Assessment and Treatment of Scapular Dysfunction Using a Kinetic Chain Approach

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Description: The body functions as an integrated system, in sport and in work, we are task oriented. 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) and their psychological state to meet the demands of the task (throwing, lifting packages into a truck, inserting rivets) and the environment the task is performed. In the common microtraumatic presentation of an injury our job is to determine which component(s) are creating the pathology, impairments and functional limitations. 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.

Objectives:

1. Identify factors leading to upper extremity dysfunction (scapular dyskinesis)
2. Review normal biomechanical function and motor control shoulder and scapular dynamic motion
3. Describe an evaluation procedure for upper extremity that incorporates the entire system (kinetic chain) and incorporates scapular assessment
4. Identify indicators of impairments and/or functional limitations that may be addressed in the intervention

Incidence of Problem

- Scapular dyskinesis Intimately involved with glenohumeral derangement
  - 64% Instability
  - 100% Impingement[72]

- Dyskinesis - Impairment of the power of voluntary movement resulting in fragmentary movements.[16]

Role of the Scapula[29]

- 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
- Transmission of forces through the kinetic chain
- Scapular motion is critical for normal motion and function of the upper extremity[24]

Potential Scapular Dysfunction Factors

- Glenohumeral pathology[17, 44, 46]
- Neuropathy[64, 73]
- Muscle weakness[9]
- Muscle tightness[5]
- Muscle fatigue [52]
- Pain[6]

- Loss of neuromuscular control [65, 70]

Role of Scapular Control in Injury
- Upward rotation, external rotation, and posterior tilt necessary for typical arm elevation & function
- Scapular Kinematics altered in patients with RC tendonopathy
  - Demonstrate diminished posterior tilting (~10°)
  - Excessive superior translation of scapula significantly higher (~2cm)[46]
- Protracted posture decreases sub-acromial space[67]
- Altered muscular activations
  - Elevated Upper Trapezius activity[44]

Neurological Deficits[64]
- Long thoracic / Spinal accesory nerve palsies
  - Reduces mechanical stability of the shoulder
- Highlights the role of neuromotor control of scapula and its effect on the entire upper extremity

- Pain inhibits motor activation[6]

Chronic Shoulder Pain Neuromuscular Adaptations
- Swimmer's with painful shoulder
- Serratus Anterior inhibition
- Substitution of upper trapezius and rhomboids[65]
- Delayed activation of Serratus anterior by 80 ms (* $p < 0.05$) indicating poor muscular control[70]

Shoulder Instability in Pitching Affects Neuromuscular Control[17]
- Decreased activation of Serratus Anterior
- Increased activation of supraspinatus and biceps to stabilize humeral head
- Decreased activation of accelerators (internal rotators)
  - latissimus dorsi, subscapularis, & pectoralis major

Role of Scapular Control in Glenohumeral Instability
- Abnormal motion can
  - Overload joint capsule
  - Impinge underlying rotator cuff & labral tissues
- Hyperangulation of humerus
  - Excessive horizontal abduction
  - Macrotraumatically cause dislocation
  - Microtraumatically leads to postererior impingement & subluxation[7, 60]

Poor Proximal Control
- Without proximal control distal movement are compensating for a poor foundation
- Single leg squat
  - Women tend to go into more valgus[75]
- Single leg stance is not just hip abductor strength

- Hip abductor strength poorly correlated with 2D Hip Adduction[12]

Appreciate Normal Motor Control and Kinematics

- The ability to lift arm is dependent on proximal stability: glenohumeral joint, scapulothoracic, & spine
- Dynamic stability of proximal segments arises due to anticipatory postural adjustments[10, 74]
- The kinetic chain model is linked segments commonly used in biomechanics[61]
- The human body can be characterized as a kinetic chain
- Kinetic chain theory supports that distal force production is due to summation of forces in the proximal segments throughout the entire kinetic chain (hitting or kicking a ball)
- Breakdown along the chain Increase demand on segments such as shoulder
- Typical motor control pattern activates in a proximal – distal manner in Shoulder Elevation [10, 22]
- Transverse abdominal and multifidus musculature precedes distal arm motion to stabilize trunk and prevent postural perturbation

