Glenohumeral Internal Rotation Deficit: Mechanisms and Operational Definitions for Clinicians

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Disclosures

- No one pays me for selling/promoting things

Objectives

- Recognize the frequency of shoulder pain in youth overhead athletes
- Understand the association of GIRD and injury risk in overhead athletes
- Define the three main mechanisms that contribute to internal rotation deficit of the shoulder in overhead athletes
- Apply the clinical definitions of GIRD to prevent and treat upper extremity injuries in overhead athletes

Discussion Points

1) Mechanisms of GIRD
2) What do bony adaptations of the shoulder mean for shoulder ROM?
3) How does a tight posterior capsule affect our treatment decisions as clinicians?
4) What ROM deficits should be address clinically?
5) Are these ROM changes protective adaptations, or pathological processes?

Combatting Demands of OH Athletics

Sports Specialization….

Little research at this time

Clinically, we see the impact…

Sports Specialization…

30.7%

43.4%

19%

↑ Risk of Arm Tiredness & Arm Pain

↑ Risk of Pitching-related Injuries

Yang et al., *AJSM* 2014

Youth Baseball…

1,563 7-12 year olds

15.9% Shoulder Pain

29.2% Elbow Pain

Matsuura et al., *Phys Sportsmed* 2016

Youth baseball…

In a survey of over 200 healthy baseball players ages 8-18

- 74% reported pain while throwing
- 80% reported pain the day after throwing

46% reported being encouraged to continue playing despite arm pain

Makhni et al., *AJSM* 2015

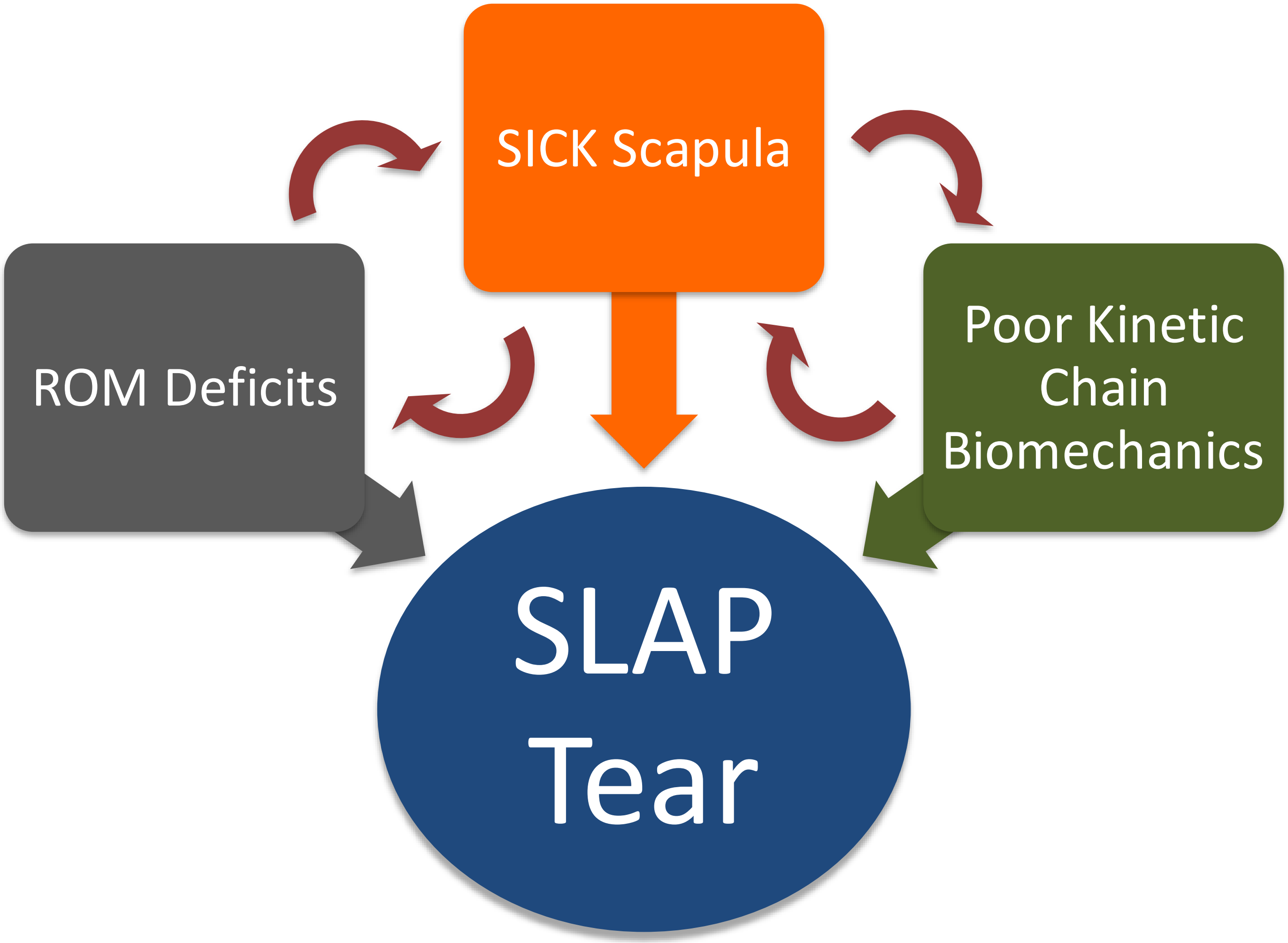
Clinically, we see a large number of year-round volleyball, baseball, and softball players with chronic shoulder and/or elbow pain

What ***pathology*** is at play?

“Shoulder Impingement” is <u>not a specific diagnosis</u> that we can treat in young patients

Where it started…

The Disabled Throwing Shoulder (Burkhart et al., 2003)

