Recognizing the Importance of Lower Trapezius Strength and Function

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Disclosures

• I have no actual or potential conflicts of interest to disclose with regard to the contents of this presentation
Goals

• Brief anatomy review

• Scapulothoracic function with focus on the role of the lower trapezius

• Dysfunction of the lower trapezius

• Treatment considerations
Anatomy - Trapezius

• Origin
  – Medial one third of nuchal line
  – External occipital protuberance
  – Ligamentum nuchae
  – Spinous processes of C7-T12
  – Supraspinous ligament

• Insertion
  – Lateral one third of the clavicle
  – Medial aspect of the acromion
  – Scapular spine
  – Tubercle just lateral to medial border of scapular spine

• Innervation
  – Spinal accessory nerve, C3, C4

Hobart et al, 2008
Anatomy

Thieme Atlas of Anatomy
Anatomy – Scapulothoracic “Joint”

- Pseudoarticulation

- Indirect connection to axial skeleton via clavicular articulations

- Resting position with respect to thorax
  - Slight upward rotation
  - ~30-45 degrees internal rotation
  - ~5-20 degrees anterior tilting
Scapulothoracic Motion

• Scapulothoracic motion
  – Frontal plane
    • Upward and downward rotation (U/DROT)
  – Sagittal plane
    • Anterior and posterior tilting
  – Transverse plane
    • Internal and external rotation (I/EROT)

• All motions multiplanar given orientation of scapula on thorax
  – Protraction/Retraction

Ludewig and Reynolds, 2009
Scapulothoracic Motion

• Most consistent scapular kinematic findings with elevation
  – UROT throughout elevation

• Variability in the literature
  – Tilting
  – I/EROT

• Generally accepted
  – Posterior tilting
  – EROT

Laudner et al, 2006
Ludewig and Reynolds, 2009
Ebaugh and Spinelli, 2010
Scapulothoracic Motion

- Scaption from supported sitting
  - Raising and lowering
  - Kinematics and EMG

Ebaugh and Spinelli, 2010
Scapula

• Functions of the scapula in the overhead athlete
  – Stable base for glenohumeral joint (GHJ)
  – Retract/Protract through the motion
  – Rotate the acromion to allow clearance
  – Base for muscle attachment
  – Transfer kinetic energy from the trunk to the upper extremity

• Most commonly discussed with regard to throwing
  – Reaching
  – Lifting
  – Weight-bearing
  – Swinging

• In summary – provide dynamically stable platform for upper extremity function

Kibler, 1998
Trapezius - Function

• Upper fibers (UT)
  – UROT
  – Elevation

• Middle fibers (MT)
  – Adduction (Retraction)

• Lower fibers (LT)
  – UROT
  – Depression

• Not so straightforward
  – Complex interaction between different fibers, other musculature
  – Different roles depending upon position
  – Mobility and stability function
Function – Force Couple for Upward Rotation

• Coordinated contraction
  – Synergistic UROT
  – Antagonistic elevation/depression
  – Results in dynamically fixed axis for UROT

• Do not forget
  – MT
  – Posterior rotator cuff
  – Pectoralis minor...

# Function - Throwing

<table>
<thead>
<tr>
<th>Muscles</th>
<th>No. of subjects</th>
<th>Phase</th>
<th>% MVIC</th>
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</tr>
</tbody>
</table>

*Data are given as means and standard deviations, and expressed for each muscle as a percentage of an MVIC.*

*From initial movement to maximum knee lift of stride leg.*

*From maximum knee lift of stride leg to when lead foot of stride leg initially contacts the ground.*

*From when lead foot of stride leg initially contacts the ground to maximum shoulder external rotation.*

*From maximum shoulder external rotation to ball release.*

*From ball release to maximum shoulder internal rotation.*

*From maximum shoulder internal rotation to maximum shoulder horizontal adduction.*

*MVIC = maximum voluntary isometric contraction.*

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Escamilla and Andrews, 2009

DiGiovine et al, 1992
Function - Throwing

• Stride phase
  – Scapular stabilization
  – Upward rotation for GHJ position for abduction

• Cocking phase
  – Scapular stabilization
  – Retraction for GHJ position for horizontal abduction and EROT

• Acceleration
  – Scapular stabilization
    • Base for rapidly rotating humeral head

• Deceleration
  – Eccentrically control scapular elevation, rotation, protraction

Escamilla and Andrews, 2009
Function – Golf Swing

Table VIII. Scapular activity by muscle and phase during the golf swing\(^a\) (adapted from Kao et al.,\(^{45}\) with permission)

<table>
<thead>
<tr>
<th>Muscles</th>
<th>No. of subjects</th>
<th>Phase</th>
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<tr>
<td></td>
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<td>take-away (% MVIC)</td>
<td>forward swing % MVIC</td>
<td>acceleration (% MVIC)</td>
<td>deceleration (% MVIC)</td>
<td>follow-through (% MVIC)</td>
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<td><strong>Levator scapulae</strong></td>
<td>15</td>
<td>29 ± 19</td>
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<td>Trail arm</td>
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MVIC = maximum voluntary isometric contraction.

