Objectives

• Describe and demonstrate an evaluation procedure for upper extremity that incorporates the entire system (kinetic chain) and incorporates scapular assessment as part of comprehensive shoulder examination.
• Explain theoretical rationale for an integrated kinetic chain approach for evaluation and rehabilitation.
• Demonstrate exercise interventions incorporating a kinetic chain approach that would address impairments and functional limitations in patients that presenting with shoulder pain and have associated scapular dyskinesis impairment.

Assessment of Scapular Dysfunction

• Share an overview of assessment of scapular dysfunction developed in Lexington
  – W. Ben Kibler MD
    • Colleague since 1985
  
• Understanding scapular kinematics, muscle activation is critical in assessment of the shoulder
Appreciate Normal Motor Control and Kinematics

- The ability to lift arm is dependent on proximal stability
  - Joint integrity
  - Scapular motion & musculature
  - Spine motion & musculature

Shoulder Evaluation

- Focus on location of pain
- Myopic view

Shoulder Evaluation

- Focus on location of pain
- Myopic view
- Miss the rest of the potential causes of pain
- Evaluate the whole system
Clinical Assessment of Shoulder Function

- Observation
  - Posture
  - Scapular assessment
    - Static position
    - Dynamic motion
    - Scapular Repositioning
- ROM
- Strength
  - Manual Muscle Testing
- Special or Provocative Tests

Laboratory

<table>
<thead>
<tr>
<th>Tests</th>
<th>Considerations</th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder ARROM</td>
<td>Active Forward Elevation</td>
<td></td>
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<tr>
<td></td>
<td>Active Abduction</td>
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<tr>
<td></td>
<td>External Rotation</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Internal Rotation up spine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scapular AROM</td>
<td>Flexion with load when appropriate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scaption with load when appropriate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cervical AROM</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Trunk AROM</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Tests</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static posture bilateral stance</td>
<td>Feet / Knee / Hips / Pelvis Thoracic Scoliosis / Kyphosis – Inclinometer Scapular position Shoulder/Scapula – double square / Atrophy Forward Head</td>
</tr>
<tr>
<td>Dynamic Posture Core Stability (note hip/knee/ankle)</td>
<td>Dynamic gait Stand on R leg Stand on L leg Squat on right leg Squat on left leg</td>
</tr>
<tr>
<td>Rotator Cuff Strength (standing)</td>
<td>Supraspinatus – thumb up Subscapularis – belly or lift off Infraspinatus – internal rotated 45° Seratus Anterior - 120° elevated</td>
</tr>
</tbody>
</table>
Assessment Summary

- Assessment of scapular motion can be performed with moderate reliability within the standard examination of the upper quarter.
- Its presence is relatively common but its role is unclear and at this time be considered an impairment that may be a factor contributing to pain
  - Much like excessive pronation in patellofemoral pain syndrome
- Repositioning tests to alter symptoms along with other assessments of strength and flexibility forms a complete examination
- Further investigation to the meaningfulness or the predictive nature of these test is needed.

Algorithm of treatment of shoulder pain

- Co-ordinated (smooth) scapulohumeral movement based on movement analysis research and side-side comparison with correct humeral head position in glenoid and no compensatory trunk movement
  - Klintberg et al., 2014
Applying Principles of Kinetic Chain into Scapular Rehabilitation

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Division of Athletic Training
College of Health Sciences
University of Kentucky

Rehabilitation Plan Considerations (ICF)

• Body Function & Structure
  – Strength
  – Flexibility
  – Tissue disruption

• Activity Limitations
  – Reaching overhead
  – Throwing
  – Weight lifting

• Participation status
  – Practice/ Game/ Work

International Classification of Function (ICF) Model

World Health Organization, 2002

Health Condition (Disorder or Disease)

Body Function & Structure

Activity

Participation

Environmental Factors
1. Gravity
2. Pace
3. Time

Personal Factors
1. Goals
2. Expectations
3. External Pressures

Theoretical Foundations of Kinetic Chain Rehabilitation?

1. Kinetic link model
2. Motor control activation patterns
3. Proprioceptive Neuromuscular Facilitation principles

— McMullen & Uhl JAT 2000

Assessment and Management of Scapular Dyskinesis 2015 WFATT
1. Kinetic Link Model

- A model of linked segments commonly used in biomechanics
- Acceleration of distal segment comes from the “controlled deceleration” of proximal segments

2. Motor Control Activation Patterns

**Proximal Stabilization Anticipatory Postural Adjustment**

- Transverse abdominal and multifidus musculature precedes distal arm motion
- This activation provides trunk stabilization and prevents postural perturbation
  - Hodges and Richardson. Exp Brain Res 1997
  - Cordo and Nashner. J Neurophysiol 1982
- Panjabi Model spine
  - Passive – Osseoligamentous structures
  - Active – Muscular system
  - Neural – Control system
  - Panjabi J Spinal Disorder 1992

Force Transmission through the Kinetic Chain

- Diagonal orientation of muscle that produce large forces to move distal segment
- Other Functions
  - Absorb force
  - Stabilize spine