Scapula part of the CHAIN

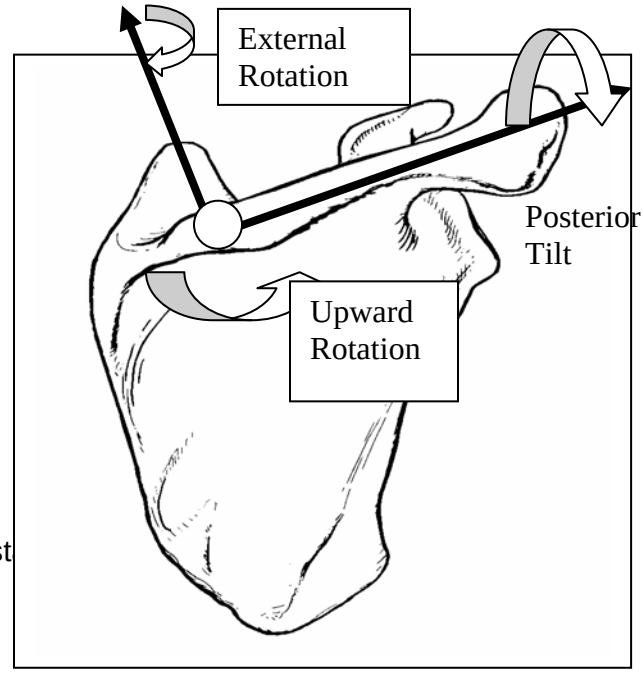
- Critical links between trunk & upper extremity
- Periscapular musculature act to transfer energy through the kinetic chain
- Missing segment in link models
- Throwers develop adaptations:[54]
  - Increased upward rotation
  - Increased internal rotation
  - Increased retraction during scaption than non throwers

2-D Biomechanics of Scapula

- Scapulohumeral rhythm of 2:1 following a setting phase[24]
- Radiographs at multi-angles to evaluate scapular and humeral movement[15, 59]

Scapular Kinematics[50]

- 3 Rotations
  - Upward/ Downward (50 ± 5°)
  - Internal/External (24 ± 13°)
  - Anterior/Posterior (30 ± 13°)



Clinical Assessment of Shoulder

1. Observation
   a. Static posture bilateral stance
   b. Static posture single leg stance
   c. Dynamic gait
   d. Dynamic single leg stance
2. ROM (ASES format)
   a. Active & Passive Elevation
   b. Internal rotation at 90° with scapula st
   c. ER at 90°
   d. IR up spine for function

    e. GIRD = difference in degrees between dominant and non-dominant IR measures
3. Strength
    a. Rotator cuff
    b. Scapular
4. Special test
    a. Scapular Assistance
    b. Scapular Retraction
    c. Kinematic analysis
        i. Inclinometer
        ii. 3-D kinematics

Postural Assessment

-Cited as a potential cause of shoulder and neck pain [26]

Slouched thoracic posture reduces humeral and scapular motion along with reducing strength[27]

-Recent report on short pectoralis minor has demonstrated reduced scapular motion [5]

Slouched Thoracic Posture[27]

- Shoulder abduction ROM
  - Erect: 157.5° (± 10.8)
  - Slouched: 133.9° (± 13.7)
- Abduction strength @ 90°
  - Erect: 10.4kg (± 4.5)
  - Slouched: 8.7kg (± 3.5)
- Scapular Kinematics
- Upward rotation:
  - Erect: 43.1° (±7.5)
  - Slouched: 37.9° (±6.5)
- Posterior tilt
  - Erect: 44.7° (±6.8)
  - Slouched: 40.6° (±6.9)

Rounded Shoulder Posture[5]

