Closing the Chain on Shoulder Injuries in Overhead Athletes

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I have no relevant financial or nonfinancial relationship to disclose related to this presentation or program.

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- Most upper extremity ADL are OKC
- Why do CKC for injury prevention and rehab?

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Types of Shoulder Injuries

1. Too tight
2. Too loose
3. Too weak
   - Scapular stabilizers

“The People vs. The Supraspinatus”

- by: Don Walendzak, PT
- Supraspinatus is put on trial for problems with the shoulder…when the scapular muscles are to blame.

Scapular Dyskinesis

- Scapular dyskinesis: abnormal movement of the scapula

- Scapular dysfunction is found in approximately 70% of rotator cuff injuries and 100% of glenohumeral instability cases (Warner, et al. 1992).

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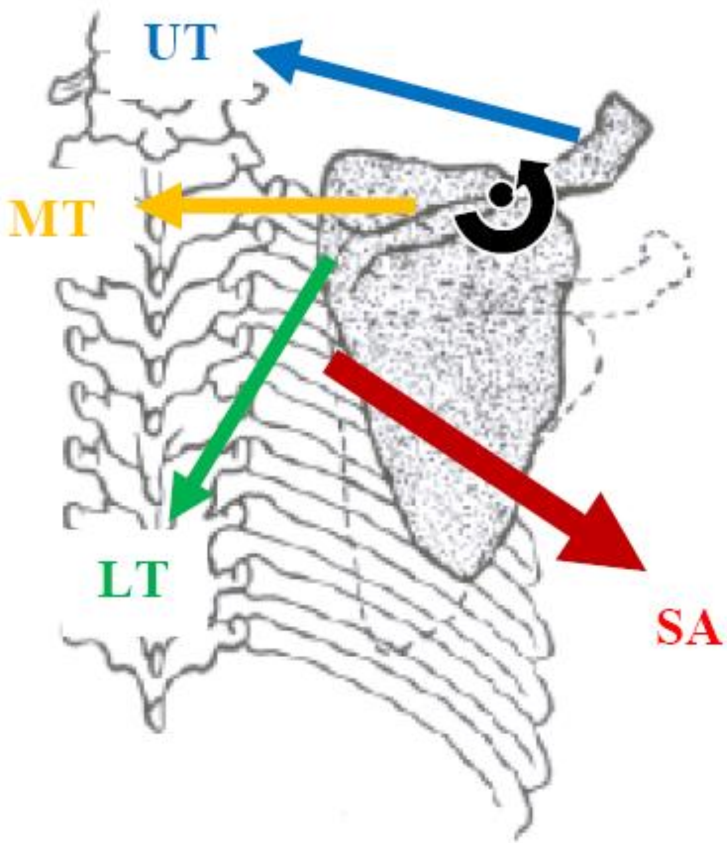
Normal Upward Rotation



- Upward Rotation:
  - Upper trapezius
  - Lower trapezius
  - Serratus anterior
- An appropriate amount of upward rotation allows the shoulder to be elevated above 90˚

Serratus Anterior During Throwing

- SA: >100%MVC during late cocking and acceleration phases

  vs.

- UT: activation was minimal throughout all phases

  (Gowan, et al. 1987)

- Similar SA findings for swimming and tennis serve (Moynes, et al. 1986)

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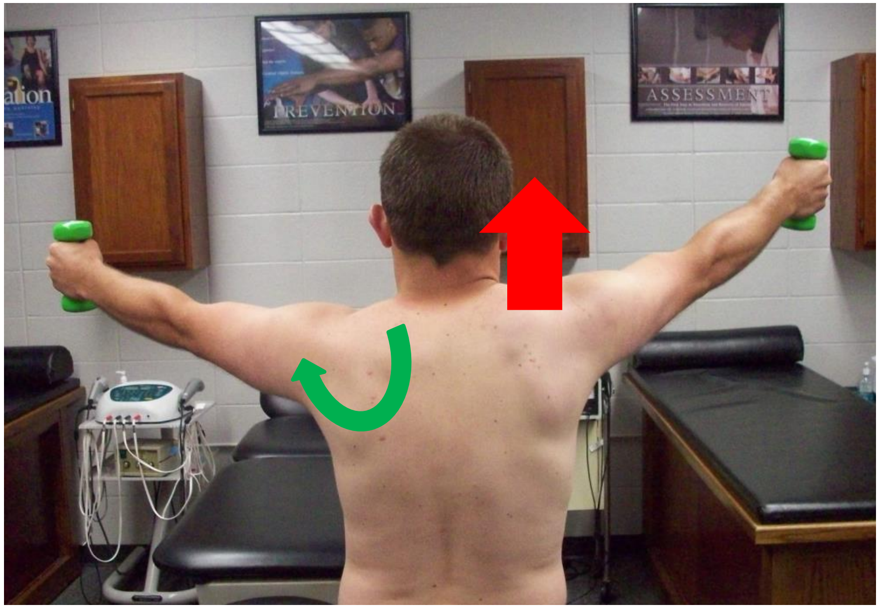
Scapular Dyskinesis

- A muscle force imbalance between the serratus anterior and upper trapezius causes the scapula to abnormally translate, causing decreased upward rotation (Ludewig and Cook, 2000).