Core Anatomy: Anterior Serape

- **Anterior Oblique Sling**

- **Serratus Anterior**

- **External Obliques**

- **Internal Obliques**

- **Hip Flexors**

Drive off same leg
Core Anatomy: Posterior Serape
Posterior Oblique Sling
Decelerators: Posterior cuff/Scapular/
Multifidus/Thoracodorsal fascia/
Gluteals/Thigh musculature

Decelerate off contralateral leg

3rd Component is Integrating PNF Principles

- Normal development proximal to distal and cervicocaudal (Head to toe)
- Reciprocal relationship between flexors and extensors for stability and normal motion
- Motor behavior is an orderly sequence of total patterns of movement and posture
- Improvement of motor ability depends on motor learning
- Frequent stimulation promotes learning
- Goal directed activities (Task)

Applying PNF Principles to Kinetic Chain Rehabilitation

- Clinician must help the patient relearn the movement pattern
  - Selecting resistance or assistance
  - Visual, auditory, and tactile feedback
  - Increased muscular recruitment
  - Seitz et al., J Electromyog Kines 2014
- Stronger components of a movement pattern facilitate weaker (irradiation)

Isolating vs. Integrating Exercises

- Prone Extension
  - Posterior cuff (teres minor) and deltoid >60% MVIC
    - Blackburn et al., JAT 1990
    - DeMey et al., AJSM 2012
- Standing shoulder extension with forward step
  - Trunk/Scapular/Cuff musculature
- Two different approaches neither is wrong
Scapular Rehabilitation Algorithm

Ellenbecker & Cools Br J Sports Med 2010

Scapular Rehabilitation Interventions

1. Post-operative Shoulder Rehabilitation
2. Scapular dyskinesis and shoulder pain in overhead athlete during season
3. Scapular dyskinesis 6 months following labral repair

Motor Control
Stability
Patient Outcome
Mobility

Pain Modulation

1. Post-op Patient
   - Status-Post 5-10 day from superior labral repair
   - Physician want to follow a phased motion recovery
     — Wilk et al., JOSPT 2005
   - Patient is in moderate pain and somewhat apprehensive to move

<table>
<thead>
<tr>
<th>Flexion</th>
<th>Internal Rotation</th>
<th>External Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 0-2</td>
<td>75</td>
<td>45</td>
</tr>
<tr>
<td>Week 3-4</td>
<td>90</td>
<td>55</td>
</tr>
<tr>
<td>Week 5-6</td>
<td>145</td>
<td>55 @ 45 ABD</td>
</tr>
<tr>
<td>Week 7-9</td>
<td>180</td>
<td>75 @ 90 ABD</td>
</tr>
</tbody>
</table>

Post-Operative Rehabilitation
SLAP Repairs: Precautions

Immobilized for approximately ≈ 3 weeks
   - Restrict external rotation to 0°
   - Restrict shoulder extension
   - Gradual ROM progression
   - Sleep in shoulder immobilizer ~ 4wk
   - Avoid isolated biceps contractions (5-6 wks)
     — Wilk et al., JOSPT 2005
   - Caution with bimanual tasks (open jar) increases Biceps activity
     — Smith et al., JSES 2004

• Posterior shear forces tears bicep anchor to labrum with less force than distraction force
  — Shepard et al., AJSM 2004

• Late cocking position of throwing (Abd & ER) produce greatest labral strain on anterior and posterior portion of superior labrum
  — Pradhan et. al, AJSM 2001

• Rehabilitation Implications:
  — Limit external rotation / abduction gradually increase motion over the first 2 months

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Passive & Active Assistive Exercises

- Scapula Orientation
  - Sternal lifts
  - Clock
- Arm supported motion
  - Forward Bow
  - Table slides

Rehabilitation Progression

- Protect weakened tissues
- Regain motion & function
- Activate inhibited/weakened muscles gradually

EMG Assessment of Passive, Active-Assistive, & Active Exercises

Subdividing Active-Assistive Elevation Exercises
**2. Non-operative Scenario**

- 17 y.o. overhead athlete
- Hx: Insidious onset of shoulder pain over 4 wks with overhead sport
- Objective:
  - Painful arc at 110° with (+) SAT
  - 4/5 Weakness with pain in
    - Elevation
    - External rotation
    - Lower trapezus
  - Rates pain with activity as 5/10
- Forward shoulders & head
- Scapular dyskinesis

**Scapular Muscle Activation Levels**

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Muscle Activation</th>
</tr>
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<tbody>
<tr>
<td>Lying</td>
<td>Upper Trapezius</td>
</tr>
<tr>
<td>Standing</td>
<td>Lower Trapezius</td>
</tr>
<tr>
<td>Sitting</td>
<td>Serratus Anterior</td>
</tr>
<tr>
<td>Supine</td>
<td>Gravity minimized</td>
</tr>
<tr>
<td>Forward Elevation</td>
<td>Upright</td>
</tr>
<tr>
<td>Sidelying</td>
<td>Assisted</td>
</tr>
<tr>
<td>Ball Roll Standing</td>
<td>Active</td>
</tr>
<tr>
<td>Wall walk</td>
<td>Unassisted</td>
</tr>
</tbody>
</table>

UT/SA Ratio = .2 for supine forward elevation

**Positional Progressions**

- Altering gravitational loads based on biomechanical theories is suggested in the literature
- Massive RC tears - Supine → wedge → upright
  - Levy JSES 2008
- Biceps tenodesis - Side-lying → supine → upright
  - Krupp JOSPT 2009
- Utilizes patient’s hand in contact with surface to unload the weight of the arm for AAROM exercises
  - Wise, JSh Elb Surg 2004

