Movement System Impairment
Syndromes of the Shoulder

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The Human Movement System

The Body System for which Physical Therapists are Responsible.
The System of our Expertise
Our Identity – APTA 2013

THE HUMAN MOVEMENT SYSTEM

The Movement System

- Movement is an essential function of life at all levels of living organisms.
- From ions moving through membranes to moving your limbs to moving in your environment.

The human movement system is a system of physiological organ systems that interact to produce movement of the body and its parts.

http://pt.wusm.wustl.edu/AboutUs/Pages/HumanMovementSystem.aspx

Movement System Diagnoses

Musculoskeletal  Neurological  Cardiopulmonary

O’Sullivan Syn.

MS Impairment Syndromes

- Neuromuscular impairment syndromes

MSI Syndromes: the main emphasis is on making the diagnosis & identifying the contributing factors

Why Do Repeated Movements and Sustained Alignments Change Movement Precision?

- Alters intra & inter joint relative flexibility
- Muscle adaptations of relative length, strength, stiffness
- Neuromuscular activation and deactivation
**Kinesiopathologic Model of Movement System**

Musculoskeletal → Nervous → Cardio-Pulmon -

**INDUCERS**
- Repeated movements
- Sustained alignments
- Relative stiffness of muscle & connective tissue
- Relative flexibility
- Micro trauma
- Joint Accessory

**Path of Least Resistance**

**Tissue Adaptations**
- Joint Accessory
- Hypermobility
- Relative stiffness of muscle & connective tissue
- Relative flexibility
- Micro-Macro trauma

**Working Theory**

- **Musculoskeletal pain is**
  - A lifestyle issue like other health problems
  - A progressive condition
  - Starting with acute pain – first indication of tissue damage
  - High reoccurrence rate > chronic
  - The result of tissue changes associated with degeneration of aging and tissue injury from impaired joint movement that develops with activity

**The Challenge: Keeping the Acute Problem From Becoming Chronic**

- **Step 1:** alleviate the acute symptoms
  - Possible with a wide variety of interventions
- **Step 2:** prevent reoccurrence
  - Why is there reoccurrence?
  - Because the cause – the impaired movement - has not been identified & addressed. Tx is symptomatic not preventive
- **Step 3:** identify the cause & contributing factors
- **Step 4:** develop a treatment program that includes
  - Specific exercises
  - Correction of performance of daily activities

**Movement System Impairment Syndromes – Guiding Theory**

- **Little things mean a lot!!!**
- **Underlying problem: micro-instability:**
  - The Wobble – Wobble condition
  - Accessory motion (roll, spin, glide) becomes excessive in one or more directions (hypermobility/micro-instability)
  - Micro-trauma from shear force and points of high contact pressure
  - Becomes macro-trauma

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**Joint Micro-Instability**

- Characterized by moving
  - In range that is more than optimal (joint surfaces not optimal during movement)
  - Points of high contact stress & shear force
  - More often than optimal
  - More readily in specific directions
- **Accessory motion micro-instability**
- Can progressively increase
- With physiological motion that is
  - Normal
  - Excessive
  - Limited

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Movement System Impairment (MSI) Syndromes

- Impairment level of the organism
  - Any abnormality of anatomical, physiological or psychological function.
- Syndromes
  - Collection of impairments based on observable impairments, primarily kinesiological, and their relationship to symptoms
  - Correction decreases or eliminates the symptoms
  - Named for principal impairment – the movement direction most consistently affecting the symptoms
  - Other impairments are contributing factors

Key Concepts I

- Path of least resistance for motion
- Relative Flexibility
  - Intra-joint: intrinsic accessory motion mobility
  - Inter-joint: physiological motion, e.g. back vs hip
- Relative Stiffness: passive tension of muscle & connective tissue
- Joint (micro-instability) hypermobility causes the pain
  - Accessory motion
  - Range & Frequency
  - What moves is what hurts

Key Concepts II

- The way everyday activities are performed is the critical issue
  - Repetitive movements and sustained alignments

Key Concepts III

- You get what you train (many strategies to create moments at a joint or within a limb)
  - Presence of a muscle does not mean appropriate use
  - No magic in an exercise except if the desired motion is evident

Movement System Impairment (MSI) Syndromes

- Named for movement direction that causes symptoms and that is impaired.
- Correction of the movement usually decreases the symptoms.
- Identify the **cause** of the dysfunction & contributing factors
  - tissue & neuromuscular impairments
  - Organize & cluster specific tissue and movement impairments
  - Provide a direction for treatment
  - do not require identification of a specific pathoanatomical structure (**source**)
  - Based on anatomy and kinesiology

Cause versus Source Operational Definitions

**Cause**
- the mechanical factor (movement) that results in tissue irritation
- e.g. scapular insufficient upward rotation, humeral anterior glide

**Source**
- the tissue or pathoanatomical structure that is symptomatic
  - e.g. impingement, supraspinatus tendinopathy (itis, osis, opathy)
Glenohumeral Considerations

Superior capsular ligg - relaxed
Inferior capsular ligg – taut
Need inferior glide to prevent impingement

1 cm translation with 22 deg abd

Pain Problem – No Identifiable Pathology
- Movement impairment
- Mechanisms
  - Weakness
  - Insufficient stiffness
  - Length adaptation
  - Activation impairment
Interscapular pain for 2 years; radiological & electro-physiological studies negative: No pathoanatomical diagnosis
MSI diagnosis: scapular internal rotation with anterior tilt & abduction

Shoulder Flexion – Optimal or Impaired?