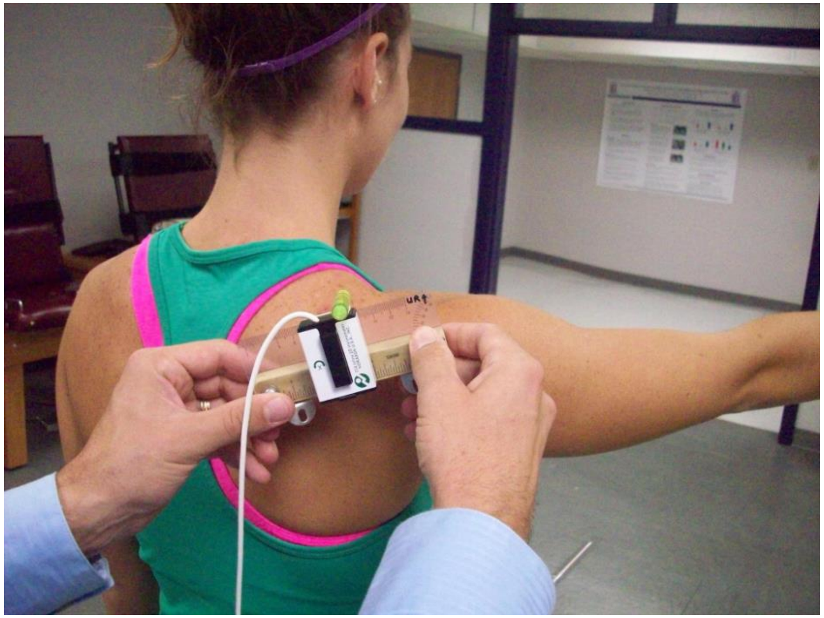


Scapular Dyskinesis

- This form of scapular dyskinesis has been associated with instability, impingement, SLAP lesions and rotator cuff tears (Kibler, 1991; Burkhart and Morgan, 1998; Burkhart, et al. 2000).

Clinical Evidence

- 16 collegiate volleyball players:
  - 13 healthy (all with adequate UR)
  - 3 with PHx shoulder injury (all decreased UR)



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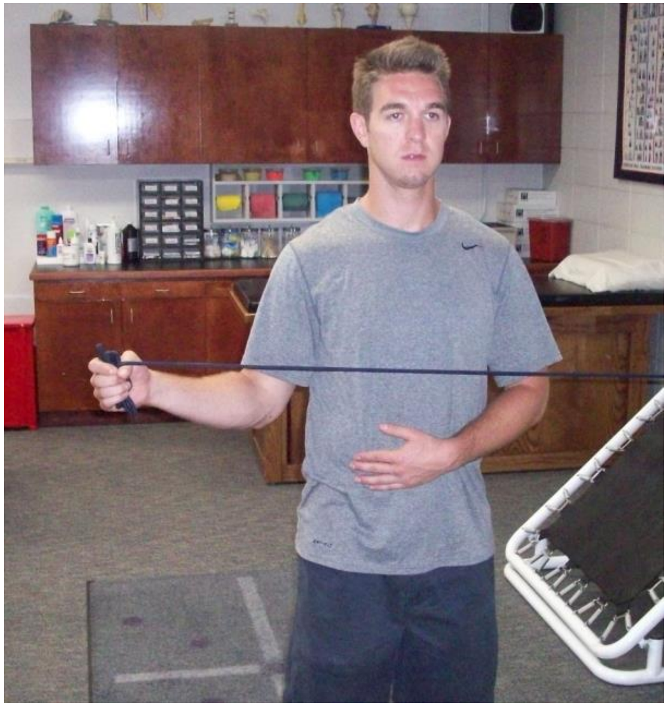
Open Kinetic Chain

- Benefits of OKC
  - Increases ROM
  - Strengthens isolated muscles
  - Replicates functional activities

Open Kinetic Chain



- Myers, et al. 2005, evaluated 10 common rubber tubing exercises.
- ER & IR at 0° abduction: serratus anterior activation was 18.0% & 20.5% MVIC.
- Exercises in which the GH joint was elevated at or above 90° elicited higher activation levels (≈66%).

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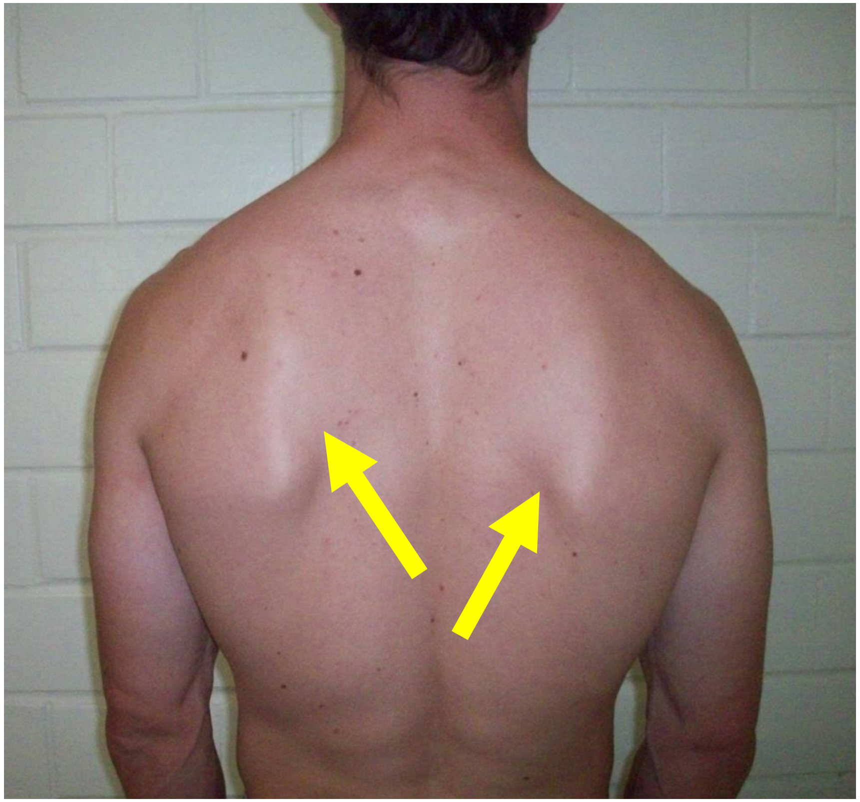
Clinical Evidence



- Strength & Conditioning Coach
  - Gradual on-set of s/s
  - Regular upper extremity resistance training, all OKC
  - Weak SA
  - Dx: shoulder impingement syndrome

OKC vs. CKC

- Patients with shoulder impingement: overactive upper trapezius and suppressed serratus anterior (Ludewig and Cook, 2000)

  …during OKC activities.

- We don’t see the same muscle activation imbalance during CKC exercises (Tucker, et al. 2010).