- Clinician based exercise progression following these concepts
  - Gravity minimized
  - Upright assisted
  - Active unassisted
  - Gaunt et al., Sports Health (2010)
- Incorporates legs and trunk to initiate and facilitate arm elevation
  - Kibler, Med Sci Sport Ex 1998
  - McMullen & Uhl JAT 2000

**Scapular Rehabilitation Algorithm**

Patient Education

- Determine and set expectations
  - Exercises must be integrated into their life
- Explain to the patient what is going on and how treatment will address complaints
- Provide 2 week expectations with treatment
- Identify activities that provoke symptoms
- Identify exercises that can address deficits that don’t increase symptoms
- Use Science
  - Continuum of functional rehabilitation is driven by patient’s response to exercise

Finding Appropriate Intensity Level of Exercise

- Standing - attempt to gain scapular control with sagittal plane elevation
  - Functional
- Standing - work on transverse plane
- Static arm – exercise trunk and possibly scapula
- Unload weight of arm or shorten lever arm

Exercise Selection based on Scapular Control & Pain Response

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Lower Trapezius</th>
<th>Infraspinatus</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>15 ± 11%</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td>20 ± 21%</td>
<td>27%</td>
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<tr>
<td></td>
<td>65±37%</td>
<td>62±13%</td>
</tr>
<tr>
<td></td>
<td>59±27%</td>
<td>39±17%</td>
</tr>
</tbody>
</table>

Regaining Scapular Motor Control: Science

- Scapular orientation effects strength
  - Neutral position generates more strength than either protraction or retraction
    - Smith et al., Arch Phy Med Rehab 2002
- Scapular orientation exercises indicate patients can learn to find a neutral scapular orientation position (r=.92)
  - Mid-position
    - UR/DR
    - IR/ER
    - AT/PT
  - Mottram et al., Man Ther 2009
Conscious Control Increases Motor Activity: Science

- Visual, Auditory, & Kinesthetic cueing of scapular orientation
  - Increased Scapular Muscular Recruitment by 7-10% in Sidelying ER & Prone Extension
  - No alteration of UT/LT muscle ratios occurred
    - DeMey et al., JOSPT, 2013

- Auditory & Kinesthetic cueing of scapular of scapular retraction during PHA
  - Increased lower trapezius activation over written instructions by 10-15%
    - Seitz et al., J Electromyog Kines. 2014

Regaining Scapular Motor Control: Art

- Scapular orientation exercises using a scapular clock to learn to control scapula independent of arm
- Arm supported scapular motor control
  - Rhythmic initiation
- Biofeedback

Fundamental Program

- Side-lying
  - Elevation
  - ER
- Prone
  - Horizontal Abduction with ER
  - Extension

Effective in increasing function & reduced UT compensation during elevation

Low Demand Exercises to Facilitate External Rotation Progression

- Low to Moderate activity 20-40%MVIC
Kinetic Chain to Facilitate Scapular Position

- Active trunk extension (sternal lift) with scapular retraction
- Facilitate proper posture with re-education techniques

High Demand Exercises to Facilitate External Rotation Progression

High activity >60%MVIC

Fundamental Movements

- PNF Diagonals
- Reaching / Lowering
- Push / Punch / Throw
- Pull
- Functional

Fundamental Patterns

- Punch or Pull
- Reverse Throw
Integrating Entire Body with Elevation

- Step forward punch
- Activate legs → trunk → scapula & rotator cuff muscle in normal pattern
  - Zattara & Bouisset. J Neurol 1988
  - ~10% increase in scapular recruitment
    - Uhl et al., PMR 2010, Smith et al., APMR 2006
- Support arm to reduce substitution
  - Wise et al., JES 2002
- PNF concept of irradiation (strong muscles facilitate inhibited muscles)

Ball Roll

Wall Slide

Scapular Dyskinesis 6 months following Superior Labral Repair

- Penn Shoulder Score
- Pain was 21/30
- Satisfaction was 4/10
- Function 42/60
- What else do you need to examine?
  - Algorithm

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ROM & End Feel

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Active Flexion</td>
<td>182</td>
<td>162</td>
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<tr>
<td>Active Abduction</td>
<td>164</td>
<td>154</td>
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<tr>
<td>Active ER</td>
<td>96</td>
<td>66</td>
</tr>
<tr>
<td>Pass ER</td>
<td>80</td>
<td>55</td>
</tr>
<tr>
<td>Pass IR</td>
<td>58</td>
<td>54</td>
</tr>
</tbody>
</table>

- Inferior glide was significantly less mobile but not reactive to overpressure
- Pain in superior shoulder during abduction and external rotation
  - Relieved by humeral head posterior glide

Stretching Matrix: Hold 30 Seconds for 4 repetitions

- **Anterior**
  - Home: Towel Roll, 1 arm doorway, 2 arm doorway
  - Clinic: Massage/Manual, Contract/Relax, Manual w/ trunk

- **Posterior**
  - Home: Cross body, Cross body stabilized, Sleeper stretch
  - Clinic: Massage/Manual, Contract/Relax, Active stretch