Movement System Impairment Syndromes
- Scapular
  - Internal rotation: with insufficient upward rotation, anterior tilt, abduction
  - Depression with insufficient upward rotation
  - Adduction with insufficient upward rotation
  - Elevation
  - Winging
- Humeral
  - Anterior glide, superior glide, hypo, multidirectional hyper, medial rotation,

Muscle Strain - weakness
- Excessive load
- Prolonged load
- Disruption of sarcomeres
  - Z-line
  - Overlap of actin & myosin
- Common in upper shoulder girdle muscle
Thoracic Pain for 3 months after lifting file cabinet rated at 7/10

Alleviation of Symptoms

Alleviate Strain–Support Scapula
Decrease Load on Shoulder

Shoulder Flexion with Support of Scapula

No Sxs – Able to Lift 30#

Pre
Post

Initial
6 weeks later
Muscle Condition

• Strain – tears of Z-lines of sarcomeres
• Results in pain and weakness

Muscle Strain

Treatment requires
- alleviation of stress
- time to heal
- progressive strengthening

Length-associated Changes

- Muscles maintained in lengthened position
  - add sarcomeres in series
  - shift length-tension curve to right
  - test weak at short length

Williams & Goldspink 1981
**Tested in Shortened Length**

<table>
<thead>
<tr>
<th>Lengthened</th>
<th>Control</th>
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2.4 microns – sarcomere set-point

- 7 sarcomeres in series
- 11 sarcomeres in series

Long muscle adds sarcomeres in series – alters length tension curve.

**Muscle Length Impairments**

- Increased length
  - Addition of sarcomeres in series
- Decreased length
  - Decreased sarcomeres in series

**Scapular Adductors - Long**

Experienced muscle cramps when adducted

**Kendall: Muscles Testing & Function**

Serratus anterior long
Rhomboids short

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Relative Stiffness of Muscle

- Abdominal muscles stiffer than hip flexors
  - No pelvic tilt with stretch of hip flexors

- Hip flexors stiffer than abdominals
  - Pelvic tilt with stretch of hip flexors

Relative Muscle Stiffness

- Hypertrophy of muscle increases the passive stiffness
- Daily activities can induce different degrees of hypertrophy of muscles on either side of a joint

Relative Stiffness: serratus anterior vs scapulohumeral muscles

Muscle Stiffness = passive tension

- Change in tension/unit change in length
  - normal property
- Through the range
  - sarcomeres in parallel
  - Muscle size
**Relative Stiffness**

- In a multi-joint system, movement occurs at the joint with the least resistance
  - taking the path of least resistance (law of physics)
- In a system with "springs" in series, the least stiff "spring" will elongate when stretch is applied to the segments to which the "springs" (muscle attach)

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**Optimal Relative Stiffness**

![Image of optimal relative stiffness](image)

**Impaired Relative Stiffness**

![Image of impaired relative stiffness](image)

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**Abdominal Muscle Overdevelopment**

![Image of abdominal muscle overdevelopment](image)

**Line of Gravity Affects on Muscle**

![Image of line of gravity affects on muscle](image)
Thoracic Kyphosis
Sport? Effect on Shoulder

Initial 3 months later

Scapular Internal Rotation:
Shoulder Lateral Rotators stiffer than
Serratus Anterior, Rhomboids & Trapezius

Short Scapulohumeral Muscles:
Serratus Anterior & Lower Trap less stiff
than Glenohumeral Lateral Rotators

Tennis Professional with Jaw Pain

Scapular Internal Rotation
What muscle lacks definition?

Scapular (Winging) Internal Rotation
**Brace for Scapular Winging – Shoulder Instability**

**Capsular Shrinkage for Instability**

**Correcting Movement Pattern**

**Definitions of Scapular Movements**

- **Adduction (clavicular retraction-SC):**
  - The scapula translates medially along the rib cage toward the vertebral column.

- **Abduction (clavicular protraction-SC):**
  - Translates laterally.

During these motions there is associated scapular internal or external rotation occurring at the AC joint.

- **Elevation (clavicular elevation-SC):**
  - A movement in which the scapula translates along the ribcage in a cranial direction.

- **Depression (clavicular depression-SC):**
  - Translates in a caudal direction.

**Definitions of Scapular Movements**

- **Upward rotation (lateral rotation):**
  - AC joint
  - A movement of the scapula about an axis perpendicular to the plane of scapula
  - Inferior angle moves laterally
  - Glenoid fossa rotates to face cranially.
  - SC joint
  - Posterior axial rotation of clavicle also contributes to UR.

- **Downward rotation (medial rotation):**
  - Inferior angle moves medially
  - Glenoid fossa rotates to face caudally.