Closed Kinetic Chain

n = 15 overhead athletes w/ shoulder impingement (SI)

n = 15 overhead athletes w/o shoulder impingement (NP)

Performed 3 CKC exercises

Muscle	SI	NP
Middle trapezius	23.02±19.97	15.14±8.29
Serratus anterior	66.79±34.32	56.66±25.94
Upper trapezius	30.84±33.31	38.78±38.59
Lower trapezius	21.92±12.49	21.94±13.22

Units = %MVIC

(Tucker, et al. 2010)

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Closed Kinetic Chain

- Compared to the UT, MT and LT, the serratus anterior consistently elicits the greatest level of activation during CKC exercises (Moseley, et al. 1992; Decker, et al, 1999; Ludewig, et al. 2004; Tucker, et al. 2005, 2008, 2009, 2010; Maenhout, et al. 2010)
  - Reached >80% MVC in some cases

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Push-Up

- 66% MVC needed for strength gains (McDonagh and Davies, 1984)

- Push-up variations: Serratus anterior activation was >66% (Ludewig, et al. 2004; Tucker, et al. 2008; Decker, et al. 1999; Moseley, et al. 1992; Youdas , et al. 2010)

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Push-Up Progressions

- Push-up on a BOSU ball greater UT and less SA vs. standard push-up (Tucker, et al. 2010)

- Elevating the feet on a chair during a push-up increased UT and SA activation (Lear and Gross, 1998)

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Push-Up Progressions

Wall push-up: SA≈40%

Knee push-up: SA≈60%

Ludewig, et al. 2004

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Push-Up Progressions

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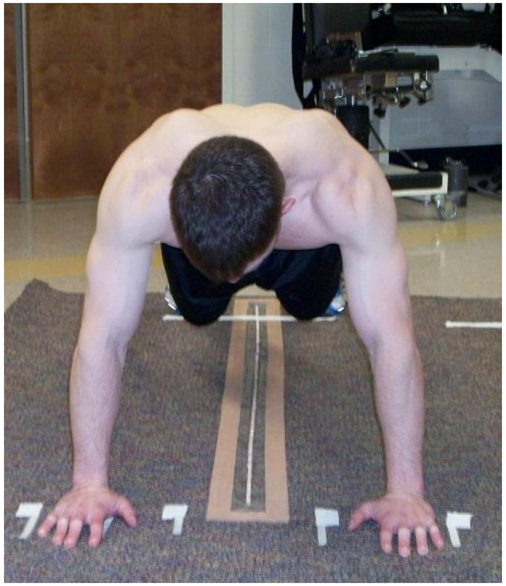
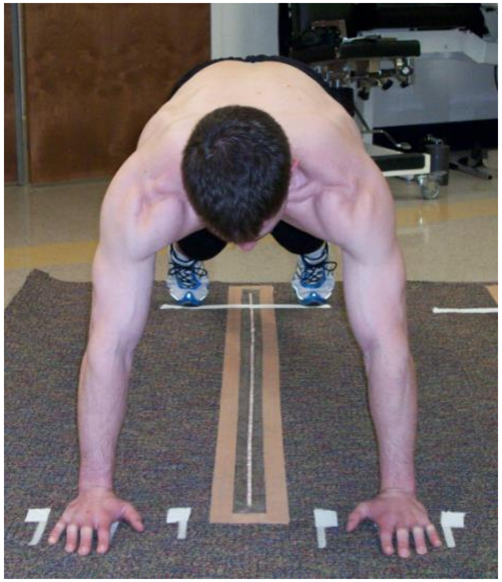
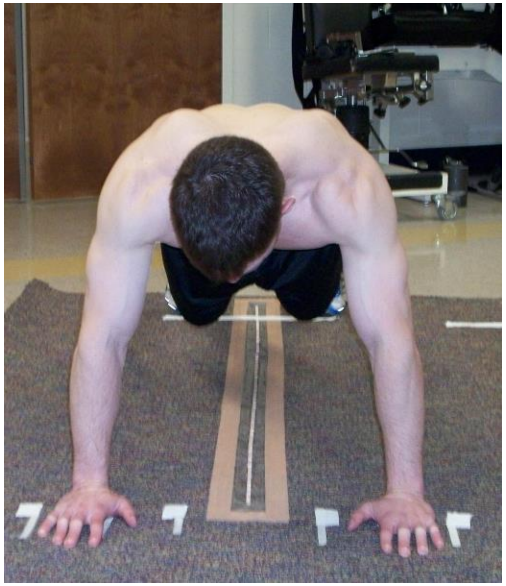
Push-Up with a Plus

- The addition of full scapular protraction following a push-up

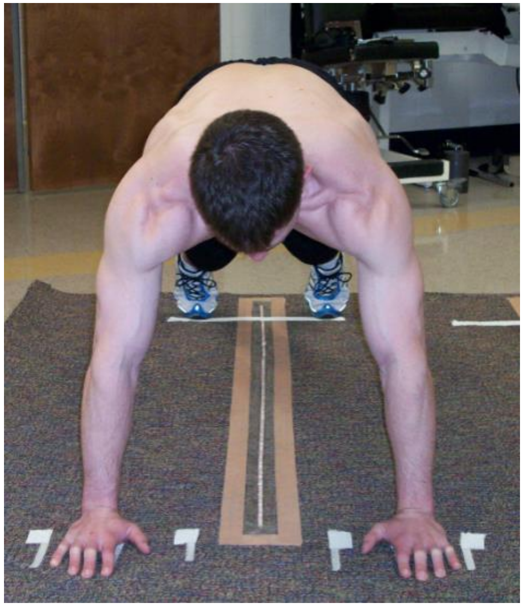
Push-Up with a Plus

Push-Up with a Plus

- SA activation was near 140% during a PU plus (Lear and Gross, 1998)

- SA activation:
  - Eccentric PU phase: 70.0%
  - Concentric PU phase: 100.0%
  - Concentric plus phase: 104.0%
  - Eccentric plus phase: 91.6 %

