THE CLOSED CHAIN APPROACH TO SHOULDER REHABILITATION

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ADVANCING KNOWLEDGE. ADVANCING CARE.

20th Annual Symposium, Bedford, NH September 14, 2013

Outline

- Background on common shoulder injuries
- Open Chain vs. Closed Chain for the shoulder
- Closed chain exercises: Examples and the evidence behind them
- Putting it all together: An example patient

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

Types of Shoulder Injuries

1. Post surgical
2. Too tight
3. Too loose
4. Too weak
   - Scapular stabilizers

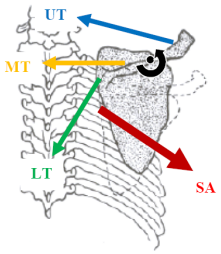
"The People vs. The Supraspinatus"

- 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).

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•

Scapular Dyskinesis

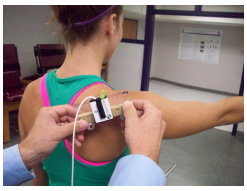
- A muscle force imbalance between the serratus anterior and upper trapezius causes the scapula to abnormally translate, causing decreased upward rotation (Ludewig and Cook, 2000).

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).

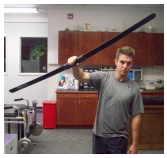
Clinical Evidence

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



Open Kinetic Chain

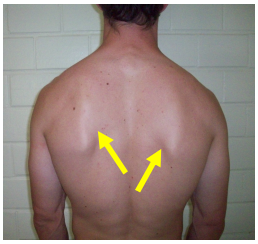
- Benefits of OKC
  - Increases ROM
  - Strengthens isolated muscles
  - Replicates functional activities



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%).

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)

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% of MVC in some cases

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)

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)

Push-Up Progressions


Wall push-up: SA • 40%

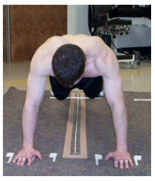
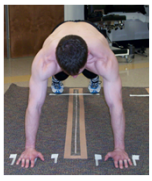
Knee push-up: SA • 60%

Ludewig, et al. 2004

Push-Up Progressions


Push-Up with a Plus

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

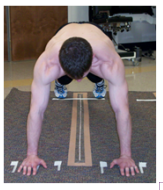




Push-Up with a Plus


Push-Up with a Plus

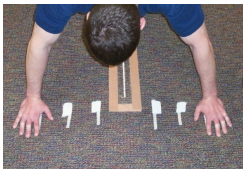
- SA activation was near 140% during a PU plus (Lear and Gross, 1998)
- SA activation:
  - Eccentric PU phase: 70.0%
  - Concentric PU phase: 100.0%
  - Concentric plus phase: 104.0%
  - Eccentric plus phase: 91.6 %

Decker, et al. 1999



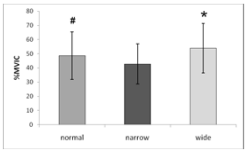
Push-Up Hand Placement

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

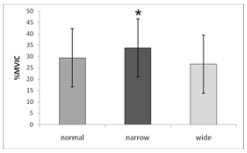


Push-Up Plus Hand Placement (Tucker, et al. 2009)

Serratus Anterior



Lower Trapezius



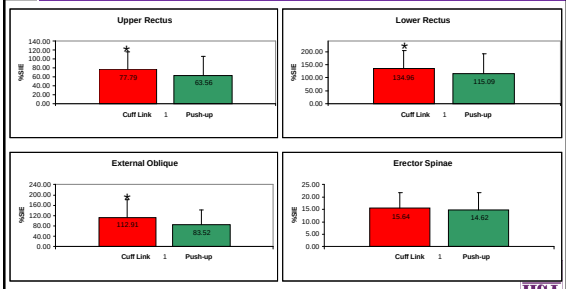
Cuff Link

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)

Cuff Link

Activation of the Core



Tucker, et al. unpublished

Cuff Link Progressions

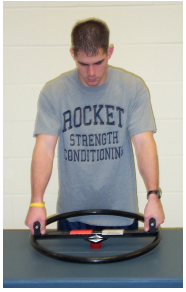
Non-Weight-Bearing

Partial-Weight-Bearing

Cuff Link Progressions

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

(Tucker, et al. 2005)



Cuff Link Progressions

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

(Tucker, et al. 2005)

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

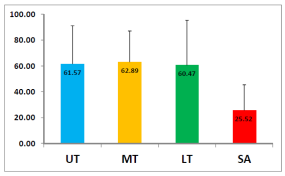
(Ludewig, et al. 2004)

BOSU Alternative

Supine Pull-Up

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)

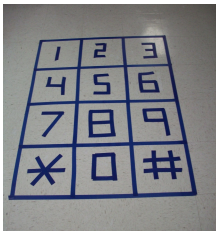
Chair Press-Up

Chair Press-Up

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

Other CKC Exercises

Number Grid

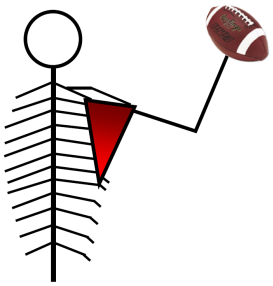


Number Grid Progression

Example Patient

- Red-shirt sophomore quarterback (Sept 2010)
- Bankhart lesion repair Dec 2009
- Symptoms: shoulder fatigue, weakness, pain, decreased velocity, SI joint/low back pain
- Signs: anterior shoulder posture, decrease IR and UR, hypertrophy of mid-back

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

What we did…

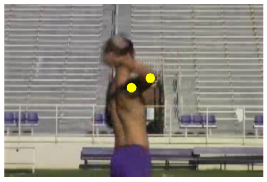
- Treatment Plan:
  - Strengthen and increase endurance of scapular stabilizers
  - Increase flexibility of pectoralis minor/major
  - Increase IR
  - Increase core strength

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

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•

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

Thank You

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