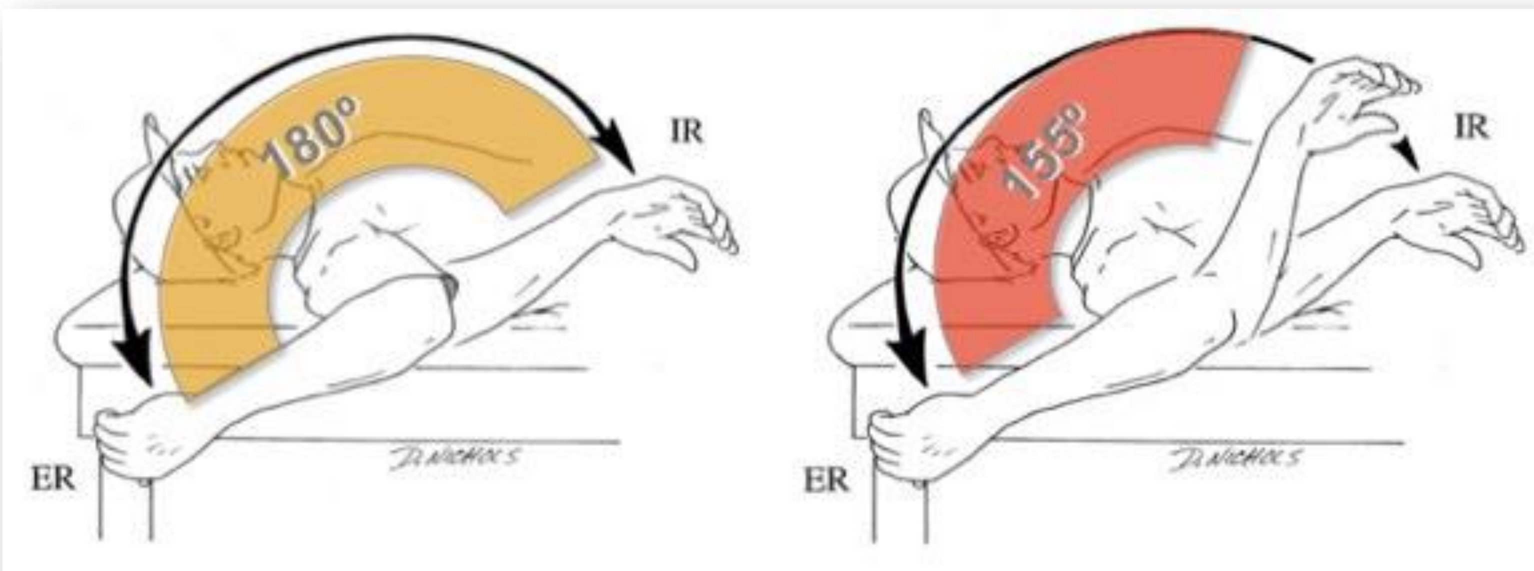


Definition of GIRD…

It Has Evolved

Limitation of Internal Rotation on dominate vs. non-dominate shoulder

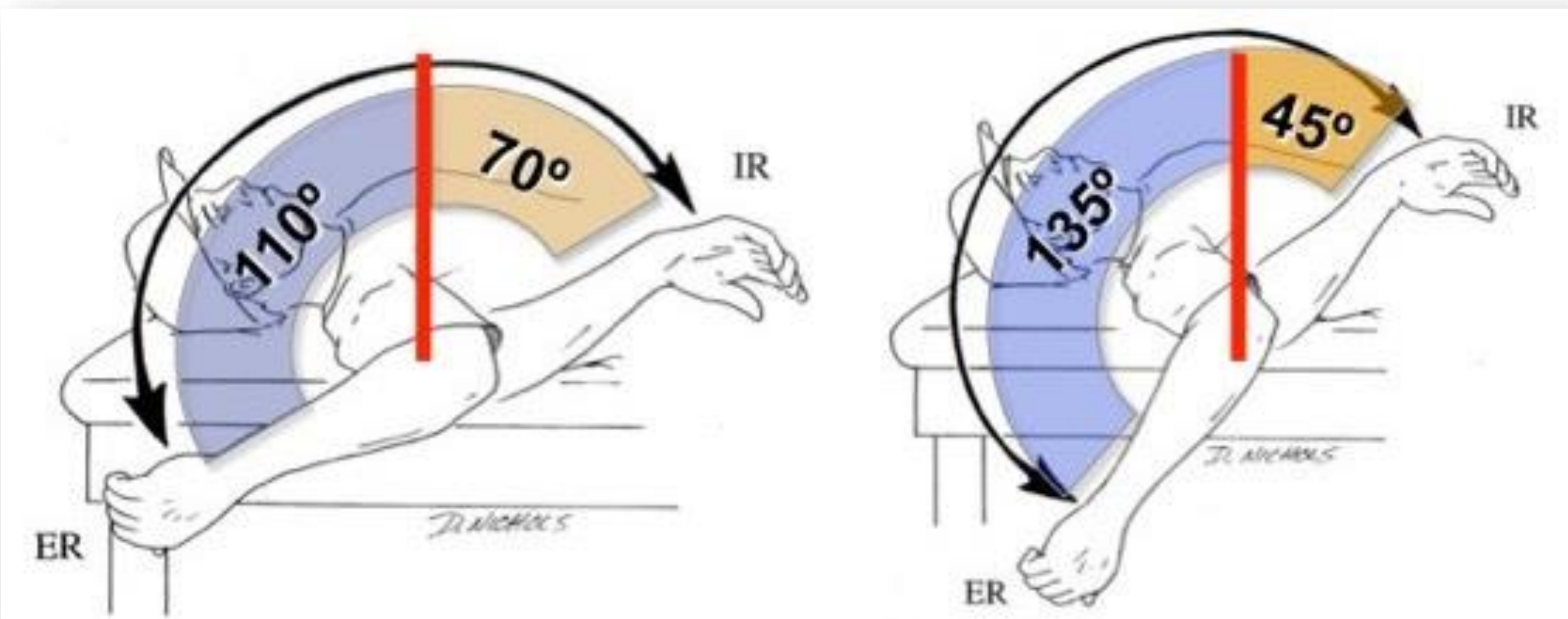
– Originally described as anything over 25 deg.



Definition of Total Range of Motion…

Difference in Total ROM (TRM) of dominate vs. non-dominate shoulder (ER + IR)

- Passive, supine in 90 deg. ABD, scapula stabilized



ROM Deficits → INJURY

- Glenohumeral internal rotation deficit (GIRD)
  - Players with ≥ 25 degree deficit in internal rotation on throwing side were at 4 times greater risk for upper extremity injury (Shanley, 2011)
- Loss in total range of motion (TRM)
  - Pitchers with deficits > 5 degrees were at 2.5 times greater risk for shoulder injury (Wilk, 2011)
  - Pitchers with deficits > 5 degrees were at 2.6 times greater risk for elbow injury (Wilk, 2014)
- Loss in shoulder flexion range of motion
  - Pitchers with deficits ≥ 5 degrees were at 2.8 times greater risk for elbow injury (Wilk, 2014)
- Loss in shoulder external rotation
  - < 5 degrees greater external rotation in the throwing shoulder placed athlete 2.2 times more likely to be on the disabled list due to shoulder injury (Wilk, 2015)

GIRD?

What are the *<u>mechanisms</u>* of Glenohumeral Internal Rotation Deficit?