- Report on short pectoralis minor has demonstrated reduced scapular motion
- Short pectoralis minor group at 90^{o} elevation
  - 7^{o} less External Rotation
  - 6^{o} less Upward Rotation
  - 7^{o} less Posterior Tilting

Clinical Measures[3]

- Scapular Index
  - A) Distance between sternal notch and coracoid (cm)
    - r = .48 to pect minor shortness
  - B) Distance between T-spine and lateral acromion
- Scapular index (A/B) X 100
- r = .37 to pect minor index (tightness)

New Clinical Measure of Posture[4]

- Measure pectoralis minor length from 4th rib to coracoid
- High reliability ICC=.82
- Based on the sample of 26 subjects typical lengths were 16 ± .3 cm

Quantitative Assessment: Lateral Scapular Slide[57]

- Measure the distance (cm) from spinous process to inferior angle
- Bilateral comparison in three position
- Does not discriminant between injured and non-injured

Scapular Assessment

- Observational static descriptions with arms at side [63]
- Downward Rotation
- Depression
- Abduction
- Winging and tilting syndrome

Scapular classification by observational analysis during AROM assessment [34]

- Normal
- Superior border pattern
- Medial border pattern
- Inferior angle pattern

Results

- Moderate reliability
- Intertester of therapists: k = .42
- Intratester of therapist: k = .49
- New observational system based on 3-D motion
- 2-dimensional Video tape analysis
- Further evidence to support observational system assessment

Follow up study of observational assessment method is better with 2 category system (sensitivity 75%)

- Presence of scapular dyskinesis
- Absence of scapular dyskinesis

The dysfunction appears to be a loss of consistency (Abstract – ASES 2004)

- Internal/external rotation
- Upward rotation

Single leg stance series:

1 leg to evaluate balance and hip stability
1 legged squat for lower strength
Without proximal control distal movement are compensating for a poor foundation

Assessment of Scapular Muscle Function [53]

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

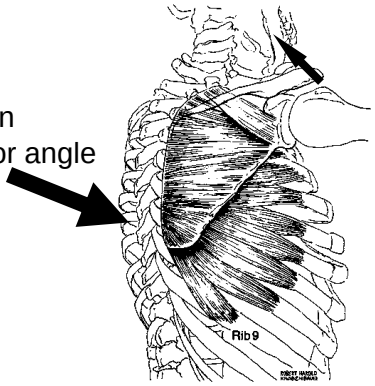
Serratus Anterior - Supine arm is flexed to 90^{o} with arm protracting so that scapular moves laterally along thoracic wall, apply pressure to resist protraction

Upper Trapezius - cervical spine side bent and rotated away with scapula shrugged, apply pressure to resist elevation and posterior occiput

Scapular Assessment Special Tests

Goal- Repositioning the scapula to 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[31, 62]

- Active elevation of the arm without scapula stabilized, patient reports pain
- Stabilize the scapula by applying anterior and upward force on the inferior angle as the arm is elevated
- (+) Pain diminished
- Indicates improving scapular motion may diminish symptoms

Scapular Retraction Test

- Perform provocative resistance test
  - Empty can to assess strength of deltoid and rotator cuff
- Have patient retract scapula actively and manually provide scapular stability then retest strength
- Improved symptoms (strength) indicates scapular muscular control is compromised

Ongoing study

20 pathological subjects improved strength 25%

The first step in rehabilitation is a complete and thorough assessment.[30]
A complete assessment of a patient with an upper extremity injury should include assessment and consideration of scapular dysfunction as part of a thorough evaluation.

