Functional Kinesiology of the Shoulder Girdle

Joseph Burris, MD
Associate Professor of Clinical PM&R
Director, Amputee Rehabilitation Program
Overview

• Bony skeleton
• Anatomic/functional articulations
• Other anatomic considerations
• Motor control—muscles
• Functional kinesiology
Bony skeleton

- Clavicle
- Scapula
- Humerus
Anatomic articulations

- Sternoclavicular joint
- ONLY anatomic articulation joining shoulder complex to axial skeleton
Anatomic articulations

SC Joint

Reinforced by:

- Sternoclavicular ligament
- Costoclavicular ligament
- Interclavicular ligament
Anatomic articulations

- Elevation/depression
- Abduction/adduction (pro/retraction)
- Anterior/posterior tilt
Anatomic articulations

- Acromioclavicular joint
- Medial-lateral rotation
- Anterior-posterior tilt
Anatomic articulations

- Glenohumeral joint
- Flexion/extension
- Abduction/adduction
- Medial/lateral rotation
  - Internal/external
Anatomic articulations

Glenohumeral joint

Reinforced by:
• Glenohumeral joint capsule
• Superior glenohumeral ligament
• Middle glenohumeral ligament
• Inferior glenohumeral ligament
• Superior acromioclavicular ligament
Functional articulations

- Suprahuemeral joint
- Coracoid
- Acromion
- Coracoacromial ligament
Functional articulations

- Scapulothoracic joint
- Scapula to thorax
Functional articulations

- ST joint
- Structures to maintain integrity of AC and SC joints
Functional articulations

Function of scapular motions:

• Orient glenoid fossa for optimal contact with upper limb during motion

• Add range to elevation of upper limb
Scapulohumeral rhythm

For every two degrees of glenohumeral motion, there is one degree of scapulothoracic motion.

Begins after the first 30 degrees of glenohumeral abduction.
Functional articulations

- Elevation/depression
- Abduction/adduction
- Upward/downward (lateral/medial) rotation
- Anterior/posterior tilt
Other considerations
Other considerations
Motor control—shoulder girdle

- Provides fixation for upper limb movements
- Scapulohumeral control
- Ability to use upper limb in a variety of positions
Anatomic planes of motion
Scapulothoracic and scapulocervical muscles

- Serratus anterior
- Trapezius
- Rhomboid major/minor
- Pectoralis minor
- Levator scapulae
Scapulohumeral muscles

- Deltoid
- Supraspinatus
- Infraspinatus
- Teres minor
- Subscapularis
- Teres major
- Coracobrachialis
Thoracohumeral muscles

- Latissimus dorsi
- Pectoralis major
Shoulder girdle movements

• Elevation: movement of distal clavicle and acromion superiorly

• Depression: movement of distal clavicle and acromion inferiorly
Shoulder girdle movements

- Abduction (protraction): movement of distal clavicle and scapula anteriorly around thorax, with scapula medial border moving away from midline

- Adduction (retraction): movement of distal clavicle and scapula posteriorly around thorax, with scapula medial border moving toward midline
Shoulder girdle movements

- **Upward rotation (lateral rotation):** movement of glenoid fossa superiorly with inferior angle of scapula sliding anterolaterally along thorax.

- **Downward rotation (medial rotation):** movement of glenoid fossa inferiorly with inferior angle of scapula sliding posteromedially along thorax.
Shoulder girdle movements

- Anterior tilt: anterior movement of superior border of scapula along with posterior movement of inferior border of scapula to maintain scapulothoracic relationship during scapular elevation.

- Posterior tilt: posterior movement of inferior border of scapula along with anterior movement of inferior border of scapula to maintain scapulothoracic relationship during scapular depression.
Scapulohumeral rhythm
Glenohumeral movements

- **Flexion:** forward movement of humerus in sagittal plane

- **Extension:** return from flexion. May also refer to posterior movement of humerus in sagittal plane (hyperextension).
Glenohumeral movements

• Abduction: sideward, upward movement of humerus in frontal plane

• Adduction: return from abduction
Glenohumeral movements

- Lateral (external) rotation: lateral movement of the humerus around its longitudinal axis

- Medial (internal) rotation: medial movement of the humerus around its longitudinal axis
Glenohumeral movements

• Horizontal flexion (adduction): anterior movement of the distal humerus in a horizontal plane, after placement of the humerus in 90 degrees of abduction

• Horizontal extension (abduction): return from horizontal adduction. May also include posterior movement of the distal humerus in horizontal plane
## Corresponding movements