Ludewig PM et al. 2009

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Definitions of Scapular Movements

- Anterior tilt/tipping:
  - AC joint
  - A movement of the scapula about an axis parallel to the scapular spine
  - Coracoid moves anteriorly and caudally
  - Inferior angle moves posteriorly and cranially.
- Posterior tilt/tipping:
  - Coracoid moves posteriorly and cranially
  - Inferior angle moves anteriorly and caudally.


Definitions of Scapular Movements

- Internal rotation:
  - AC joint
  - Rotation of the scapula about a vertical axis
  - Lateral border of the scapula moves anteromedially
  - Vertebra border moves posterolaterally such that the costal surface of the scapula faces more toward the midline of the body
  - SC joint
  - Clavicular protraction also results in scapular IR
- External rotation:
  - Lateral border of the scapula moves posterolaterally
  - Vertebra border moves anteromedially


Scapular Internal Rotators

- Posterior deltoid
- Teres major
- Teres minor
- Infraspinatus
- Pectoralis Minor (Ludewig PM)

Definition of Scapular Movements

- Winging:
  - AC joint
  - Abnormal movement of the scapula about a vertical axis
  - Vertebra border moves in a posterior and lateral direction away from the ribcage (Hall, CM, Brody LT.)

Ludewig PM 2009

Summary - Scapular Motions

- Upward rotation:
  - Primarily from the SC joint via posterior axial rotation of the clavicle on the sternum
  - Secondarily from the AC joint
  - Minimal from elevation at the SC joint
- Posterior tilt:
  - Primarily from the AC joint
- External rotation:
  - SC joint (clavicular retraction)
  - AC joint

Ludewig PM 2009

Normal Resting Standing Alignment

- 19° SC joint clavicular retraction
- 6° SC clavicular elevation
- 41° scapular internal rotation
- 5° scapular upward rotation
- 13.5° scapular anterior tilt

12 subjects; mean age 29.3

Ludewig PM 2009
Normal Movement at the AC and SC Joints (Ludewig PM. JBJS; 2009)
Bone Pin study with 12 subjects
- During arm elevation 0-120°
  - SC joint:
    - Retraction-16°
    - Elevation-6°
    - Posterior axial rotation-31°
  - AC joint:
    - UR-11°
    - IR-8°
    - Post tilt-19°

Normal Scapular Motion During Arm Elevation
- Scapula upwardly rotates and posteriorly tilts
  - Ludewig PM et. al., JOSPT 1996, 2009
  - Kibler JOSPT 2009
  - Lukasiewicz AC et. al., JOSPT 1999
  - McClure PW et. al., J Shoulder Elbow Surg 2001

Normal Scapular Motion During Arm Elevation
- Scapula externally rotates especially at the end ranges. Ludewig PM 2009
- Scapula internally rotates until after ~125° and then starts to externally rotate Braman JP 2009
- By the end of arm elevation the scapula ER so it is 10-20 degrees anterior to the frontal plane.

Clinical Assessment: Criteria for Normal Scapular Motion
- By the end range of arm elevation:
  - Acromion should be aligned with C6-7
  - Root of spine of scapula should be aligned with T3
  - The vertebral border of the scapula should reach 55-60° (+ or - 5°).
  - Normal scapular abduction is 7.5 cm (3") from the vertebral spine to the root of the spine of the scapula.
  - Scapula should posteriorly tilt 10° Ludewig PM 2009
  - Scapula should externally rotate so it is 10-20° anterior to the frontal plane Ludewig PM 2009

Normal Scapular Motion During Arm Lowering
- You shouldn’t see increased anterior tilting during arm lowering
- No prominence of vertebral border
  - Scapula had greater posterior tilting (2°) during arm lowering compared to arm raising Ludewig PM 2009

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Normal Scapular Motion During Arm Lowering

Arm lowering
- There should be decreased scapular relative to GH movement during arm lowering compared to arm raising

Braman JP 2009

Normal Resting Standing Alignment

- 19° SC joint clavicular retraction
- 6° SC clavicular elevation
- 41° scapular internal rotation
- 5° scapular upward rotation
- 13.5° scapular anterior tilt

12 subjects; mean age 29.3

Ludewig PM 2009

Evidence for Scapular Movement Impairments - Impingement

- Decreased scapular posterior tilting
  - Lukasiewicz AC et al, JOSPT 1999
  - Ludewig PM & Cook TM, Phys Therapy 2000
  - Hebert LJ et al, Arch Phys Med Rehabil, 2002
  - Endo K et al, J Orthop Sci 2001
  - Lin JJ et al 2006
- Decreased scapular upward rotation
  - Ludewig PM & Cook TM, Phys Ther 2000
  - Endo K et al, J Orthop Sci 2001
  - Lin et al 2006
  - Lawrence RL 2014
- Increased scapular internal rotation
  - Ludewig PM & Cook TM, Phys Ther 2000

Torque capabilities of Trapezius

(Fey AJ, ....Ludewig PM JOSPT Jan 2007 Abstract)

- Used 3-D motion analysis and computer modeling of muscle moment arms
- Findings of Primary Torque Capability:
  - Upper trap = clavicular elevation
  - Middle trap = scapular external rotation
  - Lower trap = scapular external rotation and upward rotation
  - Serratus anterior = upward rotation, posterior tilt and external rotation

Scapular Internal Rotation

Anterior Tilt at Rest and Insufficient External Rotation - End range
Scapular Internal Rotation with Anterior Tilt - End range

- Secondary test:
  - Passively or actively increasing scapular external rotation and posterior tilt at end range arm elevation decreases symptoms.