- **Cervical/Thoracic**
  - Home: Supine AROM, Sitting AROM, Manual overpressure
  - Clinic: Massage/Manual, Contract Relax

- **Inferior**
  - Home: Towel slides, Doorway slides
  - Clinic: Massage/Manual, Contract/Relax, Active stretch

Scapular Rehabilitation Algorithm


Addressing Posterior Shoulder Tightness and Scapular Stability

- Stabilizing scapula with overpressure
- Integrate massage to teres/lats
  - Trigger point release
**Blocked Scapula Stretching**

- Pure glenohumeral motion
- Pain free
- Patient controls stretch
- Therapist stabilizes scapula
- Need to have at least 120° unblocked passive flexion

**Take Home Points**

- Find appropriate intensity level
- Use the scientific foundations to create your art of rehabilitation
- From a scientific foundation & patient’s response
  - Individualize patients intervention
- Mobility to Stability
- Think motor control not just strengthening
Evaluation and Treatment of Scapular Dyskinesis

Tim L. Uhl PT ATC PhD FNATA, Division of Athletic Training, Department of Rehabilitation Sciences, College of Health Sciences, University of Kentucky, Lexington, KY, USA (tluhl2@uky.edu)

Description: The body functions as an integrated system, in sport and in work, and is in part driven by specific activities. Understanding how the entire system works together as a functional unit within its environment is indispensable for appropriate evaluation and intervention to restore patients’ to their full functional level. An individual patient develops movement patterns and resting postures dependent on their physical characteristics (strength, flexibility, endurance) to meet the demands of the activities (throwing, lifting packages into a truck, inserting rivets) and the environment the task is performed (athletic field, in the water, at a desk). In the common micro-traumatic presentation of an injury our job is to determine which component(s) are creating the pathology, impairments, and functional limitations that are affecting the individual participation in sport or work. The focus of this presentation will address the biomechanical, anatomical, and the physiological considerations needed to create interventions to ultimately resolve the functional limitations to allow the patient to return to full function.

Rehabilitation just as evaluation needs to incorporate the entire functional unit. The first step in rehabilitation is a complete and thorough assessment. During rehabilitation our focus needs to shift from isolating the problem to creating interventions that address the impairments and functional limitations. The approach described in this presentation takes an integrated approach incorporating the kinetic chain model, motor control pattern of proximal to distal activation, and incorporating many principles of proprioceptive neuromuscular facilitation to achieve the goals of restoring function. Consideration for the individual impairments and the environment that the individual lives must be integral to the intervention as the patient is often attempting to return to the same activity that may have precipitated the initial injury.

Objectives:
1. Review normal function of scapular dynamic motion.
2. Explain theoretical rationale for an integrated kinetic chain approach.
3. Describe and demonstrate an evaluation procedure for upper extremity that incorporates the entire system (kinetic chain) and incorporates scapular assessment as part of comprehensive shoulder examination.
4. Demonstrate exercise interventions incorporating a kinetic chain approach that would address impairments and functional limitations in patients that present with shoulder pain and have scapular dyskinesis impairment.

Why do We Care about Scapular Dysfunction?
- Scapular motion is critical for normal motion and function of upper extremity
- Critical link between trunk and upper extremity
  - Site of multiple muscular attachments
- Provide mobile base for the humerus to maintain glenohumeral stability

Incidence of Problem
- Scapular dyskinesis is intimately involved with glenohumeral derangement
  - 64% Instability
  - 100% Impingement
- Dyskinesis is not associated with the presence of mild pain in athletes
• Recent 3-D kinematic analysis suggests that asymmetry is very common. The dominant side scapula appears to
be more internally rotated and anteriorly tilted in healthy college athletes.\textsuperscript{6}
• 76% of the participants out of 56 had at least one plane of scapular asymmetry\textsuperscript{7}
• Observation of dyskinesis does not indicate injury but in the presence of symptoms should be a trigger to further
investigate causes

Potential Scapular Dysfunction Factors
• Glenohumeral pathology\textsuperscript{8-10}
• Glenohumeral stiffness
• Neuropathy\textsuperscript{11,12}
• Muscle weakness\textsuperscript{13}
• Muscle tightness\textsuperscript{14}
• Muscle fatigue\textsuperscript{15}
• Pain\textsuperscript{16}
• Loss of neuromuscular control\textsuperscript{17,18}
• Dyskinesis - Impairment of the power of voluntary movement resulting in fragmentary movements.\textsuperscript{19}

Appreciate Normal Motor Control and Kinematics
• The ability to lift arm is dependent on proximal stability
• Glenohumeral joint stability
• Scapular musculature
• Spine stability
• Dynamic stability of proximal segments arises due to anticipatory postural adjustments\textsuperscript{20,21}

Scapular Kinematics\textsuperscript{22,23}
3-D Kinematics
Recent advances in technology and the continued integration
of research with clinical assessment has facilitate a better
understanding of scapular motion\textsuperscript{24,25}

• 3 Rotations
  — Upward/ Downward (50 ° + 5 °)
  — Internal/External (24 ° + 13 °)
  — Anterior/Posterior (30 ° + 13 °)
• 2 Translations
  — Superior/Inferior
  — Anterior/Posterior
  — Medial/Lateral constrained by clavicle