Evaluation Format:

	Considerations	Findings
Observation		
Static posture bilateral stance Lateral view	Lower Extremity Hips/pelvis Thoracic Kyphosis – double square Shoulder/Scapula – tape measure Head	
Anterior/Posterior view	Feet Knee Hips Scapular position (Lateral Scapular Slide) Scolosis Atrophy Dynamic gait	
AROM		
(standing)	Add load for strong patients 5-10 forward flexion 5-10 scaption Trunk motion (4-6 directions)	Dysfunction Yes No Yes No
Core Stability (standing)	Single leg balance Hip adduction Ankle control Single leg squat Hip/pelvis rotation Knee valgus	
Special Tests (standing)	Neer Hawkins-Kennedy Active compression Mayo shear Painful arc	
Rotator Cuff/ Scapular Strength (standing)	Arm elevation thumb-up (Deltoid & Supraspinatus) External rotation at 45° (Flip sign) Lift-off / Belly press Arm elevation >120° (Serratus Anterior)	
Scapular Tests (standing)	Scapular Assistance Test (+) reduction of pain with scapular support Scapular Retraction Test (+) reduction of pain and/or increase strength	
Scapular Strength (lying)	Prone flexion at 135° abduction (Lower Trapezius) Medial border retraction (Rhomboids)	
PROM/ Glenohumeral Instability (lying)	Glenohumeral internal rotation with scapula stabilized External rotation Elevation Apprehension Relocation (instability / labral) Crank Biceps Load	

Clinical Tests – Evidence from the literature on Shoulder Clinical Tests

(+) LR > 5 moderate shift toward presence of pathology. (-) LR <.02 moderate shift toward absence of pathology

Test	Specificity	(+) Likelihood Ratio	Sensitivity	(-) Likelihood Ratio	Reference
Anterior Glenohumeral instability tests					
Anterior Release Test	89%	8.40	92%	0.09	Gross ML & Distefanco MC Clin Orth Rel Res 1997[18]
Apprehension Test (apprehension)	96%	20.2	72%	0.29	Farber JBJS 2006 [14]
Relocation Test (relief of apprehension)	92%	10.4	81%	0.2	Farber JBJS 2006 [14]
Labral Tests					
Active Compression (O'Brien's Test)	98%	21.00	100%	0.01	O'Brien Am J Sports Med 1998[56]
Crank Test	93%	13.00	91%	0.10	Liu SH, et al. AJSM 1996[43]
Biceps Load Tests II	96%	26.00	90%	0.10	Kim Arthorscopy 2001[35]
Biceps Load Tests I	98%	29.00	83%	0.09	Kim AM J Sports Med 1999[36]
Resisted Sup_ER Test	82%	4.55	83%	0.21	Myers TH, et al., Am J Sports Med, 2005[55]
Anterior Slide Test	92%	8.30	78%	0.20	Kibler WB, Arthroscopy, 1995[28]
Active Compression Test	11%	0.88	78%	2.00	Myers TH, et al., Am J Sports Med, 2005[55]
Active Compression Test	73%	2.33	63%	0.51	Guanche & Jones, Arthroscopy 2003[19]
Posterior Glenohumeral instability tests					
Jerk Test	98%	36.50	73%	0.28	Kim, SH, Am J Sports Med 2005 33(8)[37]
Impingement Tests					
Hawkins	44%	1.64	92%	0.18	MacDonald PB et al JSES 9:299-301 2000[47]
Hawkins	25%	1.23	92%	0.32	Calis M, et al., Ann Rheum Dis, 2000[8]
Painful arc	81%	3.89	74%	0.32	Park HB et al., JBJS, 2005[58]
3/7 positive Hawkins, Neer, Drop Arm, Horiz. Add., Speed, Yeargason, painful arc	44%	1.50	84%	0.36	Calis M, et al., Ann Rheum Dis, 2000[8]
Neer	31%	1.28	89%	0.37	Calis M, et al., Ann Rheum Dis, 2000[8]