Decker, et al. 1999



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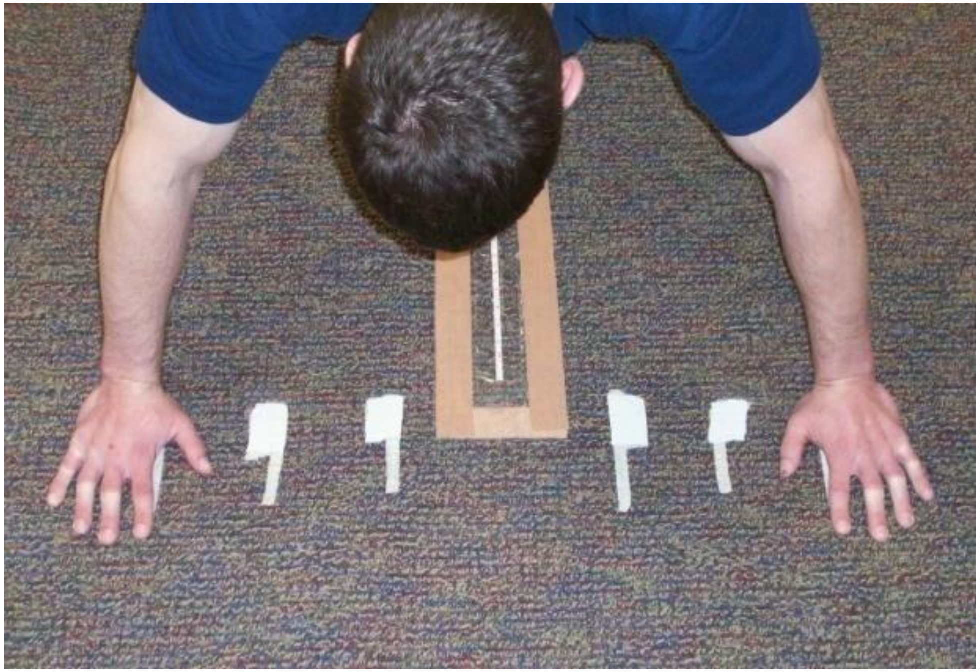
Push-Up Hand Placement

- Push-up with the hands further apart elicited greater serratus anterior activity (Moseley, et al. 1992)



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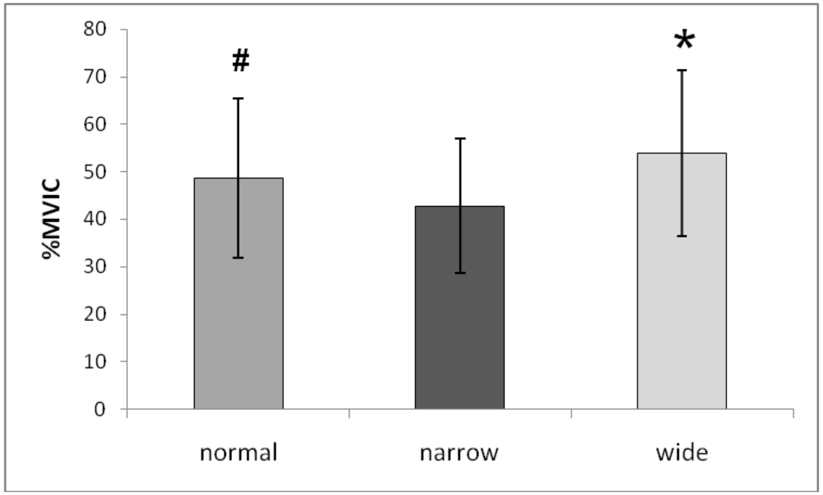
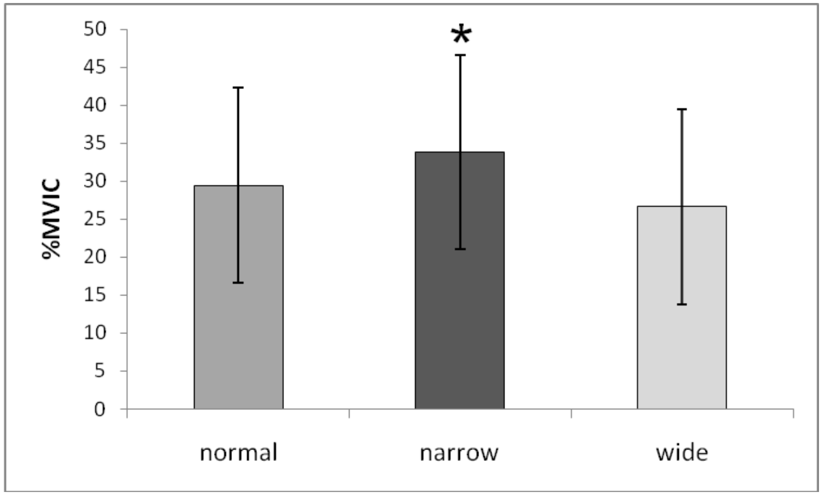
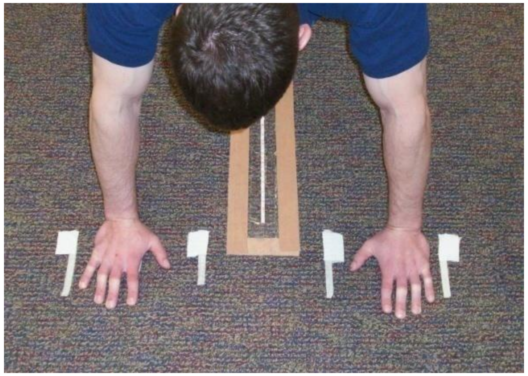
Push-Up Plus Hand Placement (Tucker, et al. 2009)