MECHANISMS OF GIRD

- BONY ADAPTATIONS
- CAPSULAR
- SCAPULA/SOFT TISSUE

MECHANISMS OF GIRD

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BONY ADAPTATIONS

Humeral Torsion

"bony twist about the long axis of the humerus"

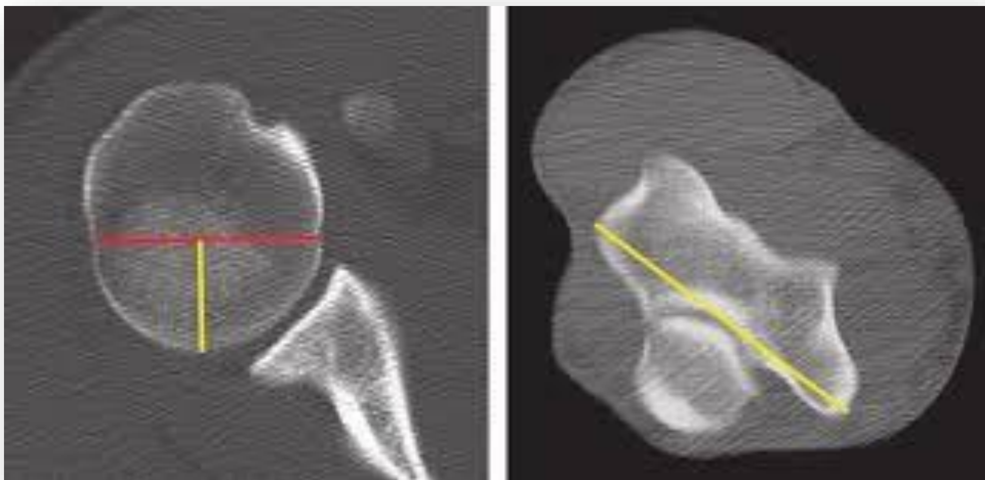
Occurs during skeletal immaturity

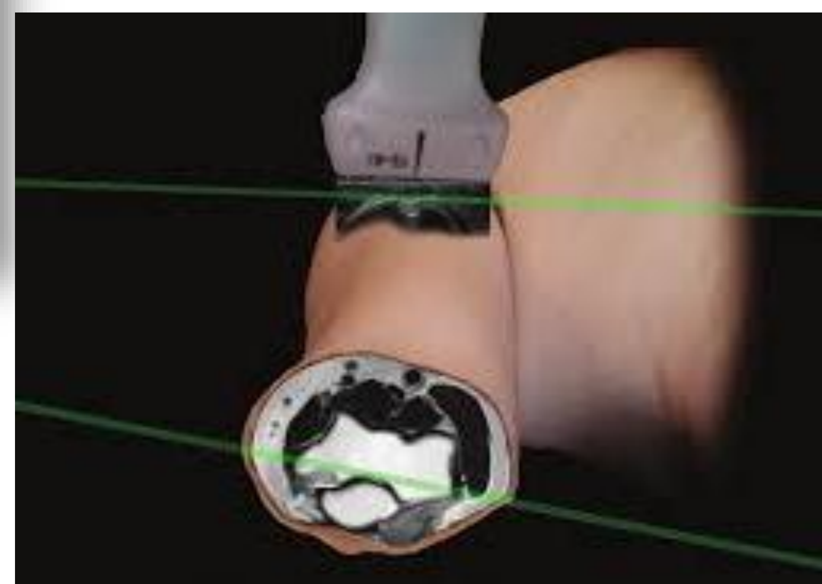
Humeral head remodels in a more posteriorly oriented direction