Scapular Internal Rotation with Anterior Tilt - Muscle activation

- Movement Impairments when there is a muscle activation problem
  - These patients usually have a combination of IR and tilting

- Secondary test:
  - Correction by verbal and manual cues to dissociate GH from ST motion decreases symptoms

Scapular Internal Rotation with Anterior Tilt - Muscle activation

- Movement Impairments when there is a muscle activation problem
  - These patients usually have a combination of IR and tilting

Axioscapular Muscle Control > Scapulohumeral

- scapulohumeral muscle control > axioscapular muscles
Alignment Impairments

- **Scapular Internal Rotation:**
  - Scapula > 30 to 40 degrees anterior to frontal plane at rest

- **Scapular Anterior Tilting or Tipping:**
  - Prominence of inferior angle of scapula
  - Criteria: >10-15° anterior tilt at rest = abnormal Ludewig PM

Structural Variations in Rib Cage with Scapular Internal vs. External Rotation

**Structural considerations**
- Heavy or long arms
- Thoracic kyphosis
- Shape of rib cage/thorax

Scapular IR and AT - Intervention

- Increase stiffness of posterior axioscapular muscles
  - Improve activation and hypertrophy
  - Stretch
    - SH muscles while maintaining scapular position
    - Pectoralis minor
  - Dissociating GH from ST motion
    - Letting go with SH muscles

Intervention Exercises

- **Intervention:**
  - Facing wall shoulder flexion with arm lift (external rotation and posterior tilt at end range)
  - Increasing activation and relative stiffness of serratus anterior and lower trapezius. Serratus anterior is key!
  - Maintain correct head alignment
  - May need to limit ROM initially
  - *May contribute to scapular internal rotation by reaching toward wall.
Scapular Internal Rotation with Anterior Tilt - End range

- Intervention: Exercises
  - Shoulder flexion facing the wall with arm lift at end
  - During lifting arms off wall, focus has to be on scapular movement, not on GH movement

Scapular Internal Rotation with Anterior Tilt - Muscle activation

Intervention: Stretch Pectoralis Minor

- Improve performance of serratus anterior

Scapular Internal Rotation with Anterior Tilt - Muscle activation

Intervention: Exercises cont.

- Serratus anterior activation and strengthening
  - Quadruped and standing shoulder flex
  - Lower and middle trapezius activation and strengthening:
    - sidelying, standing, prone
    - Pec. minor stretching
  - Stretch SH muscles

Scapular Internal Rotation with Anterior Tilt - Muscle activation

Intervention: Quadruped Rocking Backward

- Improve performance of serratus anterior
  - Elongation posterior scapulo-humeral

Scapular Internal Rotation with Anterior Tilt - Muscle activation

Intervention: Function

- Reaching: Bend elbow to shorten lever arm

- Weight lifting: Decrease weight until scapular muscles can maintain correct scapular alignment throughout motion.
Scapular Internal Rotation with Anterior Tilt - Muscle activation

GHJ extension contributes to scapular anterior tilt

Scapular Internal Rotation with Insufficient Upward Rotation

- The movement impairment can happen anywhere in the ROM.
  - Serratus anterior is the best upward rotator

Insufficient Scapular Upward Rotation

Symptoms
- If pain is along vertebral border of scapula, the source of the pain is usually the cervical spine.
- May have pain in the area of the rhomboid muscle

Activities
- New mothers
- String instrument musicians
- Weightlifters, heavy laborers, waitresses, jobs that require arm to be sustained in flexion
- Sit with keyboard or arm rests too low

Scapular Internal Rotation with tilt and Insufficient Upward Rotation

- Right (involved) shoulder lower
- Right acromion is low
- Scapula is downwardly rotated or depressed
- Insufficient scapular upward rotation during abduction

Scapular Internal Rotation with Insufficient Upward Rotation

- Structural Variations (alter stresses on the tissues)
- Thoracic kyphosis
Scapular Internal Rotation with Abduction

Excessive scapular abduction and internal rotation during shoulder flexion

Corrected

Alignment:
Backview:
• vertebral border >3" (7.5 cm) from spine

Normal scapular alignment
• 3” Sobush DB. 1996
• 2.5”, Neumann DA, 2002
• 2” (5 cm) Kendall FP, 1993, Hoppenfeld S, 1976

Left scapula 4” (10 cm), right 3.5” (9 cm) from spine

Activity contributing to abduction: wrestling

Thoracic pain:
Segment of thoracic spine is more flexible than shoulder girdle:
(Contributing factors: heavy arms, stiff pectoral muscles, scapular abduction)

right scapular pain and popping
PhD student working a lot at bench under hood so has to reach forward
pain at end of day
right handed
large breasts

corrected
Scapular Internal Rotation with Abduction

- Avoid excessive scapular abduction at rest & during arm motions

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Scapular IR with AT and ABD

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Scapular IR with AT and ABD

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Dissociating GH from ST Motion

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Scapular Depression With Insufficient Upward Rotation