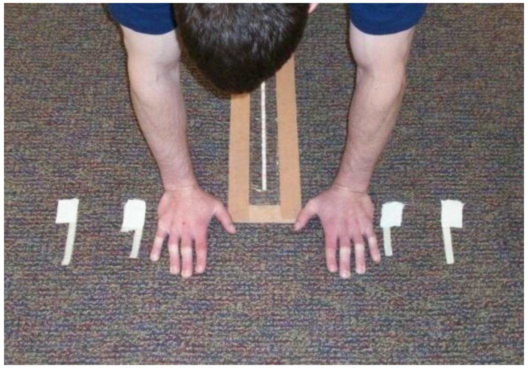
Serratus Anterior

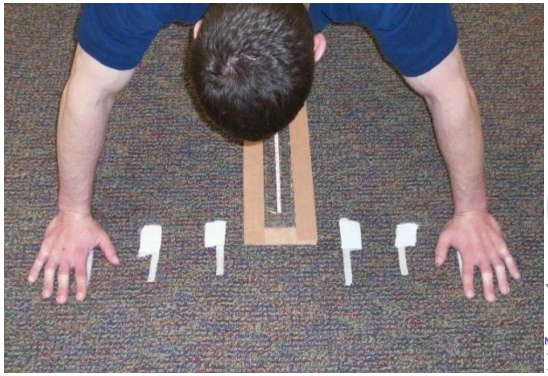


Lower Trapezius









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*Random Closed Chain Fact

- If you lift a kangaroo's tail off the ground it can't hop.

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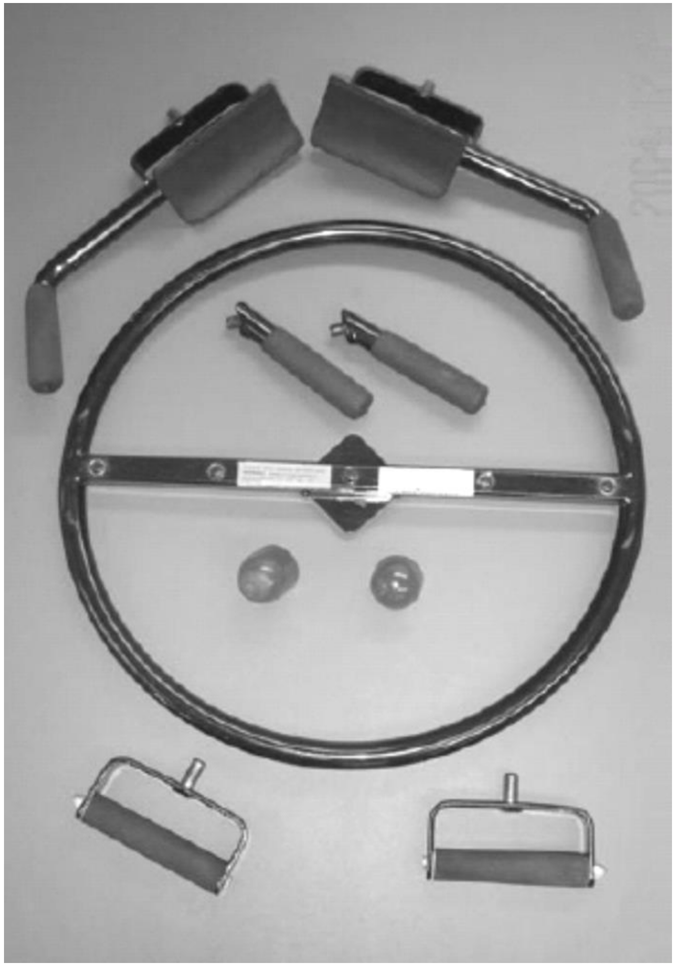
Cuff Link



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Cuff Link

- SA activation was >66% (Tucker, et al. 2005, 2008, 2010)
- Greater SA vs. push-up (Tucker, et al. 2010)
- Lower UT, MT & LT activation vs. push-up (Tucker, et al. 2011)
- Lower failure rate vs. push-up (Tucker, et al. 2008)