BONY ADAPTATIONS

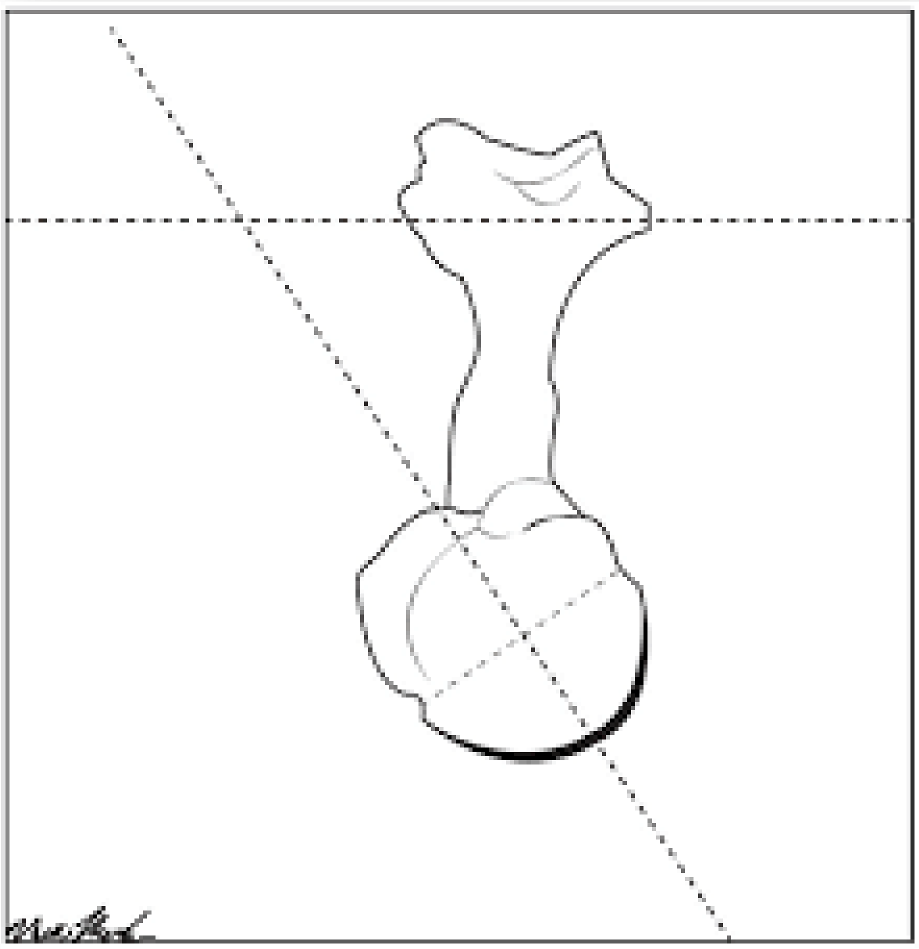
Humeral Torsion

Measured via CT or Ultrasound imaging





BONY ADAPTATIONS



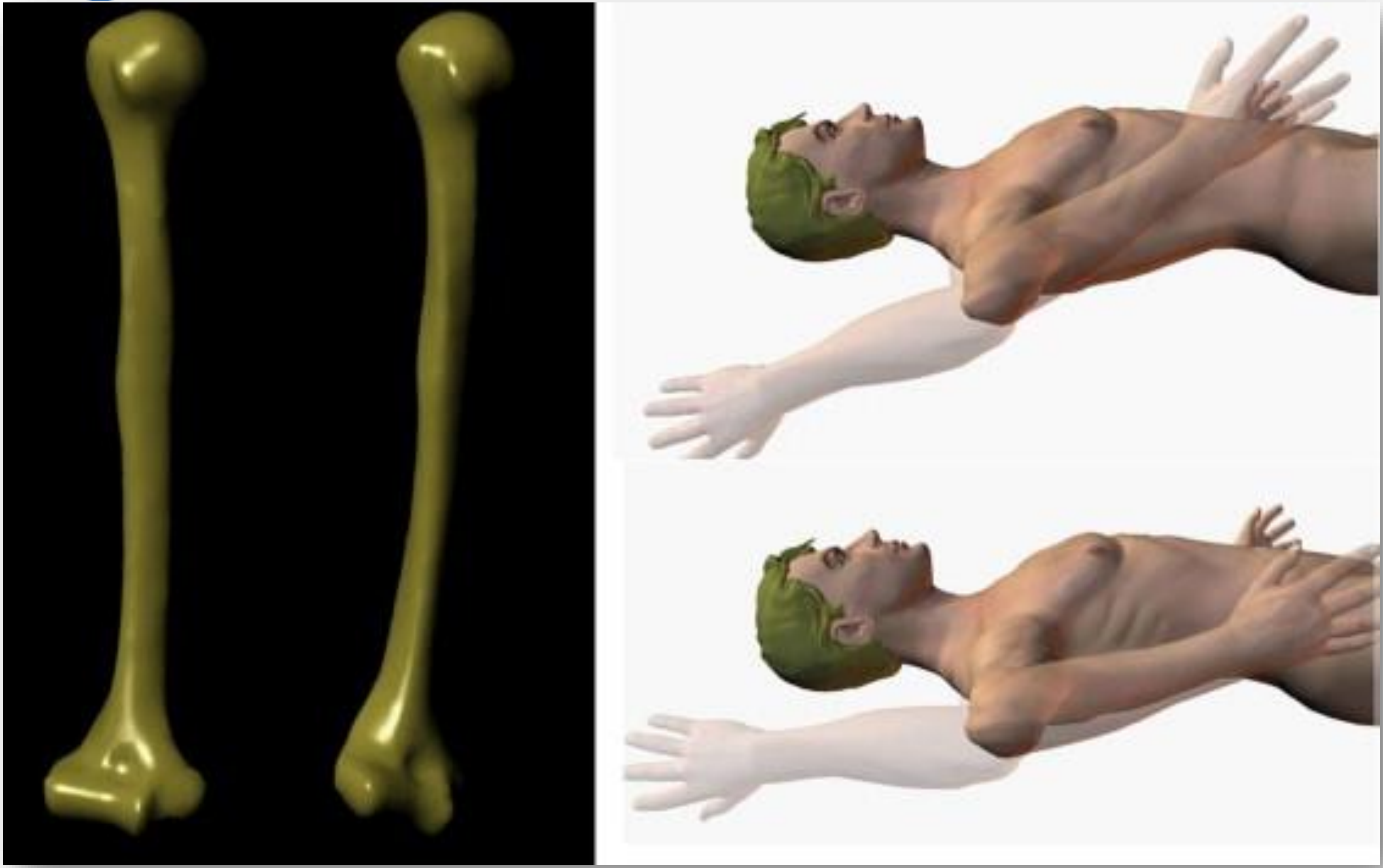
Humeral Torsion

On average,

retroverted 25-35 deg.

Greenberg et al., 2015

BONY ADAPTATIONS



BONY ADAPTATIONS

Table 1. Side-to-side differences in humeral retrotorsion in adult throwing athletes and normal population

Author	Subject	Measurement Type	Side-to-Side Difference in Retrotorsion, deg, mean
Pieper[28]	51 Olympic handball players	Radiograph	9.4
Crockett et al[8]	25 professional pitchers, 25 nonthrowing adults	CT	17
Reagan et al[30]	54 collegiate baseball players	Radiograph	10.6
Osbahr et al[27]	19 collegiate baseball players	Radiograph	10.1
			10.6
			15.6
			10.8
			13
			19.5 with GIRD[a] 12.3 without GIRD[a]
			3

Table 2. Side-to-side differences in humeral retrotorsion in youth throwing athletes

Author	Age Group	Side-to-Side Difference in Humeral Retroversion, deg, mean
Yamamoto et al[46]	Third and fourth graders	5.3
	Fifth graders[a]	7.5
	Sixth graders	1.8
	Seventh graders	2.7
	Eighth graders	3.6
Hibberd et al[15]	Youth (6-10 y; mean, 8.3 y)[a]	7.5 ± 10.1
	Junior high (11-13 y; mean, 11.9 y)[a]	10.7 ± 9.9
	Junior varsity (14-16 y; mean, 14.6 y)[a]	15.3 ± 11.1
	Varsity (16-18 y; mean, 16.9 y)[a]	16.2 ± 11.4
Whiteley et al[40]	Adolescent (mean, 16.6 ± 0.6 y)[a]	11.2

[a]Statistically significant side-to-side differences noted.

Greenberg et al., 2015

BONY ADAPTATIONS

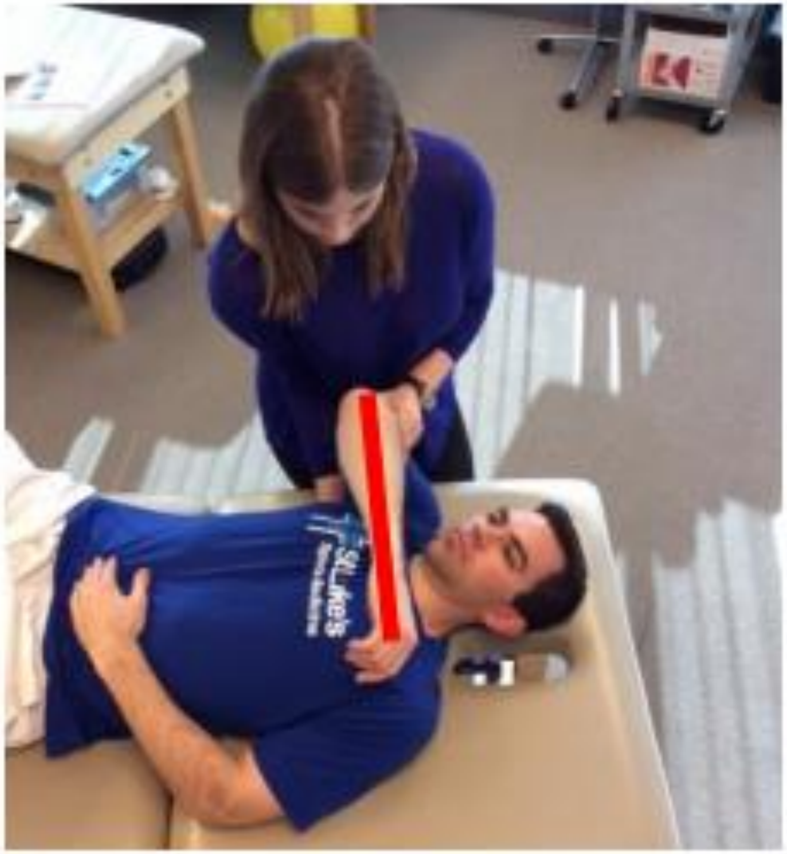
Humeral Retrotrosion and GIRD/Posterior capsule thickness

- ↑HR → ↑ GH ER, ↓ GH IR, ↑PCT in 24 collegiate baseball players (Thomas et al., 2012)
- ↑HR → ↑ GH ER, ↓ GH IR, ↑PCT in 36 8-12 year olds (Astolfi et al., 2015)
- No diff. in 35 softball players compared to matched controls (Hibberd et al., 2014)
- Professional pitchers w/ GIRD display ↑humeral retrotorsion & ↓ER and TROM compared to those w/out GIRD (Noonan et al., 2015)
- ↑in humeral retrotorsion accounts for age-related loss of GH IR (Hibberd et al., 2014)

BONY ADAPTATIONS

How do we measure this clinically?

