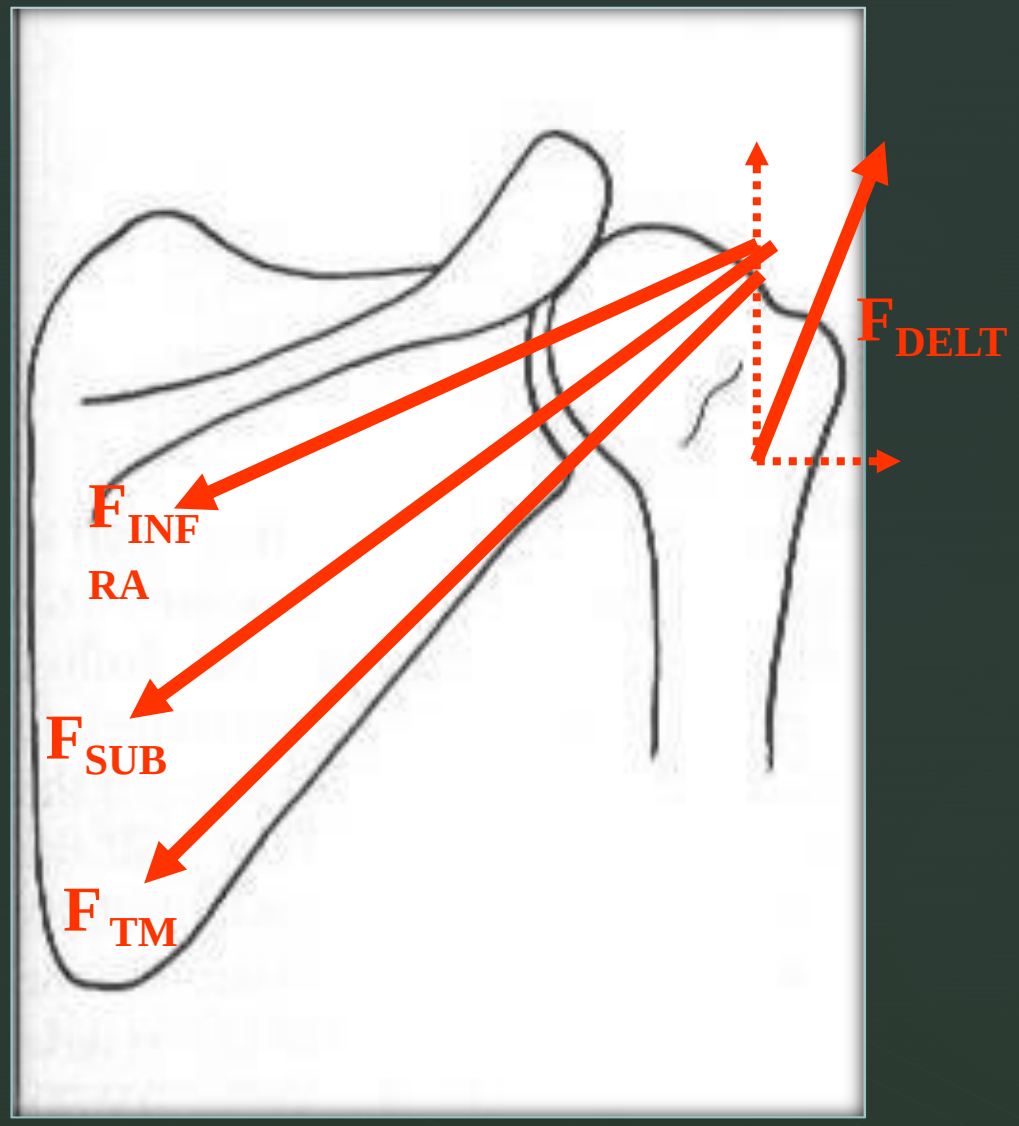
Anatomy
Subacromial Space

- Borders:
  - humeral head
  - anterior acromion process
  - coracoacromial ligament
- Width: 1.0 – 1.5 cm
- Structures:
  - Subacromial bursa
  - Supraspinatus tendon
  - Capsule
  - Long head of the biceps