Clinical Assessment of Shoulder
1. Observation
Static Postural Assessment\textsuperscript{26-29}
- Cited as a potential cause of shoulder and neck pain\textsuperscript{30}
- Slouched thoracic posture reduces humeral and scapular motion along with reducing strength\textsuperscript{28}
- Hyperkyphosis should be taken into consideration when evaluating patient’s with shoulder pain due to
potential effect on subacromial space\textsuperscript{29}
-Recent report on short pectoralis minor has demonstrated reduced scapular motion \(^{14}\)
-Double square (\$15.00 x 2) alternative approach to measure forward posture \(^{31,32}\)
-Length of pectoralis major can be assessed with tape measure \(^{33}\)

**Single leg balance and control**
- Single leg balance indicates the leg, pelvic, and trunk strength and dynamic balance without a stable platform it is difficult to generate distal force or maintain appropriate trunk posture \(^{34,35}\)
- Screening process for more specific impairments with motion or strength issues \(^{36-39}\)

2. **ROM**

Scapular observational analysis during AROM assessment

- **Static observation of scapular position** \(^{40}\)
  - Downward Rotation
  - Depression
  - Abduction
  - Winging and tilting syndrome

- **Dynamic** \(^{41}\)
  - Normal
  - Superior border pattern
  - Medial border pattern
  - Inferior angle pattern

Follow up study of observational assessment method is better with 2 category system \(^{7}\)
- Presence of scapular dyskinesia
- Absence of scapular dyskinesia

**Scapular Dyskinesis Test**
Individually evaluates scapular utilizes a loading system to bring out the dyskinetic pattern more clearly and basically uses the same idea of present or absent \(^{5,42}\)
- Dysrhythmia: Premature or excessive scapular elevation or protraction, nonsmooth or stuttering motion during arm elevation or lowering, or rapid downward rotation during arm lowering.
- Winging: Any portion of the scapular medial border is posteriorly displaced away from the thorax.

**Scapular Assessment Special Tests (Reposition tests)**
Repositioning the scapula to facilitate better scapular functional position and potentially open subacromial space. Many impingement tests drive the humerus into the scapula where these tests consider moving the scapula out of the way of the humerus

**Scapular Assistance Test** \(^{43}\)
- Assist the scapula retract and upwardly rotate as the arm is elevated
- (+) Pain diminished and range of motion increased
- Indicates improving scapular motion may diminish symptoms
- Moderate to good reliability =.-5-.94\(^{44}\)

**Scapular Retraction Test**
- Perform provocative test
- Assess strength of deltoid and rotator cuff
- Have patient retract scapula and manually provide scapular stability then retest strength
• Improved symptoms (strength~20%) indicates scapular muscular control is compromised not truly a rotator cuff problem. A small cohort with similar characteristic were found in water polo athletes.45,46
• Alters scapular kinematics47

Range of Motion
• Standard directions, ASES recommends 5
• Loss of IR important to assess48
• Loss of IR and Total Range of Motion (TROM) is predictive of future injury in baseball and softball players49,50
• Posterior shoulder tightness of internal rotation and horizontal adduction require specific consideration especially for athletic and overhead population
  - Expect overhead athlete to have internal rotation deficit
  - In measuring glenohumeral internal rotation it is important to stabilize the scapula.51
  - Horizontal adduction should be evaluated as it goes as symptoms go in pathological shoulders.52,53

3. Strength
Assessment of Rotator Cuff Muscle Function54
• Supraspinatus – elevated to 90° and thumb up
• Infraspinatus – elbow at side with arm internal rotated 45°
• Subscapularis – lift off or belly press

Assessment of Scapular Muscle Function 55
• Lower Trapezius-Prone arm is abducted to 135° shoulder is flexed and scapula retracted, apply pressure in line with fibers of lower trapezius and anteriorly to move scapula anteriorly
• Middle Trapezius and Rhomboids - Prone humerus is extended and scapula retracted (medial border near spine), apply pressure
• Serratus Anterior - Supine arm is flexed to 90° with arm protracting so that scapular moves laterally along thoracic wall, apply pressure to resist protraction
• Upper Trapezius - cervical spine side bent and rotated away with scapula shrugged, apply pressure to resist elevation and posterior occiput

<table>
<thead>
<tr>
<th></th>
<th>Mean (Kg)</th>
<th>SD (Kg)</th>
<th>ICC</th>
<th>MDC90 (Kg)</th>
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<tbody>
<tr>
<td>Lower Trapezius</td>
<td>9.2</td>
<td>3.4</td>
<td>.89</td>
<td>2.6</td>
</tr>
<tr>
<td>Medial Trapezius / Rhomboids</td>
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<td>3.2</td>
<td>.94</td>
<td>1.8</td>
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<tr>
<td>Upper Trapezius</td>
<td>16.1</td>
<td>7.1</td>
<td>.96</td>
<td>3.3</td>
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<tr>
<td>Serratus Anterior</td>
<td>15.3</td>
<td>6.3</td>
<td>.94</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Scapular Muscle Endurance
• As fatigue increases scapulohumeral relationship approaches a 1:1 ratio especially above 90°. Increased scapular rotation may be compensating for rotator cuff fatigue or improve length tension relationship 15
• Muscular latency decreases ~ 20% after fatigue of max abduction effort 56
• Many studies have investigated the effects of fatigue57-59 on scapular motion but not really a test of scapular endurance
• Two clinical endurance tests: Dynamic and Static Posterior Shoulder Endurance Test. Pilot testing in the laboratory suggest that recruits and fatigues all of the trapezius, posterior deltoid and to a limited extent the infraspinatus. These test recruit entire posterior shoulder musculature so not isolating scapular muscular endurance but shows promise as is moderately reliable, responds to training, and is clinically feasible. Reliability testing is moderate to good with MDC for the static test is 30 seconds60 and the dynamic test is 5 repetitions.61
4. Special Test – Provocative testing
   a. Rotator Cuff
   b. Instability
   c. Labral