Horizontal Adduction Test



What does this mean?

Is Humeral Retrotorsion a protective adaptation, or pathologic process?

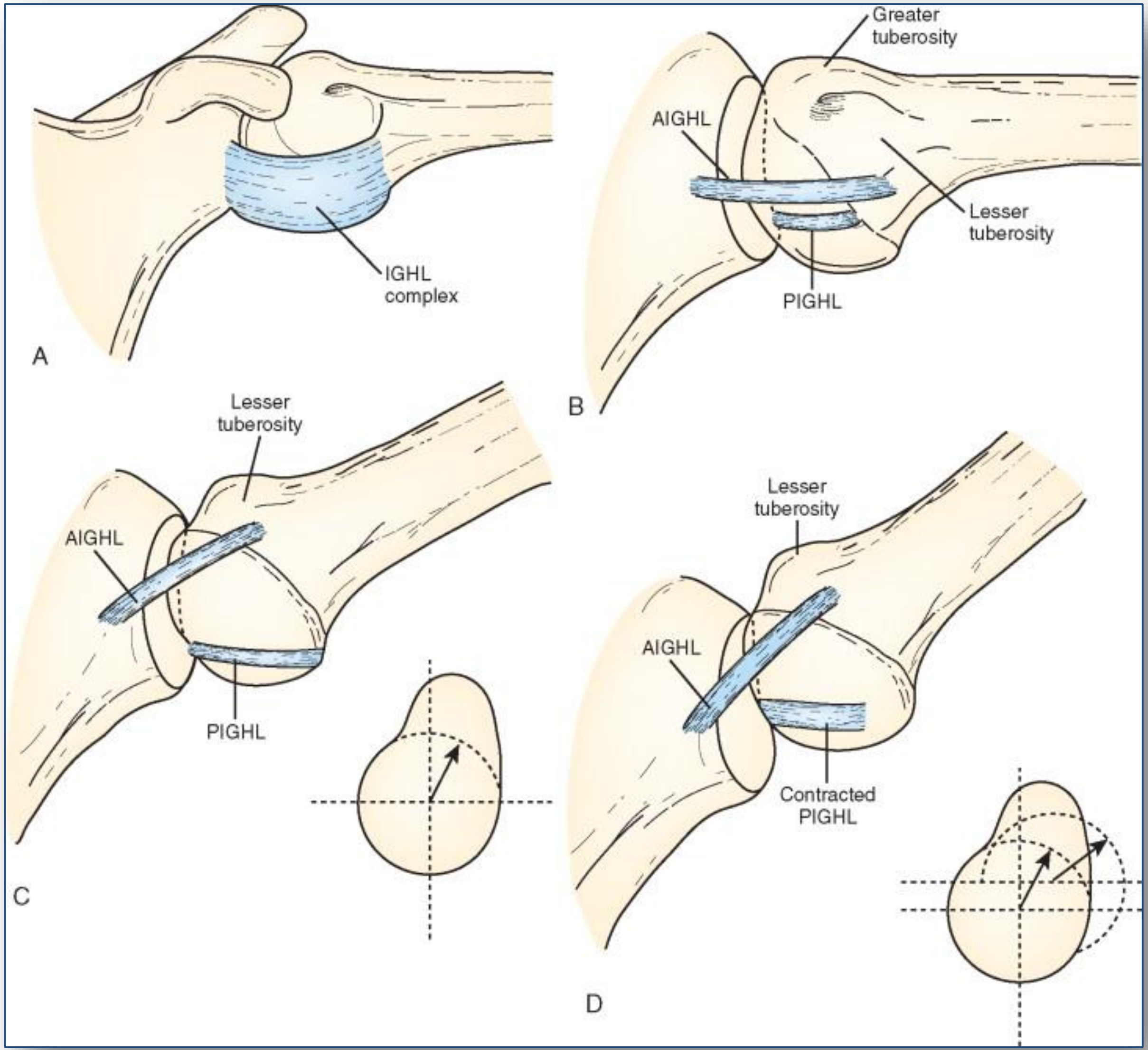
MECHANISMS OF GIRD

- BONY ADAPTATIONS
- CAPSULAR
- SCAPULA/SOFT TISSUE

CAPSULAR

What is the role of the posterior capsule in the throwing motion?