Movement Impairment - Insufficient elevation

- Acromion depresses in the first 90 degrees of shoulder flexion or abduction
- Acromion does not begin to elevate after about 30 degrees of arm elevation
- Acromion below C6 - 7 at end range

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Depression with Insufficient Scapular Upward Rotation

Unsuccessful Correction of Alignment Using Rhomboids

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Scapular Depression

Alignment
- Increased slope of shoulders R > L
- Scapula lower than T2 - T7 Swift TR, 1984
- Scapula normally positioned between T2-T7

Kendall FP 1993 and Hoppenfeld S 1976

Scapular Depression With Insufficient Upward Rotation

Alignment
- Horizontal clavicles Swift TR, 1984
  - normally clavicle should have slight upward slope
    - 25-29° Todd TW, 1912
    - 20° Telford S, 1948
    - 6° Ludewig PM 2009
- Right arm appears longer
- Increased slope

Scapular Depression With Insufficient Upward Rotation

Preferred

Corrected

Arm rests need to be close to body and high enough to support shoulders at correct height.

Positioning keyboard on desktop may be better than keyboard tray for arm support.

Neck Pain with Scapular Depression and Cervical Flexion

Pilates Instructor

videos
**External Rotation/Adduction With Insufficient Upward Rotation**

Impairments of Resting Alignment
- Vertebral border of scapula is < 6.25 cm (2.5”) from vertebral spine
- Scapula is oriented less than 30° anterior to frontal plane
- Clavicle is retracted more than 20-25°
- The thoracic spinal curve is often decreased or flattened.

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**External Rotation/Adduction With Insufficient Upward Rotation**

- Scapula less visible from sideview compared to person with scapular IR
- Associated with flat thoracic spine.

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**External Rotation/Adduction With Insufficient Upward Rotation**

Primary Focus of Intervention
- Cue to relax thoracic spine and stop constantly contracting scapular adductors.
- Improve performance of the serratus anterior
- Increase extensibility of the rhomboids and middle trapezius.

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**Scapular Winging**

Strength of serratus anterior on MMT is < 3/5

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**Left Side Involved**

Onset after biking trip for several weeks with backpack on back; 20 y/o
Scapular Elevation

Movement Impairment

- Excessive scapular elevation is usually identified early in the range and continues throughout arm elevation.

- *The primary problem is typically limited glenohumeral motion and not poor muscle performance.*

Scapular Elevation

Primary Focus of Intervention:

- If GH hypomobility is present - increase GH mobility.
- If rotator cuff function is deficient but expected to return focus is on restoring precise GH without scapular elevation.
- If rotator cuff function is deficient and not expected to improve then scapular elevation as a compensatory technique may be necessary.
Movement Impairment Syndromes of the Humerus and Shoulder

Shirley Sahrmann, PT, PhD, FAPTA & Associates

Developed by Renee Ivens, PT, DPT
Presented by Shirley Sahrmann

Normal Humeral Movement: Arm Elevation

- The humerus laterally rotates relative to the scapula as the arm is elevated in all planes
  - GH LR should be about 60° by the end range of arm elevation
  - GH LR increases the volume of the subacromial space

- During shoulder flexion
  - Movement should primarily be spinning; humeral head should stay centered on the glenoid

Normal Humeral Movement: Rotation

- During shoulder LR & MR with arm abducted
  - Movement should primarily be spinning; humeral head should stay centered on the glenoid

Evidence for Humeral Movement Impairments

- Impingement
  - Increased anterior translation
    - Ludwig PM & Cook TH, JOSPT, 2002
    - Jobe FW et al, Orthop Rev 1989
  - Increased superior translation
    - Deutsch A et al, J Shoulder Elbow Surg 1996

- Normals
  - Increased superior translation with muscle fatigue
    - Chen SK et al, 1999

Normal Humeral Alignment

- Humeral head relative to acromion- no > 1/3 of the humeral head anterior to acromion
- Humerus vertical from lateral view

With normal scapular alignment

- Posterior view- olecranon should face posterior to slightly lateral
- Anterior view- antecubital crease should face anterior to slightly medial
Reliability of Identifying Impairments

- Humeral head position - good reliability
- Humeral head position relative to acromion
  Bryde D, 2004

Normal Humeral Alignment

Humeral Diagnoses

- Humeral Anterior Glide
  - Humeral Superior Glide
  - Glenohumeral Medial Rotation
  - Glenohumeral Hypomobility
  - Glenohumeral Multidirectional Accessory Hypermobility

Humeral Anterior Glide

History

- May have general hypermobility
- Impingement
  - Pain - ant or post GHJ; worse with overhead motions or reaching esp backward
- Instability
  - C/o of clunking or shoulder slipping out of socket; may be assoc with trauma; more common in younger population.