Summary:
A complete assessment of a patient with an upper extremity injury should include assessment and consideration of scapular, spine, and lower extremity dysfunction as part of a thorough evaluation. Continued research and evolution of this approach will hopefully lead to a better clinical assessment of scapular dysfunction.

Supplies for Shoulder Evaluation: Tape Measure, Goniometer or Inclinometer, Towel, Dumbbells, Double Level, Video recorder, Hand Held Dynamometer

International Consensus for physiotherapy for Shoulder Pain
### Clinical Evaluation of Shoulder and Kinetic Chain

<table>
<thead>
<tr>
<th>Considerations</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Static posture bilateral stance</strong></td>
<td></td>
</tr>
<tr>
<td>Feet / Knee / Hips / Pelvis</td>
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<tr>
<td>Thoracic Scoliosis / Kyphosis – Inclinometer</td>
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<tr>
<td>Scapular position (Lateral Scapular Slide)</td>
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<tr>
<td>Shoulder/Scapula – double square / Atrophy</td>
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<tr>
<td>Forward Head</td>
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<tr>
<td><strong>Dynamic Posture Core Stability</strong> (note hip/knee/ankle)</td>
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<tr>
<td>Dynamic gait</td>
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<tr>
<td>Stand on R leg</td>
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<td>Stand on L leg</td>
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<tr>
<td>Squat on right leg</td>
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<tr>
<td>Squat on left leg</td>
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<tr>
<td><strong>Trunk AROM</strong></td>
<td>Trunk</td>
</tr>
<tr>
<td>Cervical/Trunk motion (6 directions) with over pressure</td>
<td>Neck</td>
</tr>
<tr>
<td><strong>Shoulder AROM</strong></td>
<td>Right</td>
</tr>
<tr>
<td>Active Forward Elevation</td>
<td>Left</td>
</tr>
<tr>
<td>Active Abduction</td>
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<tr>
<td>External Rotation</td>
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<tr>
<td>Internal Rotation up spine (functional)</td>
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<tr>
<td><strong>Scapula AROM</strong></td>
<td>Right</td>
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<tr>
<td>Add load for appropriate patients</td>
<td>Left</td>
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<tr>
<td>3-5 reps forward flexion</td>
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<tr>
<td>3-5 reps scaption</td>
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<tr>
<td><strong>Scapular Tests (standing)</strong></td>
<td>Positive</td>
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<tr>
<td>Scapular Assistance Test</td>
<td>Negative</td>
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<tr>
<td>(+) reduction of pain with scapular support</td>
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<tr>
<td>Scapular Retraction Test</td>
<td></td>
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<tr>
<td>(+) reduction of pain and/or increase strength</td>
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<tr>
<td><strong>Rotator Cuff Strength (standing)</strong></td>
<td>Right</td>
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<tr>
<td>Supraspinatus – thumb up</td>
<td>Left</td>
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<tr>
<td>Subscapularis – belly or lift off</td>
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<tr>
<td>Infraspinatus – internal rotated 45°</td>
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<td>Serratus Anterior - 120° elevated</td>
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<td><strong>Special Tests (standing)</strong></td>
<td>Right</td>
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<td>Neer</td>
<td>Left</td>
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<td>Hawkins-Kennedy</td>
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<td>Active compression</td>
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<td>Dynamic Labral Shear</td>
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<tr>
<td><strong>Scapular Strength (lying)</strong></td>
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<tr>
<td>Proraction for Serratus Anterior</td>
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<tr>
<td>Prone flexion at 135° abduction (Lower Trapezius)</td>
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<tr>
<td>Medial border retraction (Rhomoids and Middle Trap.)</td>
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<tr>
<td>Posterior Shoulder Endurance Test</td>
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<tr>
<td><strong>PROM/ Glenohumeral Instability (lying)</strong></td>
<td>Right</td>
</tr>
<tr>
<td>GH. internal rotation with scapula stabilized</td>
<td>Left</td>
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<tr>
<td>GH. External rotation active and passive</td>
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<tr>
<td>Elevation active and passive</td>
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<tr>
<td>Apprehension</td>
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<td>Relocation (instability / labral)</td>
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<tr>
<td>Crank</td>
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<td>Biceps Load</td>
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<td>Horizontal Adduction</td>
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</table>
Treatment of Scapular Dyskinesis

The Basis for using the Trunk in Upper Extremity Rehabilitation

1. The Kinetic Chain Model
   - A model of linked segments commonly used in biomechanics
   - The human body can be characterized as a kinetic chain
   - Sport activities attempt to strike or throw at high velocities
     - Kinetic chain and Leading Joint Hypothesis theory supports that distal force production is due to summation of forces in the proximal segments throughout the entire kinetic chain
     - Ability to decelerate proximal segment allows transfer of momentum to next distal segment