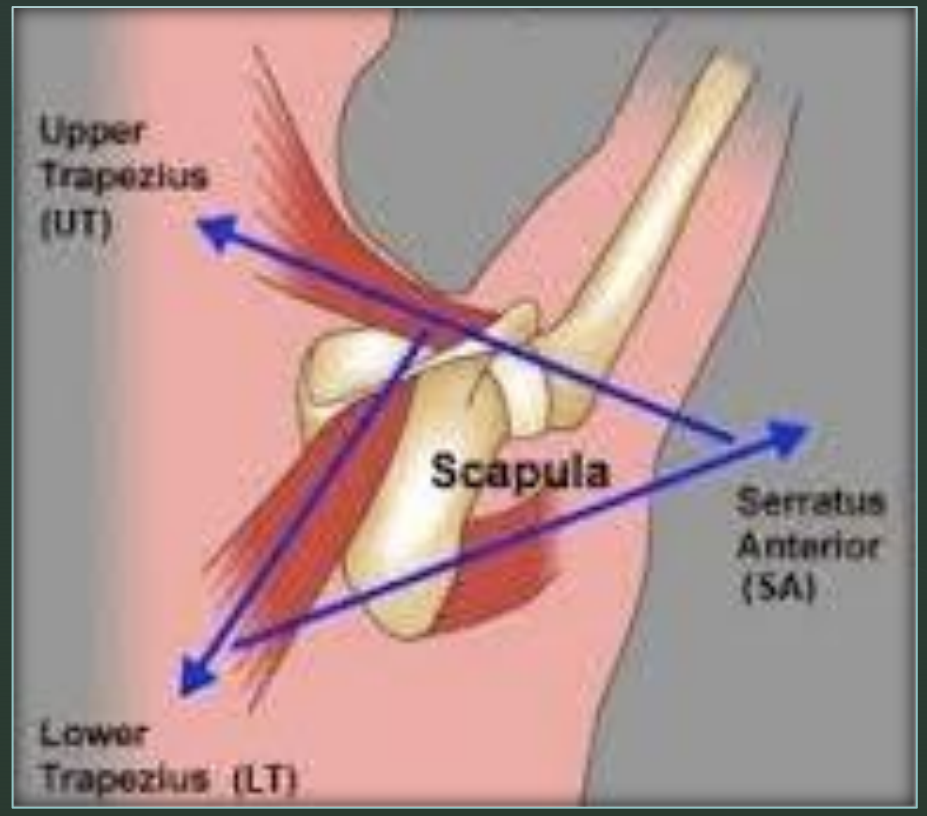


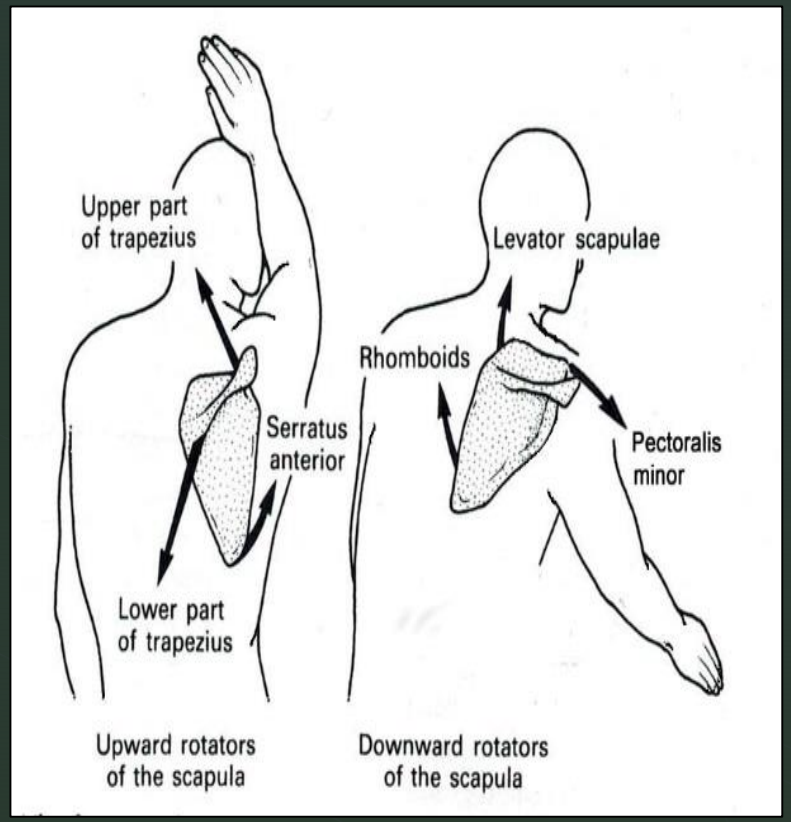
Muscular Anatomy

- 17 muscles attaching to the shoulder complex
- Force couples allow for coactivation of the dynamic stabilizers in order to centralize the humeral head and allow for normal scapular kinematics