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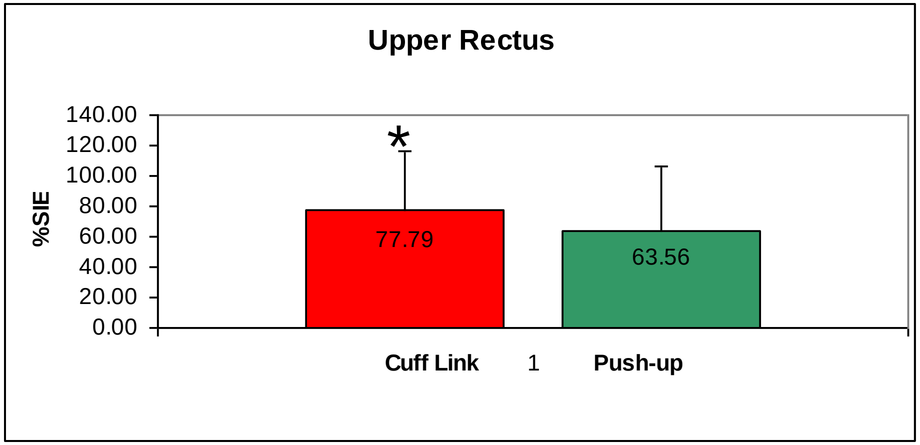
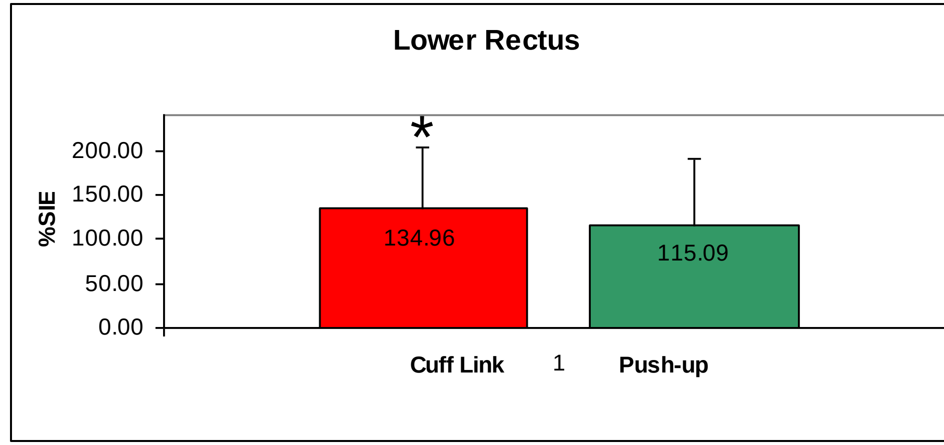
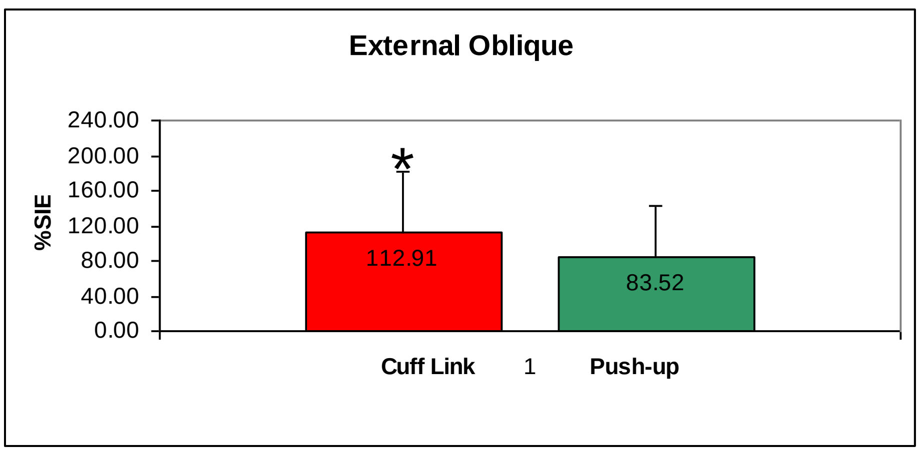
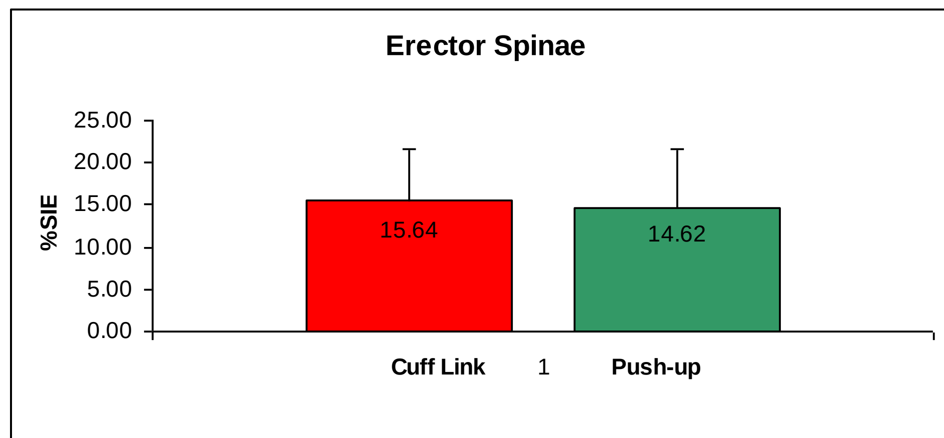
Cuff Link

Activation of the Core









Tucker, et al. unpublished

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Cuff Link Progressions

Non-Weight-Bearing

Partial-Weight-Bearing

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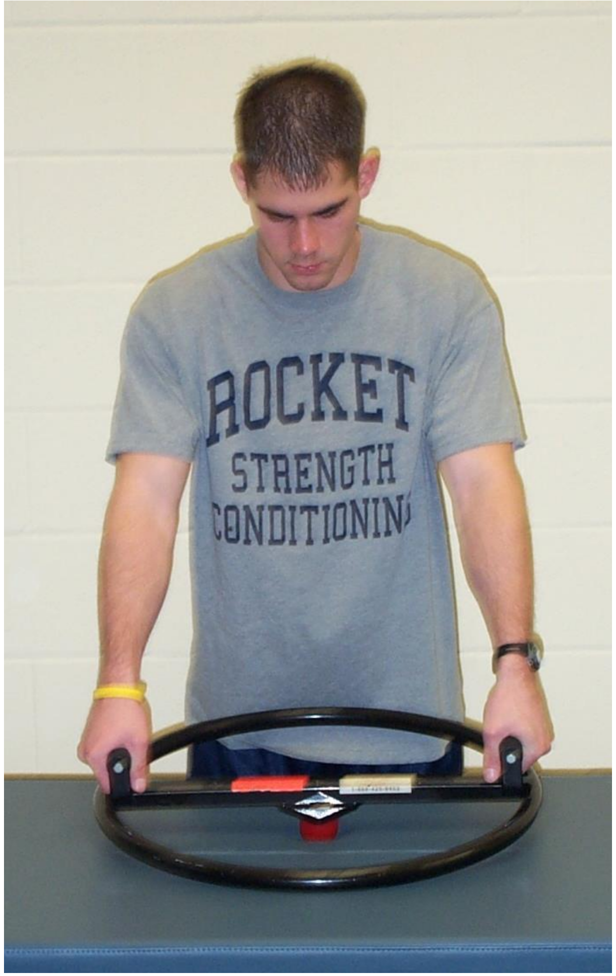
Cuff Link Progressions

- Serratus Anterior: activation increased throughout weight-bearing progression
  - NWB (11.33%)
  - PWB (34.45%)
  - FWB (81.4%)

(Tucker, et al. 2005)



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Cuff Link Progressions

- <u>Upper Trapezius</u>: activation was minimal and did not increase as weight-bearing progressed.

