Shoulder: Clinical Anatomy, Kinematics & Biomechanics

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Clinical Anatomy
• the application of anatomy to clinical practice

Kinematics
• describes the motion of objects without consideration of the causes leading to the motion

Biomechanics
• the application of mechanical principles to living organisms
Human Evolution

• Locomotive function to intricate gross and skilled functions

• Stability has been sacrificed to flexibility
Shoulder Complex

- Glenohumeral Joint
- Acromioclavicular Joint
- Sternoclavicular Joint
- Scapulothoracic Articulation
- Subacromial Space
Anatomical Orientation of the Shoulder Complex
Stability Functions of Shoulder Girdle

- Provides stable base from which shoulder muscles can generate force
- Shoulder girdle muscles as stabilizers
- Maintain appropriate force-length relationship
- Maintain maximum congruence of shoulder joint
Mobility Functions of Shoulder Girdle

- Permits largest ROM of any complex in the body
- Shoulder girdle increases ROM with less compromise of stability (scapulohumeral rhythm) (4 joints vs. 1 joint)
- Facilitate movements of the upper extremity by positioning GH favorably
Shoulder Girdle Motion

Elevation
Depression

Protraction (Abduction)
Retraction (Adduction)
Shoulder Girdle Motion

Upward rotation
Downward rotation

Upward tilt
Reduction of Upward Tilt
Muscular Considerations
Muscle Action on the Shoulder Girdle
Shoulder Girdle Muscles

- **Pectoralis Minor**: scapular downward rotation, depression, protraction
- **Serratus Anterior**: scapular protraction, upward rotation
- **Subclavius**: stabilizes sternoclavicular joint
Shoulder Girdle Muscles

- Levator Scapulae: elevation and downward rotation
- Rhomboids: downward rotation, retraction, elevation
Shoulder Girdle Muscles

Trapezius

• Upper: elevation, upward rotation of scapula

• Middle: retraction of scapula

• Lower: depression, retraction of scapula
Shoulder Joint Muscles

- **Pectoralis Major:** flexion, horizontal adduction, internal rotation of humerus

- **Deltoid:** nearly all movements of arm from shoulder joint, internal rotation, abduction, hyperextension, flexion, horizontal adduction
Shoulder Joint Muscles

- **Coracobrachialis**: forward movements of humerus
- **Subscapularis**: internal rotation of humerus, stabilizes glenohumeral joint
- **Biceps brachii**: flexion and adduction, horizontal adduction
Shoulder Joint Muscles

- **Supraspinatus**: abduction of humerus
- **Infraspinatus**: external rotation, horizontal abduction, stabilize humerus during flexion
- **Teres Minor**: external rotation, horizontal abduction, stabilize humerus during flexion
Shoulder Joint Muscles

- **Latissimus Dorsi**: extension and adduction of arm
- **Teres Major**: shoulder extension, adduction, medial rotation
- **Triceps Brachii**: adduction, extension, hyperextension of humerus
Scapulothoracic Muscles

- Elevators – Upper trapezius, levator scapula, rhomboids
- Depressors – Lower trapezius, pectoralis minor
Scapulothoracic Muscles

- Protractors – Serratus anterior, pectoralis minor
- Retractors – Mid & lower trapezius, rhomboids, levator scapulae
Scapulothoracic Muscles

- **Upward Rotators** – Serratus anterior, upper trapezius
- **Downward Rotators** - Rhomboids, pectoralis minor, levator scapulae
Glenohumeral Joint Muscles

- **Abductors** – deltoid, supraspinatus
- **Adductors** – pectoralis major, latissimus dorsi, teres major
- **Internal Rotators** – pectoralis major, subscapularis, anterior deltoid, latissimus dorsi, teres major
- **External Rotators** – infraspinatus, teres minor, posterior deltoid
- **Flexors** – biceps brachii, coracobrachialis, anterior deltoid
- **Extensors** – triceps brachii, posterior deltoid, latissimus dorsi, teres major
Specific Joints Structure and Function
Sternoclavicular Joint

- Clavicle
- Sternum
- 1st Rib
- Sternoclavicular ligaments
- Costoclavicular ligament
- Articular disc
- Muscular attachments
Sternoclavicular Joint Motions

- Elevation/Depression – 45/10 degrees Max
- Protraction/Retraction – 15 to 30 degrees in each direction
- Axial Rotation – 40 to 50 degrees
Acromioclavicular Joint

- Gliding or planar joint
- Articular disc
- Acromioclavicular ligament
- Coracoclavicular ligament
Acromioclavicular Joint Motions

- Upward & downward rotation
- Horizontal & sagittal plane adjustments
Coracoclavicular Ligaments

- Conoid ligament (medial) and Trapezoid ligament (lateral)
- Maintenance of the acromioclavicular joint
- Support of the scapula
Scapulothoracic Articulation

- Not a true joint
- Provide the movement base for the humerus
- ST motion = AC motion + SC motion
Primary Movements of the Scapulothoracic Articulation
Scapulothoracic Elevation