<table>
<thead>
<tr>
<th>Glenohumeral movement</th>
<th>Scapulothoracic movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>Upward rotation, abduction</td>
</tr>
<tr>
<td>Extension</td>
<td>Downward rotation, adduction</td>
</tr>
<tr>
<td>Abduction</td>
<td>Upward rotation</td>
</tr>
<tr>
<td>Adduction</td>
<td>Downward rotation</td>
</tr>
<tr>
<td>Lateral rotation</td>
<td>Adduction</td>
</tr>
<tr>
<td>Medial rotation</td>
<td>Abduction</td>
</tr>
<tr>
<td>Horizontal flexion</td>
<td>Abduction</td>
</tr>
<tr>
<td>Horizontal extension</td>
<td>Adduction</td>
</tr>
</tbody>
</table>
Glenohumeral and Scapulothoracic Joints
Associated Movements -- Kinesiology

• https://youtu.be/uNXMRZRZSPRcQ
## Scapulothoracic action/muscles

<table>
<thead>
<tr>
<th>Action</th>
<th>Muscles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevation</td>
<td>Upper trapezius, levator scapulae, rhomboids</td>
</tr>
<tr>
<td>Depression</td>
<td>Pectoralis minor, lower trapezius, (pec major and lat dorsi act on humerus)</td>
</tr>
<tr>
<td>Protraction</td>
<td>Serratus anterior, pectoralis minor</td>
</tr>
<tr>
<td>Retraction</td>
<td>Trapezius, rhomboids</td>
</tr>
</tbody>
</table>
Scapulothoracic action/muscles

<table>
<thead>
<tr>
<th>Upward rotation</th>
<th>Upper and lower trapezius, serratus anterior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downward rotation</td>
<td>Pectoralis minor, rhomboids</td>
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## Glenohumeral action/muscles

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</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>Pectoralis major, anterior deltoid, coracobrachialis, biceps brachii</td>
</tr>
<tr>
<td>Extension</td>
<td>Latissimus dorsi, teres major, triceps long head, posterior deltoid</td>
</tr>
<tr>
<td>Abduction</td>
<td>Deltoid, supraspinatus, biceps brachii</td>
</tr>
</tbody>
</table>
# Glenohumeral action/muscles

<p>| | |</p>
<table>
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<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Adduction</strong></td>
<td>Pectoralis major, latissimus dorsi, teres major, triceps long head, posterior deltoid</td>
</tr>
<tr>
<td><strong>External rotation</strong></td>
<td>Infraspinatus, teres minor, posterior deltoid</td>
</tr>
<tr>
<td><strong>Internal rotation</strong></td>
<td>Subscapularis, teres major, pectoralis major, latissimus dorsi, anterior deltoid</td>
</tr>
</tbody>
</table>
Kinesiology summary

• So what?
• Who cares?
• Blah blah blah…

• Yada yada yada…
Anatomy video – muscles of the upper arm/shoulder region

- https://youtu.be/kCNfvyCIHsw
WE DO!!

• Motor control for manual prostheses
  • Control cable excursion for manually operated componentry

• Myoelectric control for myoelectric prostheses
  • Myoelectric signal processing from remaining muscles to electrically operated componentry
Myoelectric signal acquisition, manipulation, and output
# Upper limb prosthetic control

<table>
<thead>
<tr>
<th>Prosthesis</th>
<th>Elbow flexion</th>
<th>Terminal device</th>
<th>Elbow lock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forequarter</td>
<td>Lat dorsi, scapular abduction contralateral side</td>
<td>Lat dorsi, scapular abduction contralateral side</td>
<td>Nudge control</td>
</tr>
<tr>
<td>Shoulder disarticulation</td>
<td>Lat dorsi, bicapular abduction</td>
<td>Lat dorsi, bicapular abduction</td>
<td>Scapular elevation ipsilateral side, chest expansion</td>
</tr>
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Forequarter amputation myo testing and control

https://www.youtube.com/watch?v=FtE3whNSz7s
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<tr>
<td>Transhumeral</td>
<td>Biscapular abduction and humeral flexion</td>
<td>Biscapular abduction, humeral flexion</td>
<td>Shoulder depression, humeral abduction &amp; extension</td>
</tr>
<tr>
<td>Transradial</td>
<td>NA</td>
<td>Biscapular abduction humeral flexion</td>
<td>NA</td>
</tr>
</tbody>
</table>
AEA manual device operation

https://www.youtube.com/watch?v=lHDik5MPk6M

https://youtu.be/UR3tv-tLtEl
BEA myotesting + device - iLimb

https://www.youtube.com/watch?v=lKeBH8in7Zg
BEA manual device operation

https://www.youtube.com/watch?v=li7ByN5SiM
BEA donning and myo sensors for myoelectric device operation

https://www.youtube.com/watch?v=4QfhGoogle4Y
BEA myoelectric gesture control operation

- https://youtu.be/nxPToKzuXF4