  (Tucker, et al. 2005)

- Push-up progression: similar results with slightly higher UT

  (Ludewig, et al. 2004)

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BOSU Alternative

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Supine Pull-Up

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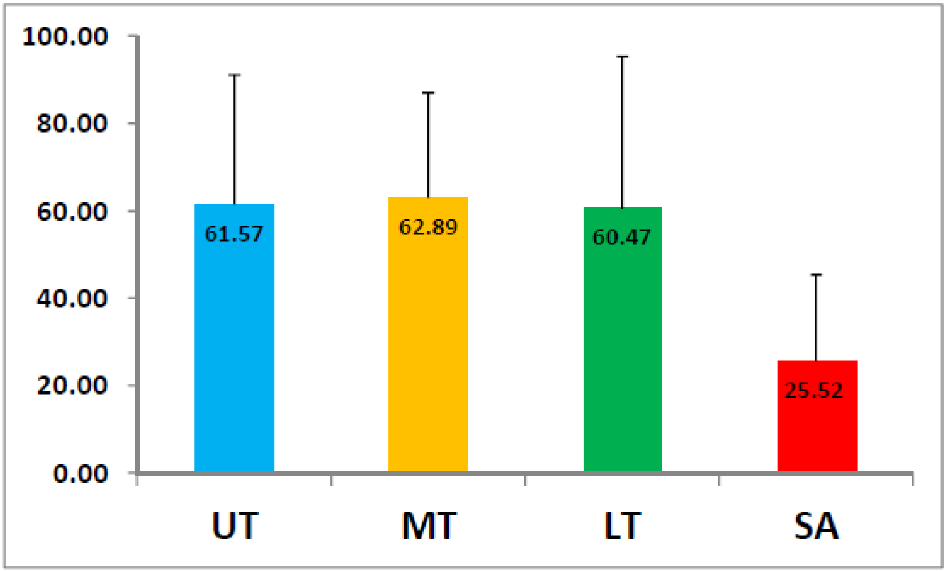
Supine Pull-Up

- n = 30 healthy OH & NOH athletes
- Greater UT, MT and LT activation vs. PU and CL
- High failure rate



Units: %MVIC

(Tucker, et al. 2011)

Chair Press-Up

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Chair Press-Up

- Recommended for activation of the pectoralis minor:
  - Townsend, et al. 1991
    - Evaluated 17 exercises
    - PM: 84% MVC
  - Moseley, et al. 1992
    - Evaluated 16 exercises
    - PM: 89% MVC

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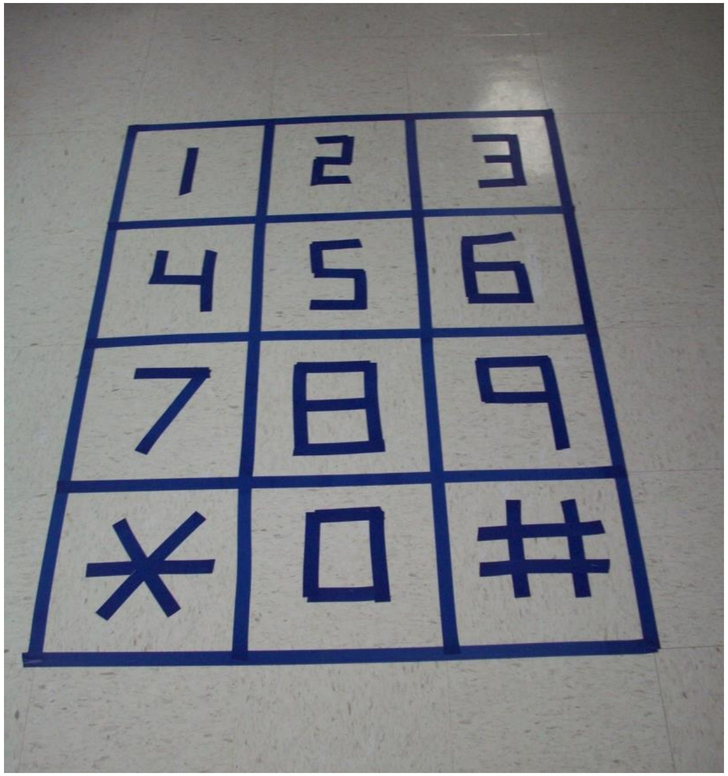
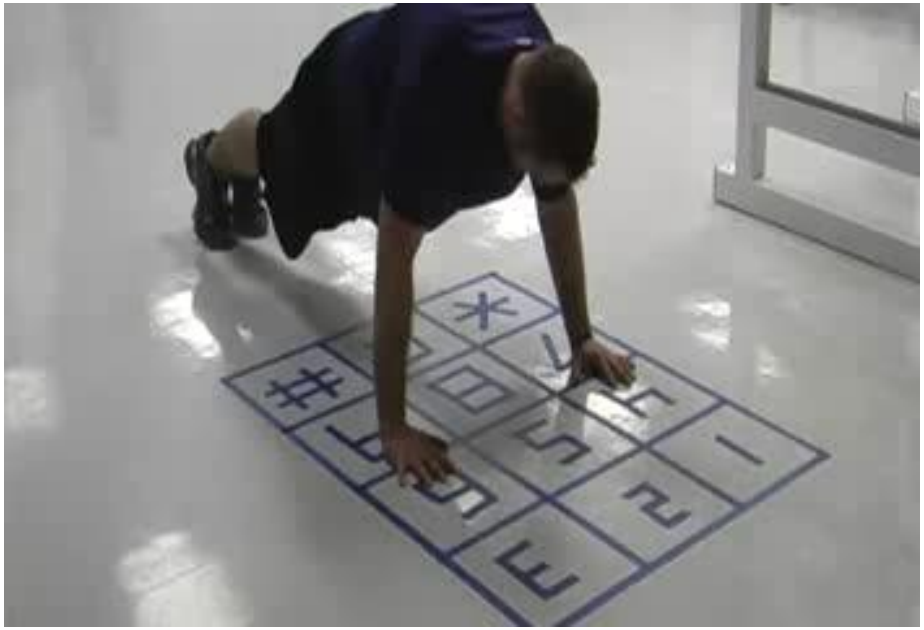
Other CKC Exercises