Test	Specificity	(+) Likelihood Ratio	Sensitivity	(-) Likelihood Ratio	Reference
Hawkins	66%	2.12	72%	0.42	Park HB et al., JBJS, 2005[58]
Rotator Cuff Tears					
External Rotation Lag Sign (supraspinatus & infraspinatus)	100%	94.00	94%	0.06	Hertel R et al JSES 1996[21]
Supraspinatus FT Tears - Empty Can (pain and/or weakness)	50%	1.78	89%	0.22	Itoi E, et al: AJSM 1999 [25]
Hawkins	43%	1.54	88%	0.28	MacDonald PB et al JSES 2000[47]
Supraspinatus FT Tears - Full Can (pain and/or weakness)	57%	2.00	86%	0.25	Itoi E, et al: AJSM 1999[25]
Neer and Hawkins combined	56%	1.89	83%	0.30	MacDonald PB et al JSES 2000[47]
Neer	51%	1.69	83%	0.33	MacDonald PB et al JSES 2000[47]
Internal Rotation Lag Sign (subscapularis)	96%	19.20	80%	0.21	Hertel R et al JSES 1996[21]
Lift Off Test	100%	62.00	62%	0.38	Hertel R et al JSES 1996[21]
Drop Arm Test	88%	2.92	35%	0.74	Park HB et al., JBJS, 2005[58]
Drop Arm Test	100%	11.00	21%	0.95	Hertel, R et al JSES, 1996[21]

Integrating the Kinetic Chain in Shoulder Girdle Rehabilitation

Description: As stated earlier the body functions as an integrated system. Rehabilitation just as evaluation needs to incorporate the entire functional unit. 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.

Assessment Implications lead to Interventions

- Clinical Testing indicate
  - Notable changes in scapular position and control
  - Flexibility restrictions
  - Able to reduce symptoms or improve strength by stabilizing scapula
- Initiate exercises to improve mobility, control of scapula, and strength

- Clinical Testing indicates

- Positive signs for tissue dysfunction
- Minimal issues with motor control and mobility of shoulder girdle is adequate
- Unable to reduce symptoms by moving or stabilizing scapula
- MD consult for further diagnostic testing indicated

The Basis for using the Trunk in Upper Extremity Rehabilitation[51]

1.Kinetic Chain

- A model of linked segments commonly used in biomechanics
- Sport and work activities attempting to strike or throw at high velocities use the kinetic chain to impart these forces
- Acceleration of distal segment comes from the "controlled deceleration" of proximal segments

Breakdown anywhere along the kinetic chain can lead to

- Increase demand on shoulder musculature
- Change the biomechanical stresses
- Diminish performance[61]

2. Typical motor control pattern activates in a proximal – distal manner in Shoulder Elevation [10, 22]

- Shoulder function depends on proximal stability
- Rehabilitation needs to establish proximal stability before distal mobility
- Transverse abdominal and multifidus musculature precedes distal arm motion[41, 74]
- This activation provides trunk stabilization and prevents postural perturbation[10, 22]
- Trunk serves to generate, absorb, and distribute forces during all activities, particularly important in sports
  - Inner Core musculature stabilize pelvis and lumbar spine and is activated prior to distal segment motion
  - Outer Core musculature provides some global stability but is integral in generating and transmitting functional mobility
  - Serape function of trunk musculature
    - Serape effect is described as the function of trunk muscles generating forces and transferring it to the extremities[40]
    - Combining all three planes of motion is functional and is a fundamental principle for many power motions[68]

3. Applying PNF Principles to Kinetic Chain Rehabilitation[39, 69]

- 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

Isolating vs. Integrating Exercises

- Prone Extension
  - Posterior cuff (teres minor) and deltoid >60% MVIC[2]
- Standing shoulder extension with forward step
  - Trunk / Scapular/ Cuff musculature
- Two different approaches neither is wrong

Integrating Entire Body with Elevation Exercise with good Core

- Step forward punch
- Activate legs→ trunk → scapula & rotator cuff muscle in normal pattern
  - Proximal to distal emphasized
- Anterior / Acceleration Serape