Muscular Anatomy

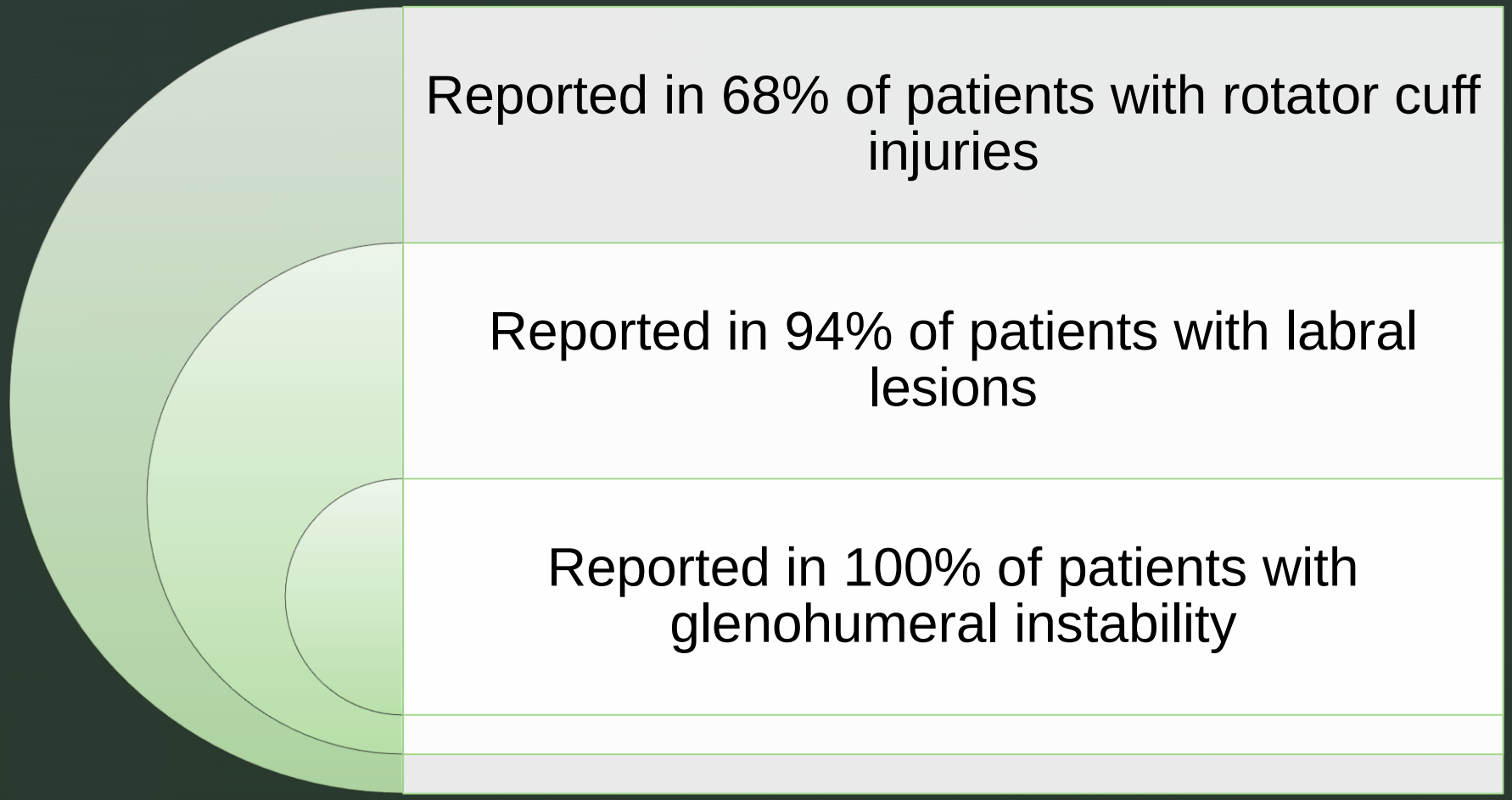




Etiology

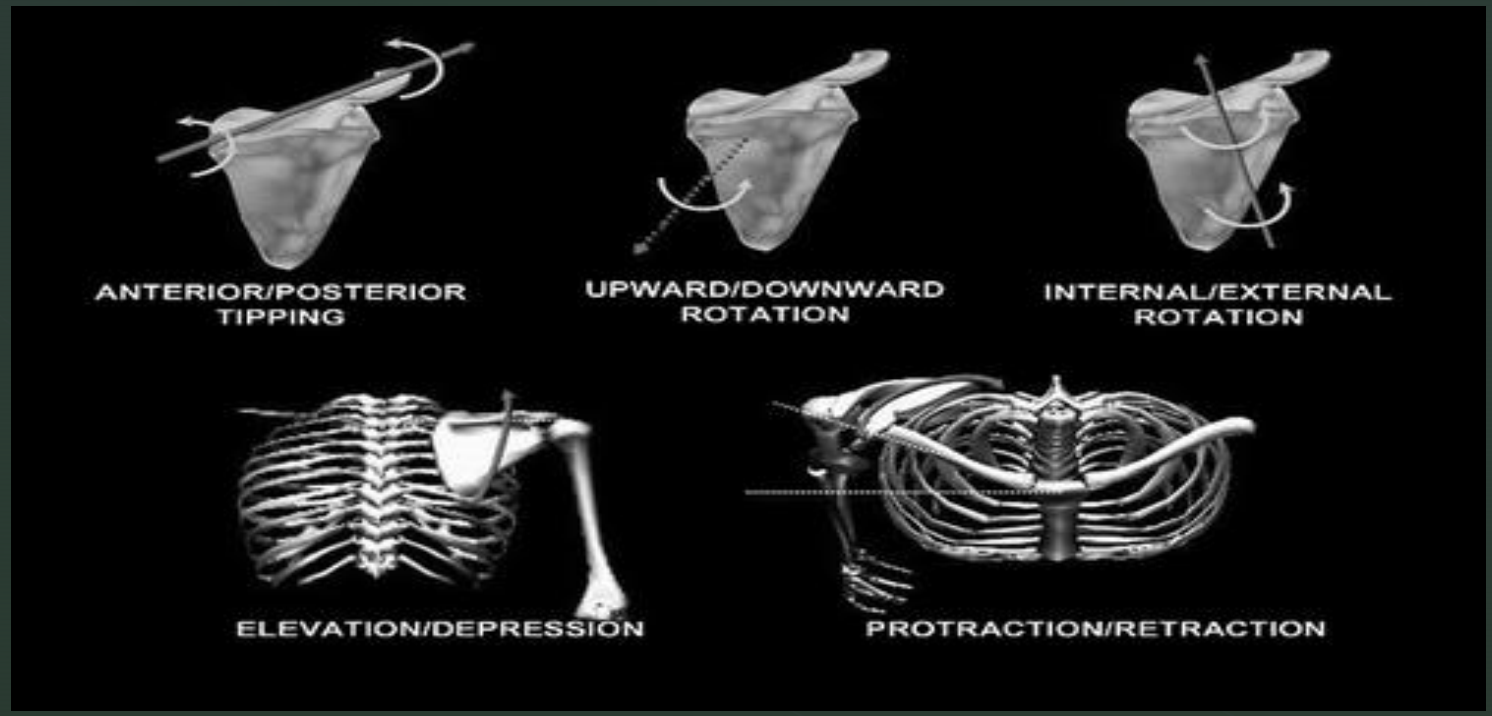
- Shoulder pain can stem from a variety of pathologies including subacromial impingement syndrome, rotator cuff tears, labral injuries, and multidirectional instability
- The more chronic injuries often stem from overuse, heavy training load, hypermobility of the shoulder, and altered scapular mechanics
- **The evidence of scapular dyskinesis present in those who complain of shoulder pain is substantial** (Ludwig et al. 2009, Kibler et al. 2010)