Humeral Anterior Glide

- Activities/habits
  - Racquet or throwing sports, volleyball, swimming
  - Stand with hands clasped behind back
  - Standing with arms crossed across chest

Humeral Anterior Glide

- Movement Impairment
  - Excessive or abnormal anterior motion of the humeral head during shoulder motions
  - May decrease the volume of subacromial space
- Relative Flexibility
  - The anterior joint capsule is more flexible than the posterior joint capsule and/or the lateral rotators
**Humeral Anterior Glide**

**Resting Alignment:** humeral head relative to anterolateral corner of acromion

**Humeral head more anterior relative to acromion during active abduction**

**Humeral Anterior Glide: Abduction**

**Humeral Anterior Glide: Rotation**

During humeral lateral rotation the humerus extends and there is increased prominence of humeral head anteriorly

**Evidence for Humeral Anterior Glide**

- Symptomatic subjects demonstrated 1.4mm greater anterior translation from 90-120° flexion
  Lawrence RL 2014
- Symptomatic subjects had significantly greater anterior translation or less posterior translation than the asymptomatic subjects in all phases of movement- 30-60, 60-90 and 90-120°
  Ludewig PM 2002
- Case report- patient with humeral anterior glide and scapular downward rotation
  Caldwell CA 2007

**Humeral Anterior Glide**

**Alignment Impairments**

- forward shoulders
- greater than 1/3rd of the humeral head anterior of the acromion
- proximal humeral head anterior to the distal end of the humerus
- indentation below acromion posteriorly

**Resting Alignment of Shoulder Extension**
Humeral Anterior Glide

- Impairments in Muscle Activation and Lengths
  - Dominance of posterior deltoid over infraspinatus & teres minor during lateral rotation resulting in:
    - GH extension or horizontal abduction during lateral rotation
    - Associated with scapular internal rotation/anterior tilt
  - Dominance or shortness of pectoralis major over rotator cuff muscles

  Jaggi A 2012

- Impairments in Muscle Strength, Stiffness, and Length
  - weak or lengthened subscapularis > teres major
    - Turkel SJ 1981, Pennock 2011
  - short or stiff posterior capsule & scapulohumeral lateral rotators: infraspinatus, teres minor, posterior deltoid

Netter

Humeral Anterior Glide

- Short or stiff posterior capsule of GH joint
  - Tests to assess the length/stiffness of the posterior structures of GH joint are supine MR and horizontal adduction.


Key Tests: Standing
- Shoulder abduction- GHJ in horizontal abduction
- Shoulder lateral rotation

Key Tests: Supine
- GHJ medial rotation (MR)– ROM limited and impaired pattern of movement
  - May have large arc of movement during humeral MR (ant –inf)
- GHJ lateral rotation (LR)– ROM excessive and impaired pattern of movement
  - Anterior glide or large arc of motion (ant-sup)
  - Horizontal adduction – ROM limited

Humeral Anterior Glide

Shoulder Medial Rotation

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Humeral Anterior/Inferior Glide

Key tests: Prone
- GHJ medial rotation
  - weak in shortened range;
  - ROM limited and associated with scapular IR
- GHJ lateral rotation
  - palpate anterior glide
  - horizontal abduction of GHJ
  - associated with scapular IR and 1’d prominence of posterior deltoid
- Middle trapezius test
  - Anterior glide

Prone Shoulder Rotation

Corrected

Prone Middle Trapezius Test
Monitoring Humeral Head

Humeral Anterior/Inferior Glide
Humeral Anterior Glide

Treatment Overview
• Patient education and practice regarding how to avoid excessive anterior glide during daily activities
• Specific exercises to address contributing factors

Humeral Anterior Glide - Treatment
Emphasis on
• Correct scapular motion during glenohumeral motion: elevation, posterior tilt, upward rotation or external rotation/adduction
  McMahon PJ 1996
• Training for precise humeral rotation pattern before strengthening
  Falla A 2003
• Lengthen lateral rotators & posterior capsule

Humeral Anterior Glide: Prone Rotation
Correct positioning
Incorrect

Humeral Anterior Glide: Prone Lateral Rotation
Moment arm of posterior deltoid is reduced for last half of range
Ackland DC 2011

Suggestion- Initiating shoulder LR with finger and wrist extension seems to help facilitate correct recruitment of GH lateral rotators without compensatory scapular motion.
Support in Literature for Stretching Posterior Structures (Patients with Impingement)

- Harryman DT et al, 1990
- Bang MD, Deyle GD, 2000
- Budoff JE, 2005
- Ludewig PM, Borstad JD, 2003
- Matsen FA, Arntz CT, 1990
- McClure PW et al, 2004
- Tyler TF et al, 2000
- Wilk KE et al, 2002

Humeral Anterior Glide - Intervention

Emphasis on
- Subscapularis - shorter, stronger, stiffer to prevent anterior glide

Humeral Anterior Glide - Intervention

Emphasis on
- Decrease activation of posterior deltoid - alignment
- Decrease recruitment of pec major and latissimus
  Jaggi A 2012

Subscapularis – Recommended Exercises

Acute Phase Exercise
- Isometric
  - Suenaga N 2003 found that sternal pec major had greater EMG activity than subscapularis during isometric IR with arm at side and in neutral rotation
  - Pennock AT 2011: during belly press test EMG activity of subscapularis was consistently at least 2x that of pec, lats, or teres major

Implication: performing the isometric with the arm in as much IR as comfortable should help isolate the subscapularis
- Precautions
  - Effect of scapular adduction/clavicular retraction?