Management Strategies

- Base intervention on level of tissue irritability
  - More inflamed or reactive – less direct activity to tissue
- Proximal control and alignment of spine a scapula are necessary prior to applying distal stressors – motor control
- Find appropriate intensity level for patient that does not create compensations
  - Facilitate scapular motion
    - Thoracic extension or rotation
    - Scapular retraction & depression (external rotation & posterior tilt)
    - Support the weight of the arm to reduce compensations
- Rehabilitation environment must match the level of function
  - must constantly be challenged to improve function
- Continuum of functional rehabilitation is driven by patient's response to exercise

Rehabilitation Components

- Address
  - Spine posture
  - Proximal stability & balance
  - Position, motion, stability, & strength of all joints of the shoulder
- Postural correction
- Proximal stability
- Rehabilitation exercises should simulate neuromotor patterns
- Flexibility and mobility
- Pain management
- Exercise progressively increase demand

Proximal Stability

- High tissue irritability

  - Acute
- Addressing proximal control or posture issues is appropriate
- Patient is observed to have poor core control
  - Remedial core program
- Adequate control
  - Integrate into complex exercises

Kinetic Chain Exercises in Sling
- EMG activity for subscapularis was moderate to high (30 – 70% MVC)
- All other cuff and deltoid musculature low <20% MVC
- Addition of step with exercise slightly increased EMG activity <10%
- Lawnmower exercise keeping elbow low activated Serratus Anterior to very high levels > 80% while other muscles remain <20%
- Lawnmower exercises are safe in early phases of shoulder rehab except for subscapularis repairs[66]

Increasing Spine & Shoulder Mobility
- Shoulder elevation can be increased by increased thoracic and cervical extension
- Joint mobilization techniques
  - Decrease muscle guarding
  - Increase mobility

Posture can be Positively Effected [71]
- 6 weeks program (3 x wk)
- Stretching
  - Pectoralis group – corner stretch
    - Hold 10 seconds – 10 repetitions
- Strengthening (Theraband)
  - Scapular elevation (shrug)
  - Horizontal Shoulder ADD (retraction)
  - ER @ 0^{o}
  - Shoulder abduction

<u>Results</u>
- Produced more erect thoracic spine
- Increased shoulder strength
- Improved scapular stability

Forward Posture can be Reduced [38]
- Competitive swimmers on 6 weeks program (3 x wk)
- Stretching
  - Pectoralis minor – partner stretching
  - Pectoralis major – ADB/ER
- Strengthening (Theraband)
  - ER @ 90^{o}
  - Shoulder flexion
  - Shoulder Horizontal ADD (retraction)
- Reduced forward shoulder posture by 9mm

Taping to Improve Posture & Scapular Position[42]

- 60 patients with Impingement Syndrome and 60 without
- Underwent taping and placebo taping correction of posture and scapular retraction
- Kyphosis decreased by 6^{o}
- Diminished lateral scapular displacement by 1.5cm
- Increased shoulder elevation by 15^{o} in flexion and scaption

Limitations to Taping

- Taping requires the assistance of a knowledgeable aid and frequent re-application
- Skin breakdown can occur with repetitive taping
- Taping can loosen with time and become wet & loose with sweating

Passive Techniques to Correct Posture

- Devices for postural (passive positioning)
  - Figure 8 clavicle straps
  - McConnell taping
  - Spine and Scapular Stabilizing Brace S^{3} (Alignmed, Santa Ana, CA)
- Research question: To determine if the Spine and Scapular Stabilizing Brace (S_3)* has an effect on scapular kinematics at rest and during arm elevation
  - 15 healthy
  - 18 injured with scapular dyskinesis

Upward Rotation and Posterior Tilt $\uparrow 3^{\circ}$

Relief of Painful Myofascial Spasms[23]

- Several combinations are effective at decreasing pain & sensitivity of trigger point
  - 1.Moist Hot pack > AROM > Ischemic Compression > TENS
  - 2. Moist Hot pack > AROM > Spray and Stretch > TENS
  - 3. Moist Hot pack > AROM > IFC > Myofascial release
- Ischemic compression @ 90 seconds provide relief of trigger point sensitivity

Address Muscular Imbalances

- Stretching for upper trapezius
- Stretching for levator scapulae
- Stretch for biceps and pect minor