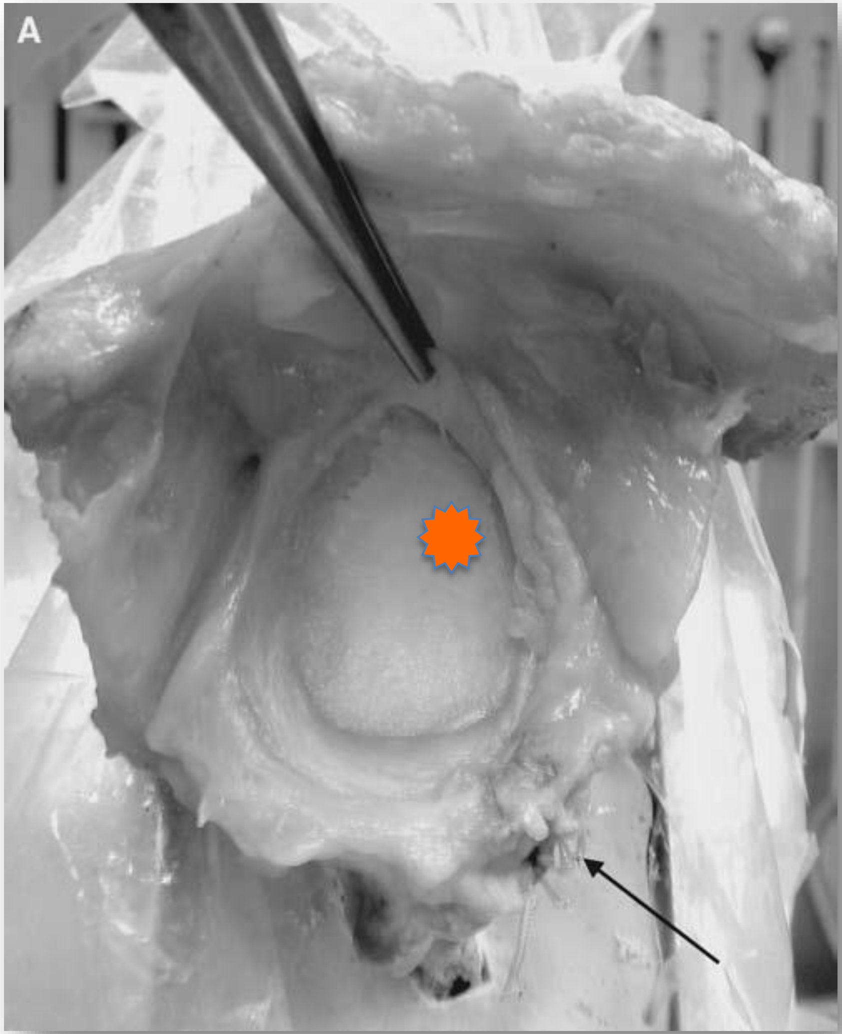
CAPSULAR

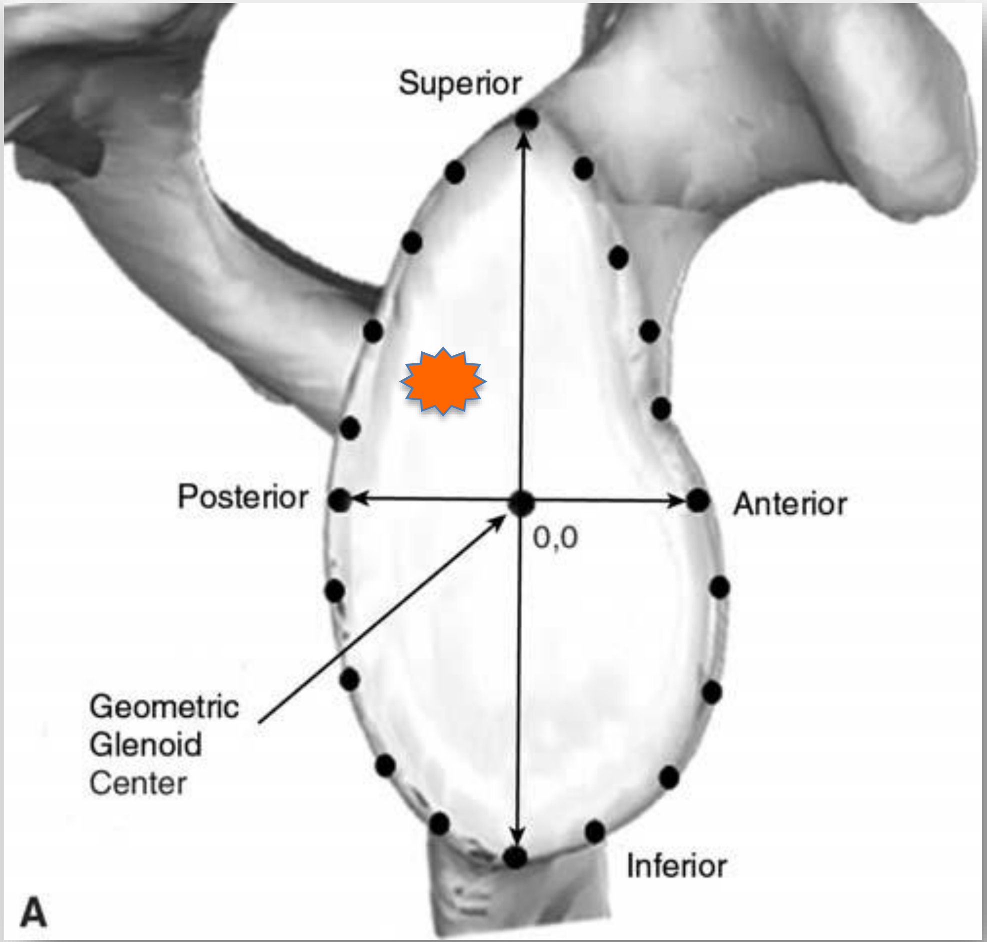

IGHL
complex
A
Greater
tuberosity
AIGHL
Lesser
tuberosity
PIGHL
B
Lesser
tuberosity
AIGHL
PIGHL
C
Lesser
tuberosity
AIGHL
Contracted
PIGHL
D

CAPSULAR

- PCT ↑ on dominate side → (-) correlation w/ PCT & IR, (+) correlation w/ PCT thickness and ER & Scapular Upward Rotation (Thomas et al., 2011)
- PCT (+) correlated with increasing HR (Thomas et al., 2012)
- Posterior shoulder capsules are thicker and ***STIFFER*** (less elastic) in dominate shoulders of healthy baseball players (Takenaga et al., 2015)
- Posterior capsules ***THICKER*** in 8-12 year old youth baseball players (Astolfi et al., 2015)