2. Typical motor control pattern activates in a proximal – distal manner in Shoulder Elevation
   - Transverse abdominal and multifidus musculature precedes distal arm motion
   - This activation provides trunk stabilization and prevents postural perturbation
   - This pattern facilitates force production in everyday life and in high demand sports
   - Proximal stability before distal mobility
   - Core critical to shoulder function
     - Trunk function – stabilize, generate and absorb force
     - Spine Model
       - Passive Structures
       - Active Structures
       - Neural Control System
   - Breakdown anywhere along the chain can lead to increased demand and added biomechanical stresses ultimately leading to decreased performance and symptoms
   - Serape effect is described as the function of trunk muscles generating forces and transferring it to the extremities

3. Applying PNF Principles to Kinetic Chain Rehabilitation
   - Motor behavior is a sequence including head, trunk, and extremities
   - Goal directed movements are dependent on synergies
   - Normal motor development occurs in a proximal to distal manner
   - Stronger components of a movement pattern facilitate weaker (irradiation)
   - Clinician must help the patient relearn the movement pattern
     - Selecting resistance or assistance
     - Verbal cueing
     - Manual contact
     - Visual, auditory, and tactile feedback
   - Combining all three planes of motion is functional and is a fundamental principle for many power motions
Case 1. Status-Post 5-10 day from superior labral repair
- Physician wants to follow a phased motion recovery
- Patient is in moderate pain and somewhat apprehensive to move

<table>
<thead>
<tr>
<th>Flexion</th>
<th>Internal Rotation</th>
<th>External Rotation</th>
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<tbody>
<tr>
<td>Week 0-2</td>
<td>75</td>
<td>45</td>
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<tr>
<td>Week 3-4</td>
<td>90</td>
<td>55</td>
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<tr>
<td>Week 5-6</td>
<td>145</td>
<td>55 @ 45 ABD</td>
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<tr>
<td>Week 7-9</td>
<td>180</td>
<td>75 @ 90 ABD</td>
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</tbody>
</table>

Rehabilitation Implications
- Gradually increase stress to the arm while staying within restrictions
- Progressively increase motion and muscular activation levels
- Exercise progression should be modified up or down based on patient’s pain and response to exercise

Case 2. 17 year old overhead athlete presents with complaints of shoulder pain due to insidious onset
- Objective Findings:
  - Painful arc at 110° with (+) SAT
  - 4/5 Weakness with pain in Elevation, External Rotation, and Prone Flexion with External Rotation (Lower Trapezius)
  - Single leg squat reaches only 50%
- Forward shoulders & head
- Scapular dyskinesis
- Rates pain with activity as 5/10 at worse, resting pain 0-2 seems to be getting worse

Rehabilitation Implications
- Identify patient expectations and discuss realistic goals in 2 weeks
- Identify exercises that address deficits without aggravating symptoms
- Fundamental program is a good starting point but may need to address kinetic chain deficits and improper movement patterns
### Exercise Continuum based on EMG literature

<table>
<thead>
<tr>
<th>Exercise</th>
<th>PROM</th>
<th>AAROM</th>
<th>ISOM</th>
<th>AROM</th>
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</thead>
<tbody>
<tr>
<td>Scapular Punch elastic</td>
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<tr>
<td>Flexion &gt; 120 elastic</td>
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<td>Extension</td>
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<td>Supine Extension</td>
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<td>Supine Press-up</td>
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<td>Robbery</td>
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<td>Lawn mower</td>
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<tr>
<td>Wedge Press-up</td>
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<td>Standing Press-up</td>
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<tr>
<td>Supine ER – w/bar</td>
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<td>Towel Slide</td>
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<td>WC Press-up, Hands apart</td>
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<td>Table slides (dusting)</td>
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<td>Side-lying elevation</td>
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<td>Inferior glide</td>
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<td>Standing ER</td>
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<td>Standing Flexion</td>
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<td>Supine Flexion w/ band &gt; 1.20</td>
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<td>Wall Slide</td>
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<td>Ext rotation 0° (elastic)</td>
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<td>Standing Rows (elastic)</td>
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<td>Standing Extension (elastic)</td>
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<td>Supine ER – D2 (elastic eccentric)</td>
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<tr>
<td>Extension</td>
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<tr>
<td>Scaption over 90</td>
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<td>Prone Extension</td>
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<td>Prone ER 90° (wt)</td>
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<tr>
<td>Prone Horizontal Abduction</td>
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<td>Prone Horizontal Ald 135°</td>
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<tr>
<td>Upper Cut/D1</td>
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</table>

### EMG Activity (%MVIC)

- **Serratus Ant.**
- **Lower Trap**
- **Mid Trap**
- **Upper Trap**
- **Supraspinatus**
- **Infraspinatus**
- **Deltoid**

---

**Assessment and Management of Scapular Dyskinesis - 2015 WFATT World Congress T. L. Uhl**
Case 3. Scapular Dyskinesis 6 months post SLAP Repair