Escamilla and Andrews, 2009
Kao et al, 1995
Function – Golf Swing

• Take-Away
  – Trail arm upward rotation and elevation for GHJ positioning

• Forward Swing
  – Lead arm retraction and stabilization

• Acceleration, deceleration, follow-through
  – Lead arm stabilization (relatively low activity)

Escamilla and Andrews, 2009
Dysfunction

• Can go wrong many ways
  – Weakness
  – Postural deviation
  – Pain inhibition
  – Muscular imbalance
  – Combination of any of the above

• Consequences
  – Force couple disruption
  – Altered length/tension relationships
  – Inability to fulfill scapular roles
Dysfunctional Motion - Dyskinesia

- Impingement/Rotator Cuff Pathology
  - 9 studies evaluating UROT
    - 4 decreased
    - 1 increased
    - 4 no difference
  - 7 studies evaluating posterior tilting
    - 4 decreased
    - 2 increased
    - 1 no difference

- Multidirectional GHJ instability
  - 4 studies evaluating UROT
    - 4/4 decreased

- Shoulder stiffness (GHJ elevation)
  - 3 studies evaluating UROT
    - 3/3 increased

Ludewig and Reynolds, 2009
Dysfunctional Muscle Activity

• Cools et al 2004
  – 19 overhead athletes with impingement side:side comparison
  – Peak force and EMG activity during isokinetic protraction/retraction

• Significant findings
  – Lower peak protraction force at high velocity
  – Lower protraction/retraction force ratio at low velocity
  – Lower LT EMG activity during retraction at high velocity
Dysfunctional Muscle Activity

• Cools et al 2007
  – 39 overhead athletes with impingement and 30 healthy controls
  – EMG activity and intramuscular trapezius ratios during isokinetic abduction, isokinetic EROT

• Significant findings
  – Higher UT EMG activity both motions
  – Lower LT EMG activity abduction
  – Lower MT EMG activity EROT
  – Altered UT/MT, UT/LT ratios
Dysfunctional Muscle Activity

• Huang et al, 2015
  – 82 subjects with shoulder pain
  – Classified dyskinesis observationally into three categories
  – EMG activity and kinematics during scaption

• Significant results
  – Lower LT activity in those with inferior angle and medial border prominence during lowering
  – Higher UT activity in those with inferior angle and medial border prominence throughout

Burkhart et al, 2003
Dysfunction

• Good evidence for changes with pathology
  – Scapular dyskinesis
  – Altered muscular activity
    • Changes in overall activity
    • Changes in inter and intramuscular firing ratios

• Questions remain
  – Factors in etiology of pathology?
  – Compensatory mechanisms secondary to pathology?
  – Representative of pain inhibition?
  – What to do about it?
Treatment - Lower Trapezius

• Increasing % MVIC
  – Low row
  – Robbery
  – D1 flexion
  – Unilateral row
  – Scaption <80
  – Scaption > 120
  – Prone horizontal abduction with EROT (T)
  – Prone EROT at 90 abduction
  – Prone flexion at 135 abduction (Y)

Uhl, 2009
Treatment – Lower Trapezius

Figure 2.  Low row exercise.

Figure 4.  Robbery exercise.

Kennedy et al, 2009
Treatment – Lower Trapezius

- Arlotta et al, 2011
  - 18 healthy subjects
  - EMG during 5 isometric exercises
  - Assessed amplitude and intramuscular ratio

- Significant findings
  - Modified prone cobra and prone row most favorable when considering amplitude and isolation

Arlotta et al, 2011
Treatment – Scapular Muscle Balance

• Clinically often identify imbalance with UT activity greater than middle and lower fibers

• Cools et al, 2007
  – High ratio of LT and MT activity relative to UT
    • Prone extension
    • Sidelying elevation
    • Sidelying EROT
    • Prone horizontal abduction with EROT

De Mey et al, 2009
Treatment – Progression

- Transition to functional motions that are specific to the athletic activity
  - Incorporate “Kinetic Chain” components
    - Regional interdependence
    - Proximal influences
    - Scapular role in energy transfer

- LT is not just a stabilizer
  - Strength
  - Power

Figure 3. Lawnmower exercise, with weight.

Kennedy et al, 2009
Treatment - Progression

- Functional motions
  - Diagonals
  - Rotation
  - Chop
  - Simulated throwing/serving

- Trunk rotation does impact firing patterns
  - Facilitation of muscle activity
  - Specificity of training

Nagai et al, 2013
In Closing

• Lower trapezius function vital in supporting the role of the scapula

• Body of evidence demonstrating altered scapular kinematics and altered activity of the scapular musculature with pathology

• Wealth of research to assist in the selection of strengthening tasks to target scapular musculature
References


References


• Hobart DJ, Anderson DA, Conroy VM. *A Dissector of Human Anatomy Emphasizing the Musculoskeletal System*. University of Maryland School of Medicine Department of Physical Therapy and Rehabilitation Science, 2008.

References


Phases of Pitching

Fleisig et al, 2006
Phases of the Golf Swing

Figure 1. Phases of the golf swing. (Reprinted with permission.)