CAPSULAR





Huffman et al., 2006

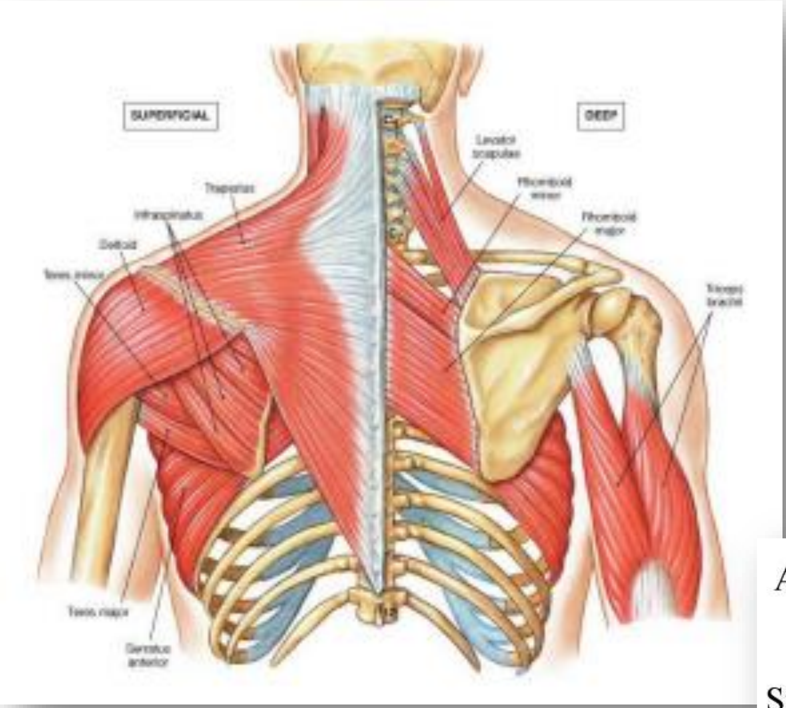
CAPSULAR

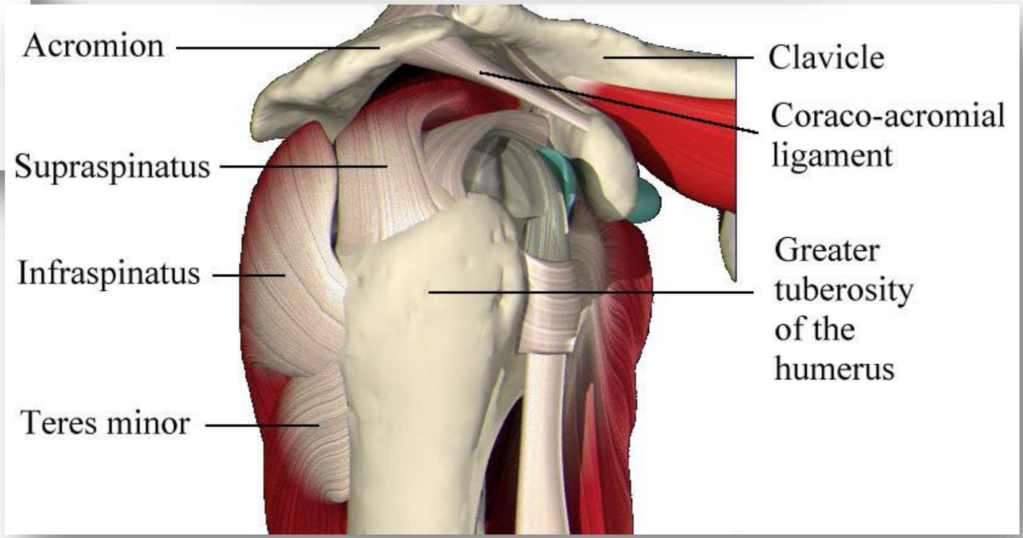
What does a thicker, less elastic posterior capsule mean?

MECHANISMS OF GIRD

- BONY ADAPTATIONS
- CAPSULAR
- SOFT TISSUE

SOFT TISSUE


SUPERFICIAL
DEEP
Levator scapulae
Trapezius
Rhomboid minor
Infraspinatus
Rhomboid major
Deltoid
Teres minor
Triceps brachii
Teres major
Serratus anterior


Acromion
Clavicle
Coraco-acromial ligament
Supraspinatus
Infraspinatus
Greater tuberosity of the humerus
Teres minor

SOFT TISSUE

Conclusion: Passive range of motion is significantly decreased immediately after baseball pitching. This decrease in range of motion continues to be present 24 hours after throwing. High levels of eccentric muscle activity have previously been observed in the shoulder external rotators and elbow flexors during pitching. These eccentric muscle contractions may contribute to acute musculotendinous adaptations and altered range of motion. The results of this study may suggest a newly defined mechanism to range of motion adaptations in the overhead throwing athlete resulting from acute musculoskeletal adaptations, in addition to potential osseous and capsular adaptations.

Michael I
Leonard
Glenn S.
From the
Hospital,
[§]Champi
Birmingh
and [#]Alab

	Before	After	24 Hours After	P for ANOVA
Shoulder				
ER	136.5 ± 9.8	135.3 ± 9.3	136.5 ± 9.0	.213
IR	54.1 ± 11.4	44.6 ± 11.9[b]	46.5 ± 10.0[b]	<.001[b]
TM	190.6 ± 14.6	179.9 ± 13.7[b]	182.9 ± 11.5[b]	<.001[b]
Elbow				
Flexion	144.9 ± 7.1	144.7 ± 5.9	145.8 ± 5.8	.264
Extension	–5.1 ± 9.5	–8.3 ± 8.8[b]	–7.7 ± 8.9[b]	<.001[b]

[a]Data are mean degrees ± SD. ANOVA, analysis of variance; ER, external rotation; IR, internal rotation; TM, total motion.
[b]Significantly different than before throwing ($P < .01$).

Reinold et al., *AJSM* 2008

SOFT TISSUE

Decreases in rotator cuff stiffness were associated with acute range of motion gains in baseball players with ROM deficits (Bailey, 2015)

IASTM to the posterior shoulder showed acute improvements in shoulder range of motion (Laudner, 2014)

SOFT TISSUE

Anterior Shoulder

- Healthy individuals with short pec minor resting length demonstrated scapular kinematic patterns similar to subjects w/

Don't Forget about the Pec Miinor!!!!

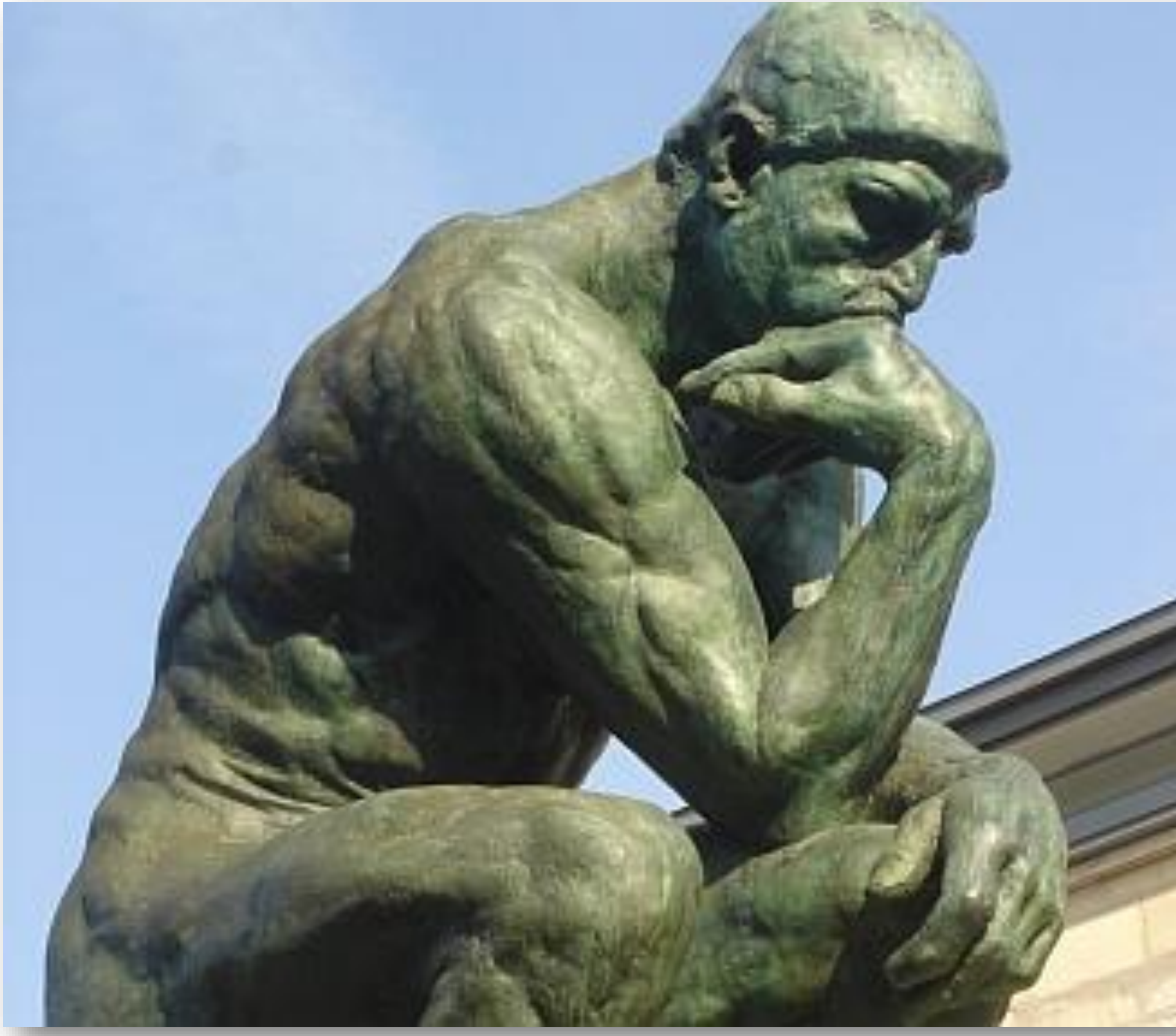
- Addressing Pec Minor tightness may lead to increased activity of scapular stabilizers, and decrease anterior tilting (Lee, 2015)