Scapular Dyskinesis and Shoulder Pain



Ludwig et al. 2009, Kibler et al. 2010, Carbone et al. 2015

Normal Scapular Kinematics



During humeral elevation: scapular upward rotation, external rotation and posterior tilt should occur

Scapular Dyskinesis

The alteration of normal scapular kinematics

Three different types:

Type I = Inferior angle prominence

Type II = Medial border prominence

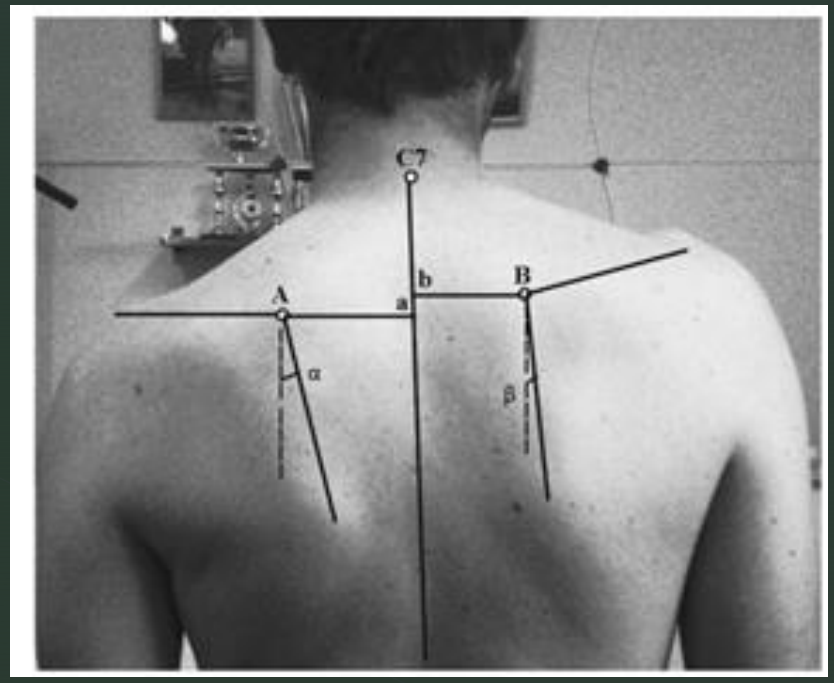
Type III= Excessive superior border elevation

Scapular Dyskinesis

SICK Scapula

- Scapular malposition
- Inferior medial border prominence
- Coracoid pain and malposition
- Dyskinesis

Burkart et al. 2003



Forward Head Posture

- Tightness in levator scapulae
- Decreased upward rotation
- Decreased posterior tilt

Ludewig et al. 2000

Rounded Shoulders

- Tightness of pectoralis major and minor
- Weakness in middle and lower trapezius

Scapular Dyskinesis and Subacromial Space

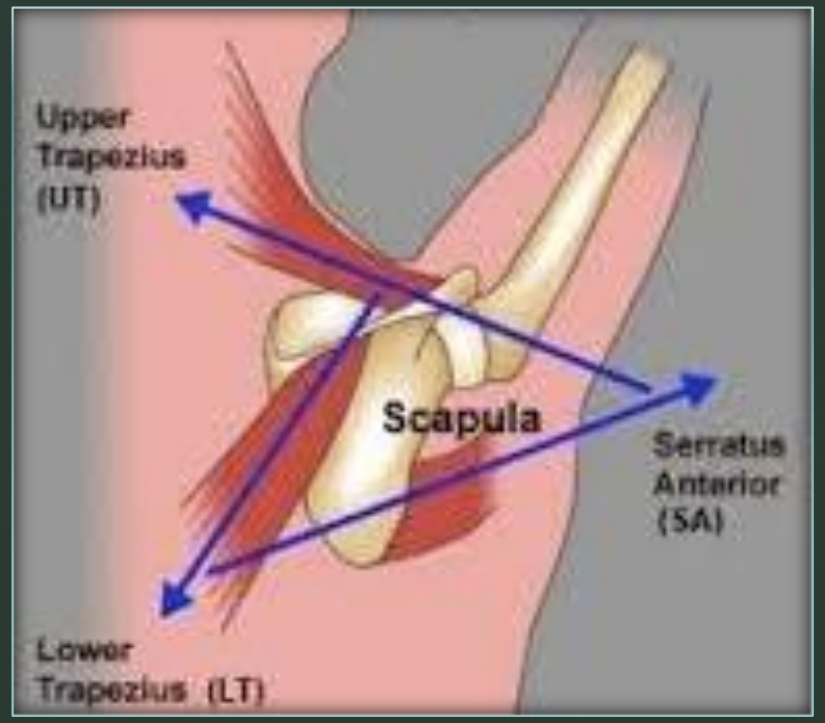
- Alterations in scapular kinematics often lead to a narrowing of the subacromial space (Paine et al. 2013, Ludewig et al. 2000, Kamkar et al. 1993)
- The most common scapular dysfunctions implicit with decreased subacromial space are excessive anterior tilt and reduced upward rotation (Ludewig et al. 2000, Michener et al. 2003)
- Any reduction in the subacromial space can lead to a host of shoulder pathologies