Pathomechanics of Tight Posterior Structures

- Scapular motion particularly at end ranges influenced by capsular tension[50]
- Humeral head is pushed superiorly into acromion
  - Anteriorsuperior[20]
  - Posteriorsuperior[7]

Stretching the Posterior Tissues

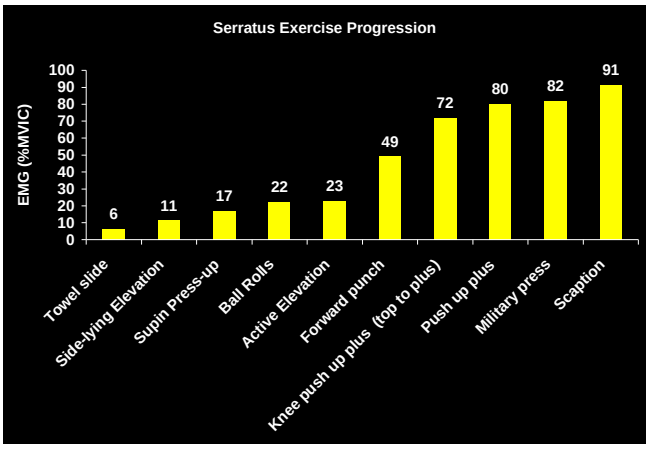
- Adaptive changes can occur shortening posterior cuff/capsule[32]
- Sleeper Stretch
- Cross body adduction with scapula stable and humerus internally rotating
- Cross body adduction increases IR motion by 20^{o} .[48]
- Hold Stretch 30 seconds (No Pain)[1]

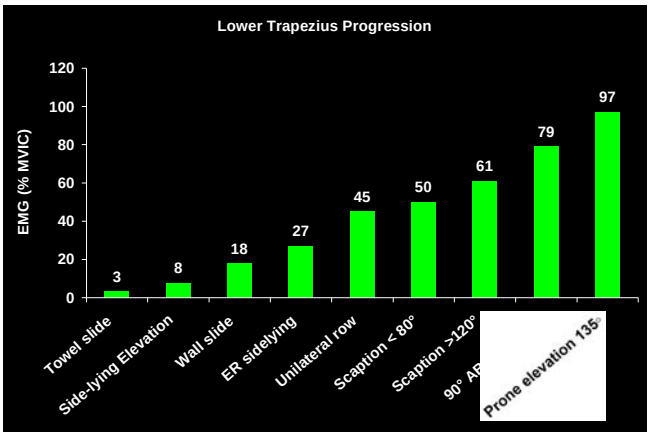
Rehabilitation Exercise

- Scapular substitution patterns present due to poor muscular performance and pain
- Rehabilitation exercise should progressively increase the stress on muscles
- Integrating
  - Posture and position of spine and scapula
  - Rehabilitation exercises should simulate normal neuromotor patterns
  - Exercise progression from low to high demand

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





Regaining Scapular Control

- Often regaining scapular retraction control first step
- Static – Low Row
- Rotational plane –
- Sagittal plane - Lawnmower

Applying PNF Principles & Kinetic Chain to Shoulder Rehabilitation

- Start motion with trunk and with scapular muscles on stretch
  - Extend and rotate spine
  - Scapula retracts
  - Shoulder externally rotates[51]
- Training Tip:
- "Tuck Elbow in back pocket"
- "Pull scapula back"
- Exaggerating transverse plane

Facilitate Scapular Muscle Activation of Retractors

- Stronger components of a movement pattern facilitate weaker (irradiation)

- Irradiation of loading proximal musculature to activate scapular musculature

Kinetic Chain Scapular emphasis “Down and Back”
- Active trunk extension (sternal lift) with scapular retraction
- Facilitate proper posture with re-education techniques
- Use trunk to activate scapular musculature and lengthening tight anterior musculature[5]