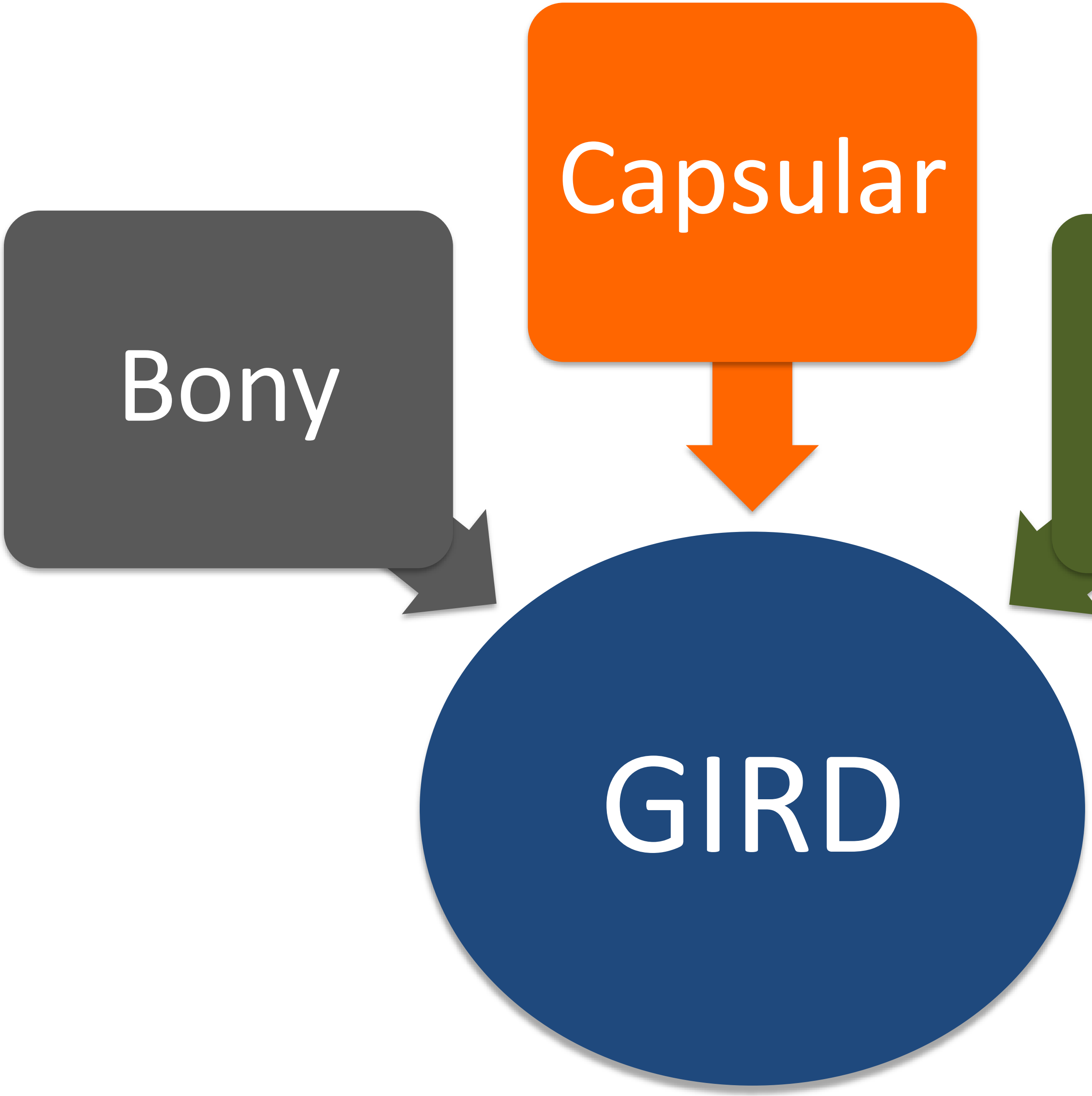
Very Limited Research at This Time!

SOFT TISSUE

SOFT TISSUE

- Acute changes in ROM likely due to changes in soft tissue stiffness
- We can increase ROM by addressing this stiffness
- Tight pec minor → ↑ anterior tilt → ↓ shoulder ROM
- Acute ROM changes = muscular, Chronic ROM changes = capsular




Capsular
Bony
Soft Tissue
GIRD

Addressing GIRD Clinically

RANGE OF MOTION!!!!

Pathologic GIRD

GIRD ≥ 18-20°

+

TROM LOSS ≥ 5° OR ERD ≥ 5°

If they fall into this category, start with stretching

Manske et al., 2013

“It is possible to catch a problematic shoulder before it becomes a painful shoulder”

-Brett Burton, PT, DPT, ATC, CSCS

Clinical Take-home Points

1) GIRD has been associated with increased risk of shoulder and elbow injuries
2) Multiple factors contribute to the development of GIRD
3) Range of Motion
4) Range of Motion
5) Range of Motion
6) We can usually fix this problem very easily (and ***PREVENT*** injury) with focused, specific stretching of the shoulder

Additional Resources for Overhead Athletes

- Eric Cressey Blog/Twitter/Facebook
  - Cressey Sports Performance
  - http://ericcressey.com/
- Mike Reinold Blog/Twitter/Facebook/Podcast
  - Champion Physical Therapy, dual credentialed
  - http://www.mikereinold.com/
- Brett Burton, DPT, ATC
  - http://www.movementguides.com/#

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