Dysfunction in Overhead Athletes

- Swimmers often present with forward head posture, rounded shoulders, and static and dynamic scapular positioning congruent with SICK scapula (Madsen et al. 2011)
- 82% of swimmers without shoulder pain presented with scapular dyskinesis after one training session (Madsen et al. 2011)
- Abnormal scapular position is seen with excessive protraction during cocking and early acceleration of the throwing phase (Burkhart et al. 2000)
- Associated with labral tears, internal impingement, and elbow injuries in throwing athletes (Burkhart et al. 2003)

- One potential cause of scapular dyskinesis is imbalance or altered muscular activity patterns within the scapulothoracic stabilizers
- The muscular imbalance of the force couple existing between the upper trapezius, lower trapezius, and serratus anterior is a common focus throughout the literature

Scapulothoracic Stabilizers



- Serratus anterior (SA), upper trapezius (UT), and lower trapezius (LT) produce upward rotation and provide stability for the scapula
- During humeral elevation, the LT also assists in posterior tilting of the scapula, while the SA produces protraction

Scapulothoracic Stabilizers: Strength or Balance?

- Some research attributes scapular dyskinesis to overall strength deficits; however, it is important to look at the imbalance of these muscles as they work as a force couple
- It has been seen noted that inhibition of the LT and SA is often combined with excessive activation of the UT in those with subacromial pain syndrome (Cools et al. 2007, Ludewig et al. 2000, Michener et al., 2016)
- When designing rehabilitation to address these issues, it is important to target the muscles that are inhibited, while minimally activating those that are hyperactive

SA and LT Strength and Subacromial Space

- Bdaiwi et al. placed neuromuscular electrical stimulation on the LT and SA muscles to stimulate a contraction while simultaneously observing the subacromial space via diagnostic ultrasound
  - found an increase in subacromial space with combined stimulation to the LT and SA
  - Signifies the important role these muscles play in the opening of the subacromial space.
- Timmons et al. measured subacromial space width before and after a lower trapezius fatigue protocol
  - Subacromial space decreased at 45º of arm elevation following the fatigue protocol

Rehabilitation Strategies

- The relationship between scapular dyskinesis, scapulothoracic muscle imbalance and shoulder pain is well established in the literature
- Rehabilitation must address the present dysfunctions
- When dyskinesis is identified, It is essential to focus on exercises that restore neuromuscular control and the balance of the UT, LT, and SA