Identifying the Intensity
- Low Row
- Inferior Glide
- Lawnmower
- Robbery
- These exercises are low to intermediate phase scapular strengthening[33]

Regaining Motor Control
- Patient awareness: Facilitate or Inhibit
  - Tactile feedback – PNF – Rhythmic Initiation /Rhythmic stabilization
  - EMG feedback
  - Visual feedback
    - Mirror
    - Video
- Muscle re-education
  - Neuromuscular control
- Utilization of video to provide feedback
- Do not overly verbal correct
- Activation of Serratus facilitates scapular posterior tilt and external rotation

Regain Motor Control: Rhythmic Initiation[39]
- Tactile feedback – PNF – Rhythmic Initiation /Rhythmic stabilization
- A technique that assists in transition from PROM to AAROM to AROM exercises
- Directing patients motion to facilitate voluntary motor pattern
- Arm can be supported
- Advantage to translate into manual resistive exercise without changing positions
  - Intensity (painless ROM)
  - Time (3-4 mins / 3 x 10)

Scapulohumeral Relationship during Manual Stability Ex’s
- Rhythmic stabilization - Isometric muscle contraction of antagnostic muscles to facilitate dynamic joint stability[39]
- Musculature are activated due to a response to load
- Emphasis is on holding a position
- Watch level of effort might injure healing tissue
- Constantly inspect patient position

Combining Video and EMG Feedback with Exercise
- Supervise for proper form is sometimes not enough
- Incorporate real time feedback with video and EMG to correctly activate SA

Elevation Progression

- Serratus Anterior needs facilitation[17]
- Exercises that emphasize Serratus over Upper Trapezius[45]
- Protraction bias upper Serratus fibers & elevation above 120^{o} biases lower fibers[13]
- Be ever vigilant on compensations

Elevation with Kinetic Chain

- Active elevation without facilitation
- If see substitution you
  - Increase trunk facilitation (step)
  - Decrease distal load by support of surface

Applying Kinetic Chain to Punch

- Scapular protraction weak in patients with impingement [9]
- Scapular protraction activates Serratus Anterior[11, 13]
- Functional rehabilitation replicate normal neuromotor pattern [10, 74]
  - Legs drive arm in diagonal
- Shoulder strengthening 3 x10 daily improves strength and function in patients with impingement[49]

Progress to Long Lever Arm Ex's Last

- Exercise place high demand on scapular musculature
  - Torque = Force x $\perp$ Distance
- Elevation above 120^{o} bias lower fiber of Serratus Anterior
- Prone elevation at 135^{o} activates Low Trap[13]

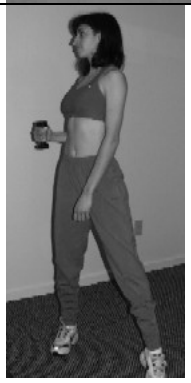
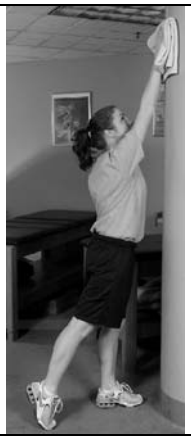
Exercise Matches Demands

- Special consideration needs to be given to athletes with no to little base of support
  - Volleyball
  - Swimming
- Unstable base facilitates trunk stabilizers
  - (non-ground based sports: volleyball)

Summary

- Management of scapular dysfunction
  - Accurate assessment
  - Respect irritable tissue
  - Work on proximal control and mobility first
  - Apply appropriate exercise intensity that does not produce compensations
  - Prescribe exercises along a continuum that meet the demands of the activity

Exercise examples

Scapula depressed and retracted		Down and Back!
Sagital plane utilizing hip extension		
Emphasizing transverse plane		
Unload weight of arm		

Vary angle of unloading to meet functional demand and patients' impairment		
Sitting unstable surface (Non-weightbearing activities)		
Static Arm emphasizing trunk and scapular co-activation		
		
Think Functional, Think Total Body, Have Fun		

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