- 27 year old rock climber underwent SLAP repair
- Reports mild to moderate shoulder pain
- Not satisfied with shoulder function (Penn Score 67/100)
- Scapular Dyskinesis is apparent
- Humeral motion restricted

Rehabilitation Implications
- Address soft-tissue restrictions
- Joint mobilization
- Blocked scapular stretching – with clinical and home assistance

Shoulder stretching matrix

<table>
<thead>
<tr>
<th>Tight Anterior structures (Pectoralis major/minor)</th>
<th>Home</th>
<th>Clinic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tight Anterior structures (Pectoralis major/minor)</td>
<td>Supine lying ½ foam roll or towel roll</td>
<td>Manual stretching in supine / Massage</td>
</tr>
<tr>
<td>1 arm doorway stretch with humerus at 45 to 90°</td>
<td>Contract/Relax techniques</td>
<td>Manual stretching incorporating trunk rotation or functional position</td>
</tr>
<tr>
<td>2 arm doorway stretch</td>
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</table>

Tight Posterior glenohumeral structures

<table>
<thead>
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<th>Tight Posterior glenohumeral structures</th>
<th>Home</th>
<th>Clinic</th>
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</thead>
<tbody>
<tr>
<td>Tight Posterior glenohumeral structures</td>
<td>Cross body stretch</td>
<td>Manual horizontal adduction or internal rotation/ Massage</td>
</tr>
<tr>
<td></td>
<td>Cross body with stable scapula</td>
<td>Contract/Relax techniques</td>
</tr>
<tr>
<td></td>
<td>Sleeper stretch</td>
<td>Active internal rotation with scapula stable</td>
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</table>

Cervical/Thoracic

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<th>Clinic</th>
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<tbody>
<tr>
<td>Cervical/Thoracic</td>
<td>Supine AROM</td>
<td>PROM and Massage</td>
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<tr>
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<td>Sitting AROM</td>
<td>Contract Relax</td>
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<td>Manual overpressure</td>
<td>Mobilization</td>
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Inferior Structures (Lats, Teres Major)

<table>
<thead>
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<th>Inferior Structures (Lats, Teres Major)</th>
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<th>Clinic</th>
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<tr>
<td>Inferior Structures (Lats, Teres Major)</td>
<td>Table top stretch sitting</td>
<td>Doorway Slides</td>
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<tr>
<td></td>
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<td>Kneeling flexion w/trunk rotation</td>
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Exercises Illustrated

<table>
<thead>
<tr>
<th>PROM</th>
<th>Forward Bow</th>
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<table>
<thead>
<tr>
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<th>Supine PROM</th>
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Assessment and Management of Scapular Dyskinesis -2015 WFATT World Congress T. L. Uhl
<table>
<thead>
<tr>
<th><strong>AAROM</strong></th>
<th>WC Press-up, Hands apart</th>
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<tbody>
<tr>
<td><strong>Towel Slide</strong></td>
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<tr>
<td><strong>Scap. Protract. on Ball</strong></td>
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<td><strong>Table slides (dusting)</strong></td>
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<tr>
<td><strong>Side-lying elevation</strong></td>
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<tr>
<td>ISOM</td>
<td>Inferior glide</td>
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<tr>
<td>Low row</td>
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<tr>
<td>AROM</td>
<td>Supine Press-up</td>
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<tr>
<td>Robbery</td>
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<tr>
<td>Lawn mower</td>
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<tr>
<td>Exercise</td>
<td>Image</td>
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<tr>
<td>Wedge Press-up</td>
<td>![Wedge Press-up Image]</td>
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<td>Standing Press-up</td>
<td>![Standing Press-up Image]</td>
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<tr>
<td><strong>RROM (Elastic)</strong></td>
<td><strong>Supine-Flexion w/band</strong> &gt;120</td>
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<tr>
<td>Wall Slide</td>
<td>![Wall Slide Image]</td>
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<tr>
<td>Ext rotation 0° (elastic)</td>
<td>![Ext Rotation 0° Image]</td>
</tr>
<tr>
<td>Standing Rows (elastic)</td>
<td>![Standing Rows Image]</td>
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<tr>
<td>Exercise</td>
<td>Image 1</td>
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<tr>
<td>Standing Extension (elastic)</td>
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<tr>
<td>Scapular Punch elastic</td>
<td><img src="image1" alt="Image" /></td>
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<tr>
<td>Flex /ABD/ ER D2 (elastic eccentric)</td>
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<tr>
<td>Flexion &gt;120 elastic</td>
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<tr>
<td>RROM (Weight) ER sidelying (wt)</td>
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<td>Prone Extension</td>
<td><img src="image1" alt="Image" /></td>
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<tr>
<td><strong>Scaption over 90</strong></td>
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<td><strong>Prone ER 90° (wt)</strong></td>
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<td><strong>Prone Horizontal Abduction</strong></td>
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<td><strong>Prone Horizontal Abd 135°</strong></td>
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<tr>
<td><strong>Upper Cut/D1</strong></td>
<td><img src="image13.png" alt="Image" /></td>
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**References:**


71. Hodges PW, Richardson CA. Feedforward contraction of transversus abdominus is not influenced by the direction of arm movement. Experimental Brain Research. 1997;114:362-370.
78. Verstegen M, Williams P. *Core Performance: the revolutionary workout program to transform your body and your life.* Rodale; 2004.