Rehabilitation Strategies

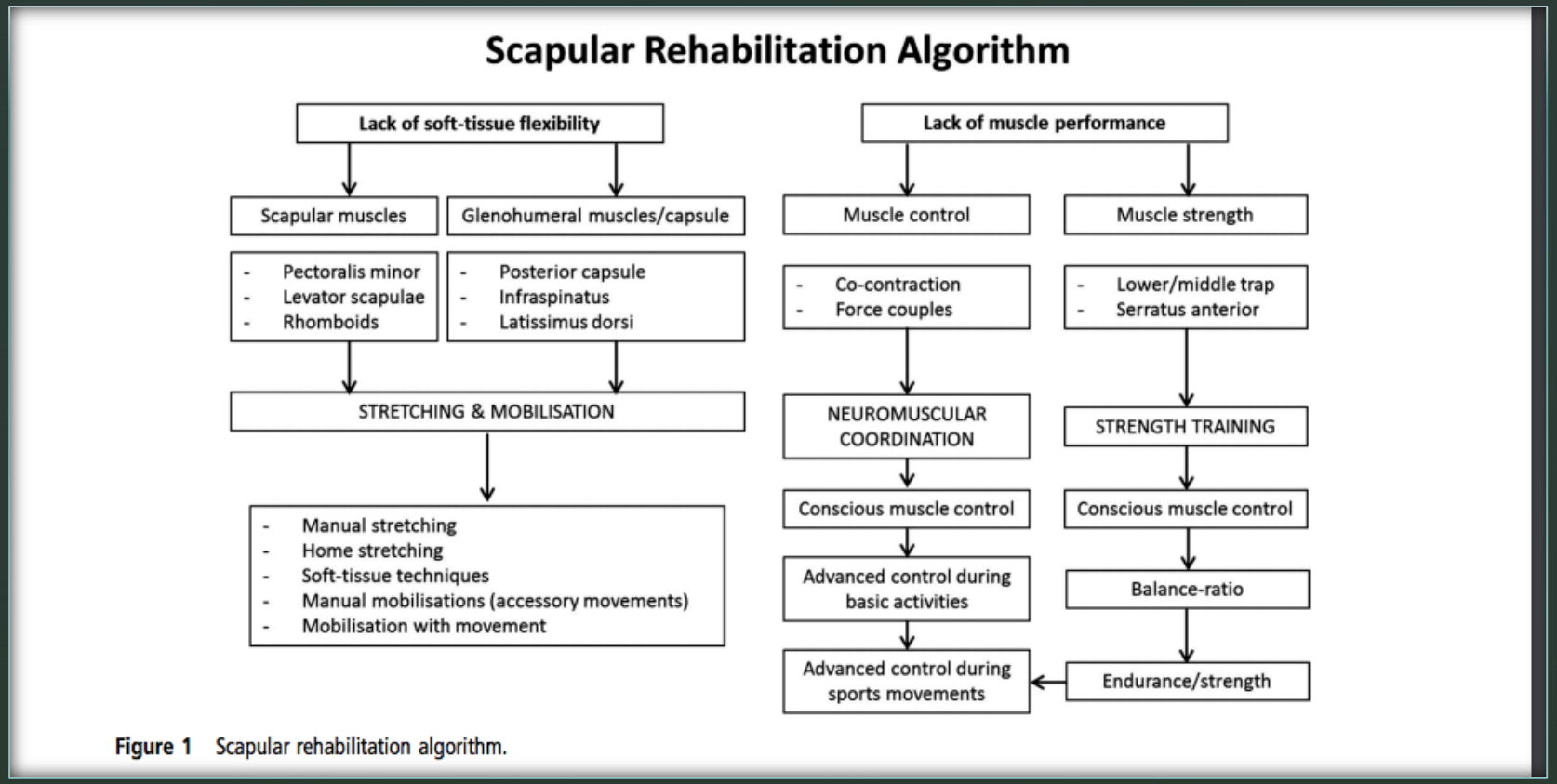
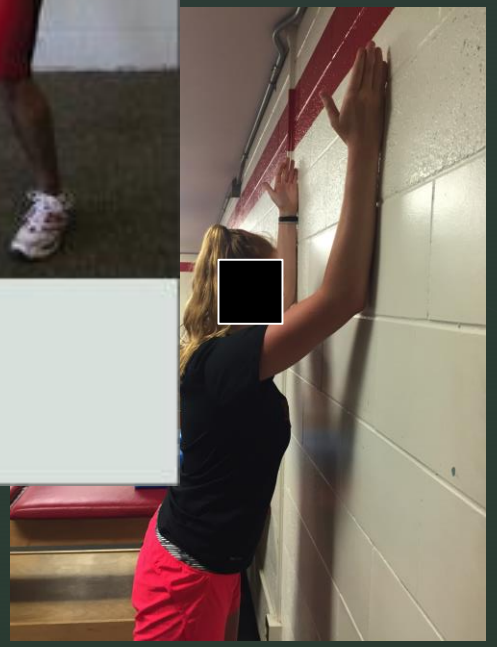


Figure 1 Scapular rehabilitation algorithm.

When scapular dyskinesis is present, it is important to distinguish between strength deficits, imbalances, or flexibility/tissue length

(Cools et al. 2013)