Number Grid





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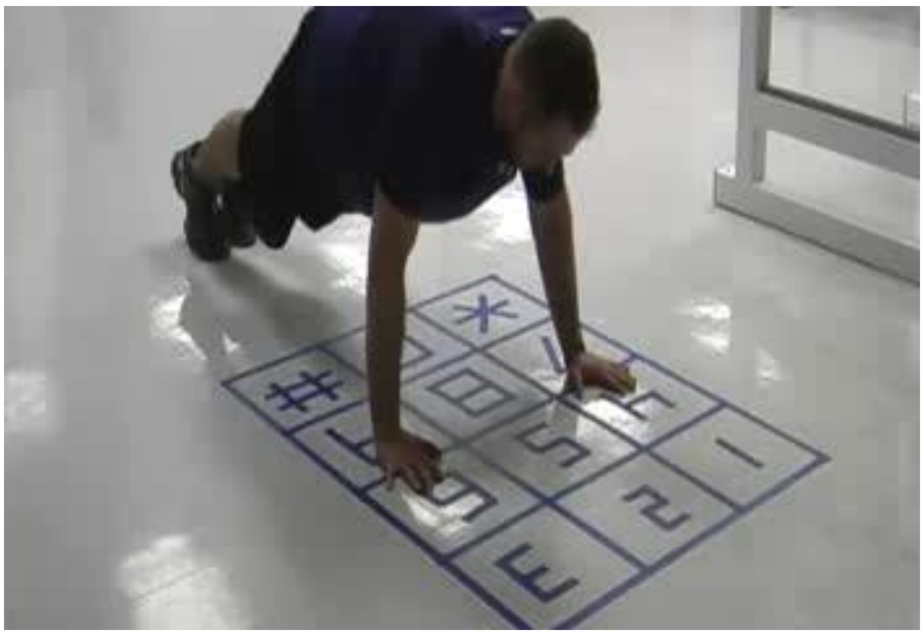
Number Grid Progression



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Example Patient

- Red-shirt sophomore quarterback (September)
- Bankhart lesion repair previous year (December)
- Symptoms: shoulder fatigue, weakness, pain, decreased velocity, SI joint/low back pain
- Signs: anterior shoulder posture, decrease IR and UR, hypertrophy of mid-back

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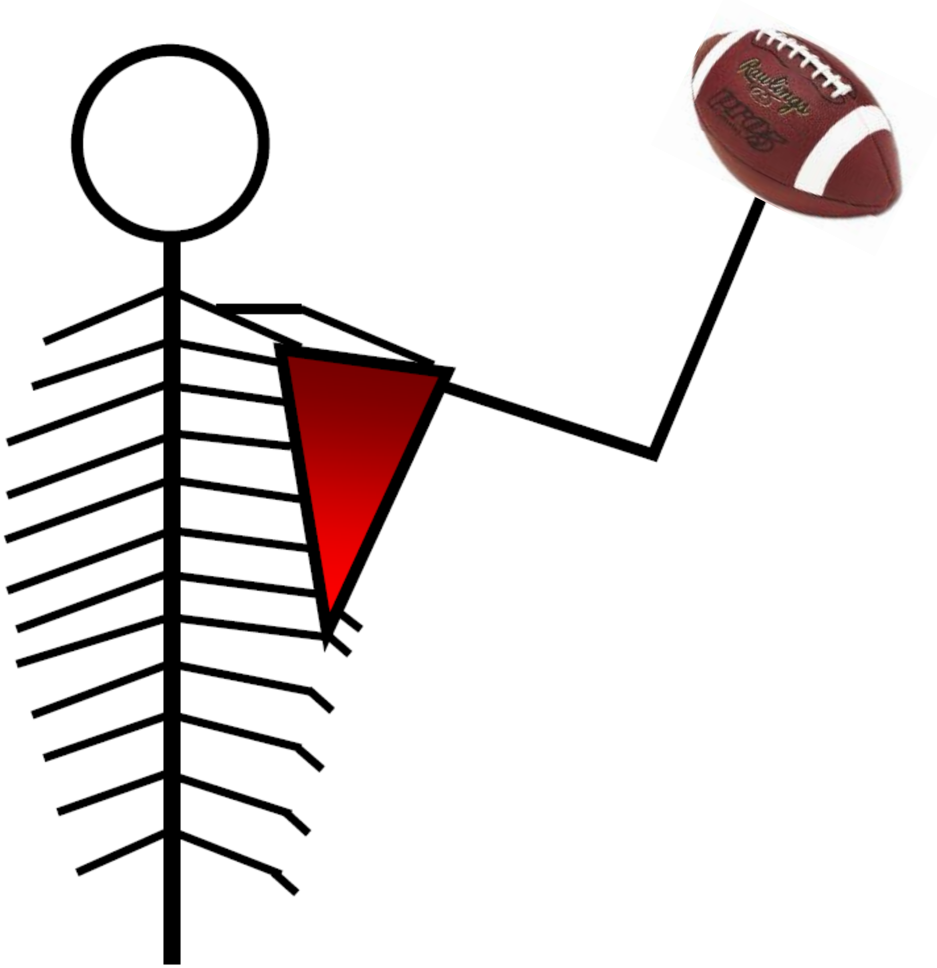
What was going on?



- Lack of upward rotation and weak scapular stabilizers
- Decreasing angle of the humerus, causing elbow to drop
- Shoulder pain and decreased velocity & accuracy
- SI joint dysfunction

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What we did…

- Treatment Plan:
  - Strengthen and increase endurance of scapular stabilizers
  - Increase flexibility of pectoralis minor/major
  - Increase IR
  - Increase core strength

What we did…

- First 30 days:
  - Stretched: pectoralis minor, posterior RC/capsule
  - OKC ex: resistance bands (IR & ER), PNF, prone retraction, rows, lat pull down, Body Blade®
  - CKC ex: push-up w/ plus, chair press-ups, floor and stability ball protraction, Cuff Link®
  - Treated SI joint dysfunction: muscle energy, core strength

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One-Month Re-Assessment

Initial

1 month

The Outcome

Initial	3 months
Internal Rotation: 59°	Internal Rotation: 75°
Upward Rotation:	Upward Rotation:
rest: 1.4°	rest: 5.1 °
60°abd: 12.8°	60°abd: 15.4°
90° abd: 21.5°	90° abd: 29.8°
120° abd: 29.3°	120° abd: 34.8°

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Take Home Points

- Why do CKC for injury prevention and rehab?
  - Activation of the scapular stabilizers
    - A common deficiency
  - Can be progressed
  - Incorporates the entire kinetic chain
    - Hips, trunk and upper extremity

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Thank You

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