Subscapularis Strengthening

- Shoulder MR at 90° abduction - compared to arm at side -
  - Moment arm of the middle portion of subscapularis for IR remains constant from 0° to 45° of IR
    - Lats and pec reduce to almost nothing by 45° of IR
      Ackland DC 2011
  - Implication: to isolate subscapularis perform exercise working into end range MR with the shoulder in abduction.

What muscle is working?
Humeral Anterior Glide

Treatment - Function
- During humeral horizontal abduction or reaching to the side - lead with scapular adduction/external rotation and possibly increase thoracic/trunk rotation
- Educate: relationship of the humeral position - distal vs proximal end
- Avoid humeral positions that elongate ant/inf capsule

Humeral Diagnoses
- Humeral Anterior Glide
- **Humeral Superior Glide**
- Glenohumeral Medial Rotation
- Glenohumeral Hypomobility
- Glenohumeral Multidirectional Accessory Hypermobility

Humeral Superior Glide

Symptoms
- Pain in GHJ, worse with overhead or reaching out to side
- Unable to sleep on affected side

Activities: Weightlifters, swimmers
Population: More common in middle-aged or older patients, post-op pts, and obese individuals.

**Humeral Superior Glide**

Movement Impairment
Insufficient inferior glide or relative superior glide of the humeral head during arm elevation

Decreases volume of subacromial space.

Imprecise Movement

Neumann DA 2010

Rotator Cuff and Deltoid Force Couple

Normally the rotator cuff offsets the superior force of the deltoid vector

Norkin & Levangie

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Humeral Superior Glide

Alignment

- Decreased subacromial space
  - Normal subacromial space 9-10 mm
  - Peterson CJ 1984
- Humerus in abduction
- Scapula depressed or downwardly rotated

Impairments in Muscle Activation, Strength, Stiffness, and Length

- Dominance, shortness or stiffness of deltoid
- Shortness & or weakness of infraspinatus, teres minor & subscapularis
- Increased activation of axialhumeral medial rotators, latissimus & pectoralis major over subscapularis

Evidence for Humeral Superior Glide

Deutsch A, 1996
- Using x-rays found an increase in humeral head superior translation in subjects with impingement or RC tears vs. normals

Chen SK, 1999
- Found increase in humeral superior glide in healthy subjects after performing shoulder exercises to fatigue
Humeral Superior Glide

Key Tests:
• Superior glide is observed more readily during arm abduction than flexion
• Passive humeral abduction

Superior Glide During Passive Abduction

Passive Abduction on Opposite Shoulder

Humeral Superior Glide

Key Tests:
• Humeral rotation in prone & supine
  • May have mild loss of range, compression into glenoid
  • Long axis traction during rotation decreases symptoms
• Manual inferior glide of humeral head decreases symptoms
• Decreased humeral horizontal adduction especially with arm in LR

EMG of Rotator Cuff
Reinold MM 2004

• Looked at EMG activity of supra, infra, teres minor and post/middle deltoid in healthy subjects
• Prone horizontal abduction at 100° with ER elicited the greatest EMG for supra and deltoid

Concluded:
• Prone horiz abduction not most appropriate choice of exercise for pts with cuff weakness or impingement relative to high level of deltoid activation

Humeral Superior Glide

Emphasis of Treatment
• Correct strength, stiffness, &/or length of rotator cuff muscles
• Decrease activation and stiffness of deltoid
  • Practice shoulder flexion leading with fingers and shoulder in LR
• Correction of scapular alignment/movement
Program in Physical Therapy

Humeral Superior Glide

Intervention - Exercises

- lengthen rotator cuff - towel roll
- strengthen rotator cuff - prone rotation with precise pattern of movement

Intervention - Function

- Minimize abduction movements
- Do not lean on shoulder/ arm - promotes superior glide

Humeral Superior Glide

- Wall slides - push into wall to assist inferior glide
  Wise MB 2004
- Shoulder flexion
  - emphasize shoulder LR to minimize activity of anterior deltoid
  - Shoulder flexion better to decrease deltoid activity than shoulder abduction motions
  - Cues: ”lead with fingers and LR humerus”

Humeral Diagnoses

- Humeral Anterior Glide
- Humeral Superior Glide
  - Glenohumeral Medial Rotation
    - Glenohumeral Hypomobility
    - Glenohumeral Multidirectional Accessory Hypermobility

Glenohumeral Medial Rotation Syndrome

Symptoms

- Pain along GH joint line or deltoid area, anterior > posterior GHJ
- worse with overhead motions or elevation combined with rotation of arm

Activities

- Weightlifters, heavy laborers
- Swimmers, water polo
- Reaching into passenger seat of car

Glenohumeral Medial Rotation Syndrome

Movement Impairment

- Insufficient lateral rotation of the humerus during shoulder flexion or abduction
- Decreases volume of subacromial space
Glenohumeral Medial Rotation Syndrome

Alignment
- Humeral MR
- Shoulders forward or dropped
- If scapula is in IR and the humeral alignment looks normal, then the humerus is really in LR
- If the scapula is in ER and the humeral rotation looks normal then the GH joint is really in MR

Impairments in Muscle Activation, Strength, Stiffness, and Length
- Dominance, shortness or relative stiffness of the humeral medial rotators
  - Axiohumeral & teres major > subscapularis
- Weakness or insufficient activity of the lateral rotators