Activation Exercises Serratus Anterior

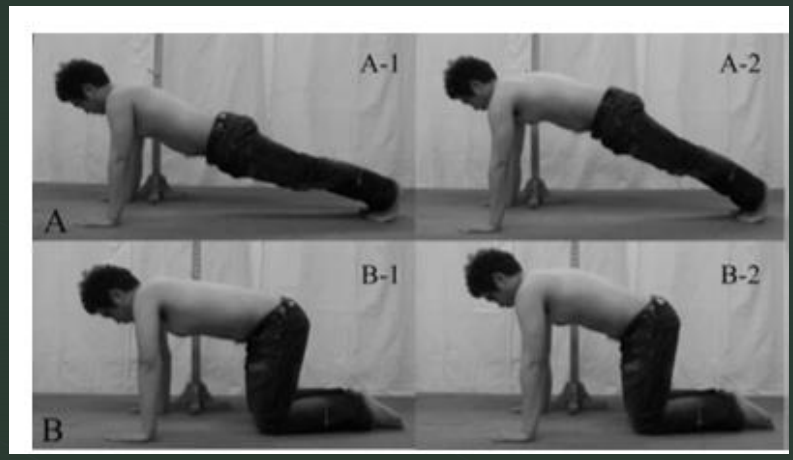


Wall Slides

Hardwick et al. 2006

Standing Scaption to 120º

Ekstrom et al. 2003,
Hardwick et al. 2006



Push-up Plus

Hardwick et al. 2006, Reinold 2009

Activation Exercises Serratus Anterior

Scapular Punches
Ekstrom et al. 2003

Dynamic Hug
Ekstrom et al. 2003, Reinold 2009

Inferior Glides
Kibler et al. 2008

Activation Exercises Lower Trapezius

Prone Ys

Ekstrom et al. 2003

Prone Ts with external rotation

Ekstrom et al. 2003

Scaption to 120º

Ekstrom et al. 2003

Activation Exercises Lower Trapezius

Prone shoulder external rotation at 90º abduction

Ekstrom et al. 2003

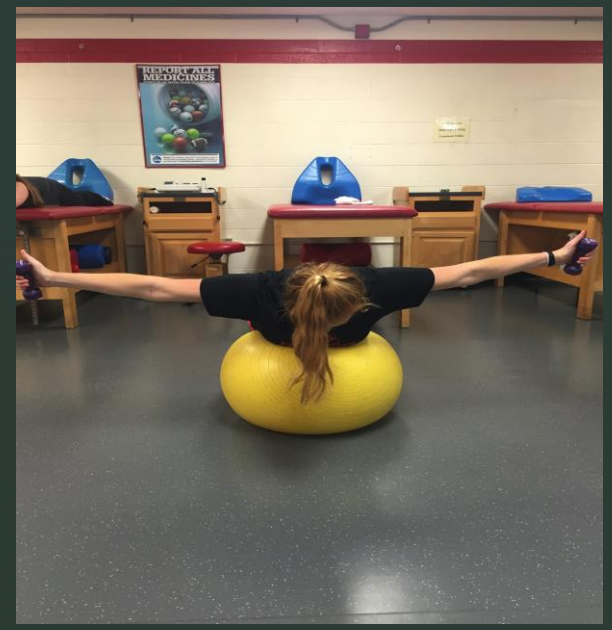
Prone Extension

Cools et al. 2007

Balance of the UT/LT

- Forward flexion in a side-lying position
- Side lying external rotation
- Prone horizontal abduction with ER (Ts)