ST Elevation = SC joint elevation + downward rotation at AC joint
Scapulothoracic Upward Rotation

ST Upward Rotation = SC joint elevation + upward rotation at AC joint
Scapular Rotation

- Enhance glenohumeral stability
- Elevate acromion to avoid impingement
- Maintain effective length tension relationship of scapulohumeral muscles
Glenohumeral Joint
Glenohumeral Joint

- Humeral Head
- Glenoid Fossa
- Glenoid Labrum
- Rotator Cuff Muscles (SITS)
- Capsuloligamentous complex
- Coracohumeral Ligament
- Long Head of Biceps
- Subacromial Space
Glenohumeral Ligaments

- SGHL
- MGHL
- IGHL complex
  - Anterior band
  - Posterior band
  - Axillary pouch
Coracohumeral ligament

- Anterior band
- Posterior band
Glenohumeral Joint Motions

• Flexion/Extension (120/45 deg)

• Abduction/Adduction (120 deg)

• Internal/External Rotations (80/70 deg)

• Cannot precisely be isolated from motion of other elements of the shoulder girdle
Glenohumeral Joint Stability

Static restraints
- Bony structures
- Labrum
- Capsuloligamentous structure
- Negative joint pressure

Dynamic restraints
- Rotator Cuff
- Biceps
- Proprioceptive receptors
- Neuromotor coordination
Kinematics and Biomechanics
Convex Concave Rules

- Convex Stationary + concave moving = gliding in same direction as angular motion

- Concave stationary + convex moving = gliding in opposite direction of angular motion
Glenohumeral Joint Motions

• Normal Arthrokinematics:
  • Combines rotation & translation to keep humeral head centered on glenoid
Glenohumeral Roll / Glide
Glenohumeral Roll / Glide
Glenohumeral Roll / Glide
Glenohumeral Roll / Glide
Glenohumeral Joint Motions

- Abnormal Arthrokinematics:
  - Capsular tightness
  - Rotator cuff tears
Glenohumeral Roll / No Glide
Glenohumeral Roll / No Glide
Glenohumeral Roll / No Glide
Clinical Implication
Subacromial Space

Clinical Relevance:

• Avoidance of impingement during elevation of arm requires:
  • External rotation of humerus to clear greater tuberosity
  • Upward rotation of scapula to elevate lateral end of acromion

• Primary impingement:
  • Structural stenosis of subacromial space

• Secondary impingement:
  • Functional stenosis of subacromial space due to abnormal arthrokinematics
Dynamic Stabilization Mechanisms

- Passive muscle tension
- Compressive forces from muscle contraction
- Joint motion that results in tightening of passive structures
- Redirection of joint force toward center of GH joint
Dynamic Stabilization Mechanisms

- Force-length relationships quite variable due to multiple joints
- Tension development in agonist frequently requires tension development in antagonist to prevent dislocation of the humeral head
- Force couple – 2 forces equal in magnitude but opposite in direction
Force Couples Acting on Glenohumeral Joint

- Transverse plane - anterior vs. posterior rotator cuff muscles
- Coronal plane - deltoid vs. inferior rotator cuff
Force Couples Disruption

A

S
I/TM

D
I/TM

B

S
I/TM
Rotator Cuff – Dynamic
GH Stabilizer
Rotator Cuff Function

• Approximates humerus to function

• Supraspinatus assists deltoid in abduction

• Subscapularis, infraspinatus & teres minor depress humeral head
Scapulohumeral Rhythm
Scapulohumeral Rhythm

- Movement relationship between humerus and scapula during arm raising movements
Scapulohumeral Rhythm

- Synergistic coordination of scapulothoracic musculature producing abduction
- Combined motion of GH, AC, SC & ST joints
- 2:1 ratio – for every 3 degrees of shoulder abduction, 2 degrees occur at GH joint, and 1 degree occurs at the ST joint (SC, AC)
Scapulohumeral Rhythm

- 0 – 90 degrees of abduction: 60 deg of GH motion; 30 degrees of ST motion

- ST abduction: 20-25 degrees of clavicular elevation, 5-10 degrees of AC upward rotation

- 90-180 degrees of abduction: 60 deg of GH motion; 30 degrees of ST motion

- ST abduction: 5 degrees of clavicular elevation, 25 degrees of AC upward rotation
Scapulohumeral Rhythm

• Preserves the length-tension relationships of the glenohumeral muscles
• sustain their force production through a larger portion of the range of motion
• Prevents impingement between the humerus and the acromion
• simultaneous movement limits relative movement between the two bones
Scapulothoracic Rhythm
Clinical Implications

- Rotator cuff pain in early phase of active abduction
- Impingement pain in mid phase of active abduction
- AC pain in late phase of active abduction
Effects of Poor Scapular Stabilization

- Poor resting posture of scapula; slightly protracted position
- Loss of upward or optimal tilt of scapula
- Loss of static stability of GH joint
- Inferior translation and internal rotation of humeral head
- Traction ischemia of rotator cuff musculature, especially supraspinatus
- Capsular laxity; poor dynamic stabilization
Thank You