Key tests
- Shoulder flexion
- 1° test- excessive humeral MR with increased symptoms
- 2° test- increasing humeral LR decreases symptoms
- Muscle length tests: latissimus, teres major & pectoralis major
  - Short or stiff
  - DSM - Humeral medial rotation
- prone & supine lateral rotation

Preferred movement pattern is humeral MR
Glenohumeral Medial Rotation Syndrome

Emphasis of Treatment

- Encourage humeral LR during upper extremity activity
  - i.e. shoulder flexion with lateral rotation
- Correction of scapular alignment/movement

Glenohumeral Medial Rotation Syndrome

Example

- Patient with shoulder pain that had multiple tests including MRI but MD’s found nothing wrong
- Patient’s job: postmaster
- Sorted mail with shoulder in MR
- Treatment:
  - Sort mail with shoulder in LR (palm up) → pain resolved

Glenohumeral Medial Rotation Syndrome

Treatment - Function

- Reaching with “elbow in” - avoiding medial rotation
- Frequent stretching during the day if patient has daily activities that require repetitive positioning of the humerus in medial rotation
- Avoid sitting with arms in MR or postures of humeral MR (arms across chest, etc)

Glenohumeral Medial Rotation Syndrome

Emphasis of Treatment

- Strengthen and increase recruitment of lateral rotators
- Correct stiffness, length, and decrease activation of MR:
  - latissimus dorsi, teres major & pect major
  - perform shoulder horizontal adduction with shoulder LR’d

Glenohumeral Medial Rotation Syndrome

Intervention - Exercises

- Supine shoulder flexion with humeral LR to lengthen latissimus dorsi
  - Keep LB flat
  - May need to assist LR

Glenohumeral Medial Rotation Syndrome

Exercises to lengthen teres major
Glenohumeral Medial Rotation Syndrome

Intervention - Exercises
- Standing shoulder flexion emphasizing humeral LR
  - back to the wall - shoulder flexion
  - facing the wall - sliding arm up the wall

Glenohumeral Hypomobility

Humeral Diagnoses
- Humeral Anterior Glide
- Humeral Superior Glide
- Glenohumeral Medial Rotation
  - **Glenohumeral Hypomobility**
    - Glenohumeral Multidirectional Accessory Hypermobility

Glenohumeral Hypomobility

Movement Impairment
- Limited glenohumeral (GH) motion in all directions
- Scapular movement substitutes for GH movement
  - Scapular anterior tilt vs. GH MR (Borich MR 2006)
  - Scapular adduction vs. GH LR
  - Scapular elevation/upward rotation vs. GH flexion and abduction

Glenohumeral Hypomobility

Key tests
- PROM & AROM limited all planes
  - capsular pattern of restriction

Glenohumeral Hypomobility

Impairments in Muscle Activation, Length, and Strength:
- Shortness in the rotator cuff and capsule
- Compensatory upper trapezius activity for lack of GH motion

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Glenohumeral Hypomobility

Emphasis of Treatment
- increase GH movement
- promote precise GH movement within the patient’s available range - do not encourage substitution
- do not emphasize scapulothoracic motion before GH motion has improved
- strengthen as range increases – emphasize activation of rotator cuff over deltoid
- patience!

Intervention - Exercises
- Precise active movements within available range - flexion, rotation
- Passive shoulder flexion - no mm contraction, this is helpful when pain > loss of motion
- Wall slides
- Distraction
- GH mobilization

Humeral Diagnoses
- Humeral Anterior Glide
- Humeral Superior Glide
- Glenohumeral Medial Rotation
- Glenohumeral Hypomobility
- Glenohumeral Multidirectional Accessory Hypermobility

Symptoms/History
- General hypermobility
- GH joint pain
- C/o instability at GHJ
  - not usually associated with trauma
  - May report dislocations anterior & posterior
- Younger population

Activities
- Maybe limited by instability
- Dance, cheerleading, gymnastics

Movement Impairment
- Excessive humeral glide observed with arm elevation or rotation
- Increased physiological GH motion
- Insufficient scapular movement
Glenohumeral Multidirectional Accessory Hypermobility

**Impairments in Muscle Activation and Strength**
- Weak or decreased activation of rotator cuff

**Impairments in Length**
- Increased length and extensibility of rotator cuff and GH joint capsule

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Glenohumeral Multidirectional Accessory Hypermobility

**Treatment**
- Avoid end range GH motions
- Improve the performance and hypertrophy the rotator cuff
- Possibly deltoid
- Correct scapular movement impairments

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Summary of Key Points

- Commonly scapular motion is impaired resulting in imprecise accessory motion of the humerus
- Timing between the scapula and humerus is impaired
- Monitor the relationship of scapular and humeral motion through the ROM

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General Guidelines for Correction of Impairments

- Optimize muscle activation patterns
- Reverse relative stiffness
- Correct muscle stiffness and length
  - Shortened the long and lengthen the shortened
  - Strengthened the weak and support the strained
  - Reduced load on long and weak
- Correct alignment

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General Guidelines for Functional Activities

- Correcting movement impairments during performance of functional, work, recreational activities is **ESSENTIAL**
- Incorporate key exercises into everyday activities

Sahrmann SA 2002