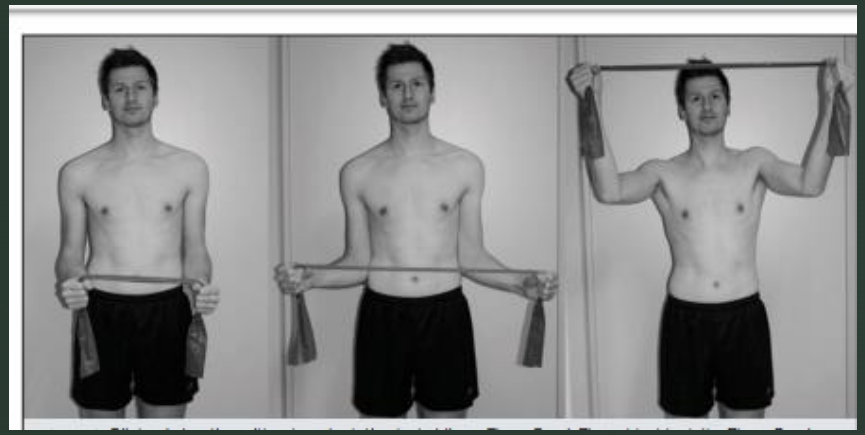
Cools et al. 2007



Balance of the UT/LT

Shoulder elevation with resisted ER

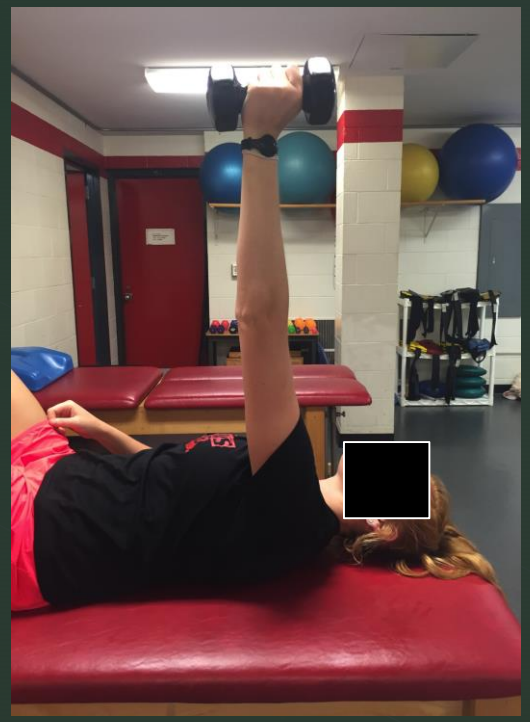
- High LT/MT activation with lower UT



Casteleine et al. 2016

Balance of UT/SA

- Scapular punches
- Push-up plus
- Inferior glides



A balancing act

Rehabilitation Strategies

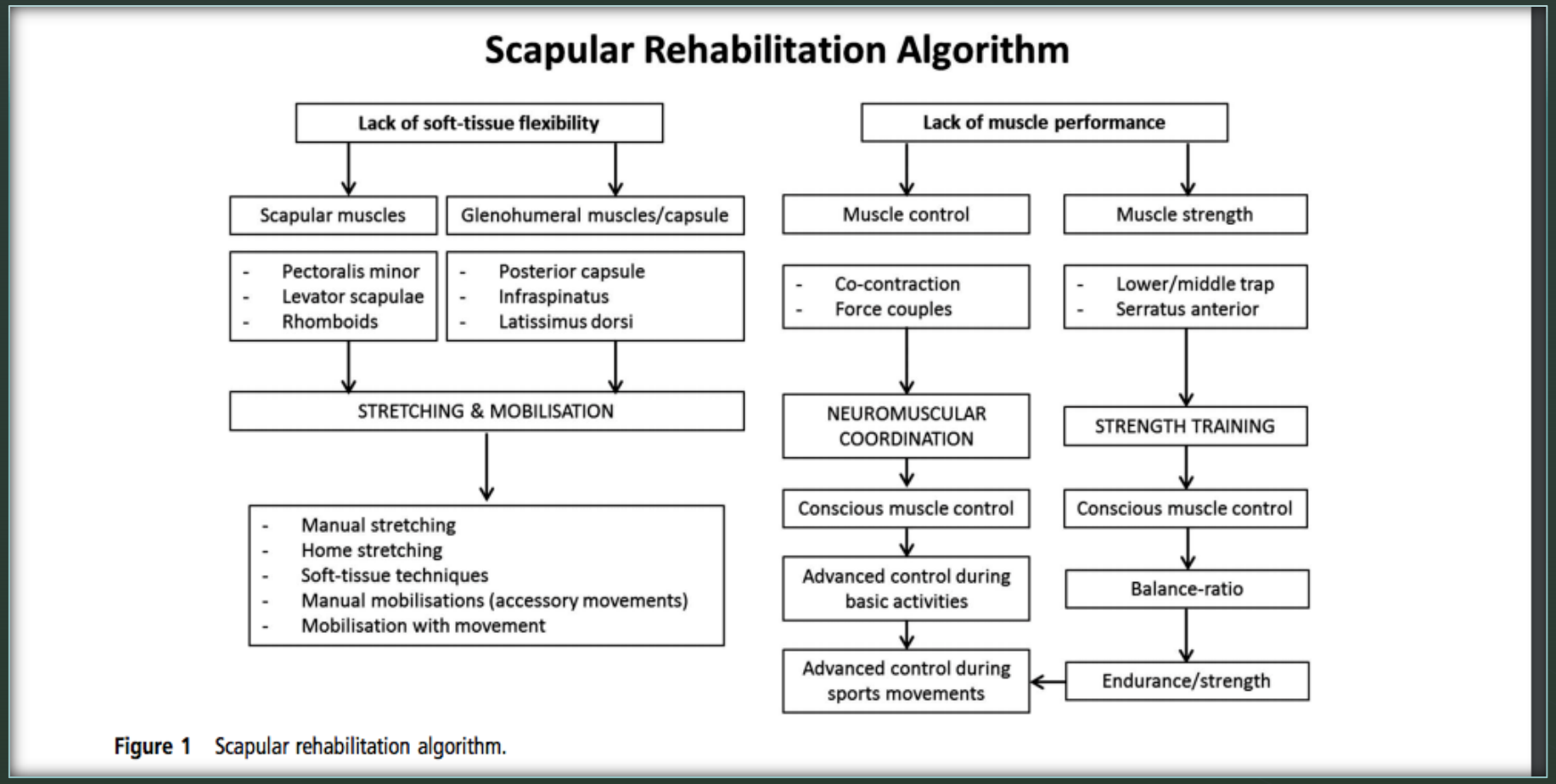


Figure 1 Scapular rehabilitation algorithm.

(Cools et al. 2013)

Rehabilitation Strategies

- Exercises for early stages of rehabilitation
  - Inferior glide
  - Side-lying ER
  - Prone extension
  - Scapular punches

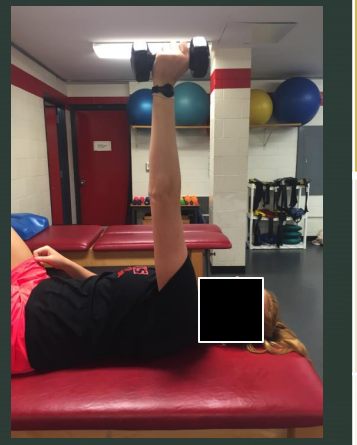
Rehabilitation Strategies

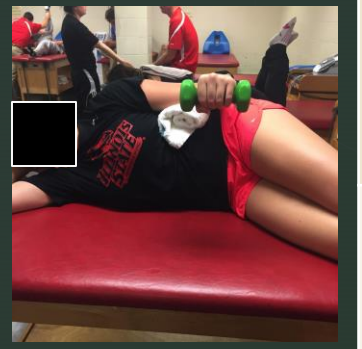
- Exercises for middle to late rehabilitation stages
  - Prone shoulder external rotation with 90º abduction
  - Prone Ys
  - Push-up plus
  - Wall Slides*

A study that looked at the effect of a 4-week strengthening intervention program, specifically targeting the lower trapezius and serratus anterior muscles, on scapular upward rotation, forward shoulder posture, and subacromial distance in collegiate swimmers

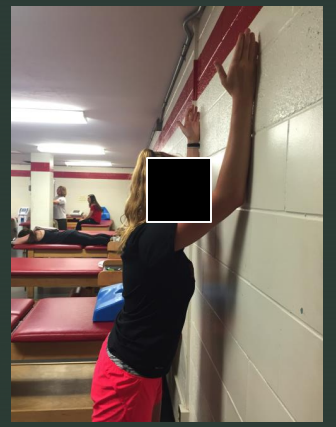
Intervention group:

Control group:





Exercise	Muscles Activated
Prone Ts w/ ER	MT/LT
Prone Ys	MT/LT/SA
Scaption (0-120)	LT/SA
S/L Fwd Flexion	LT/SA
S/L ER	LT
SA Wall Slides	SA
Scap Punches	SA
Inferior Glides	LT/SA



Significant differences were found between groups in the right subacromial space (p=.001), but not the left (p=.797).

	Baseline Covariate Value	Exercise Post 4-weeks	Control Post 4-weeks	Effect size	P-value
Subacromial Space					
Right	13.1	13.76±.39	11.22±.51	1.88 (.83-2.93)	p=.001*
Left	12.4	12.5±1.01	12.95±1.32	−.13 (-1.01 - .75)	p=.797

Conclusion

- Shoulder pain is prevalent throughout the population
- Intensity of training will continue to predispose overhead athletes to shoulder pain
- Addressing scapular kinematic dysfunction with the exercises that work towards correcting imbalances is essential

Thank you!

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