



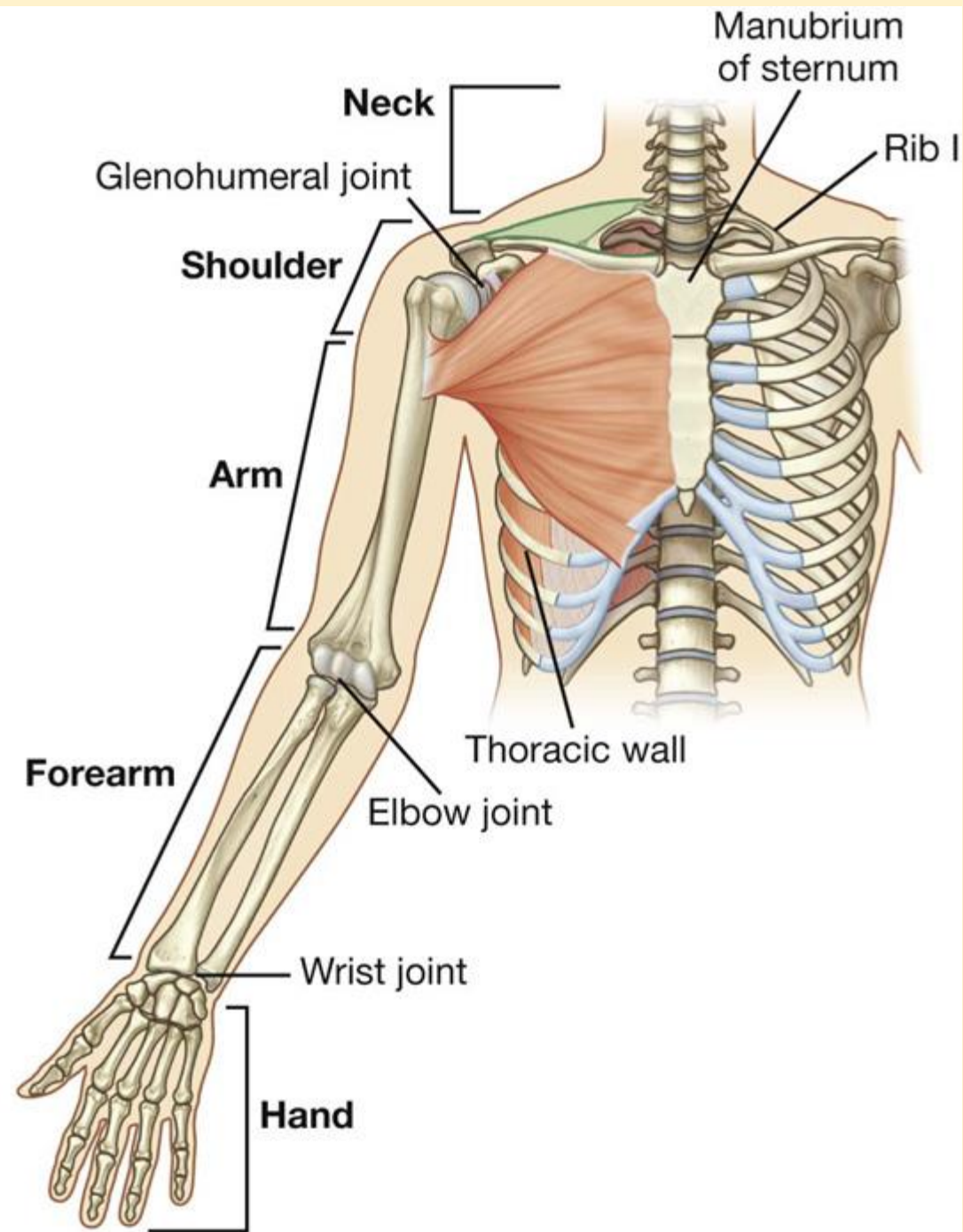
Physiotherapy Department

Biomechanics

Dr. Surajo Kamilu Sulaiman
PT., Ph.D.

surajo.sulaiman@tiu.edu.iq

Biomechanics of the Joints of the Upper Limb



Lecture 7

Biomechanics of the Shoulder Complex

28-11-2023

Synopsis

- Biomechanics of shoulder complex
 - Sternoclavicular joint
 - Acromioclavicular joint
 - Scapulothoracic joint
 - Glenohumeral joint

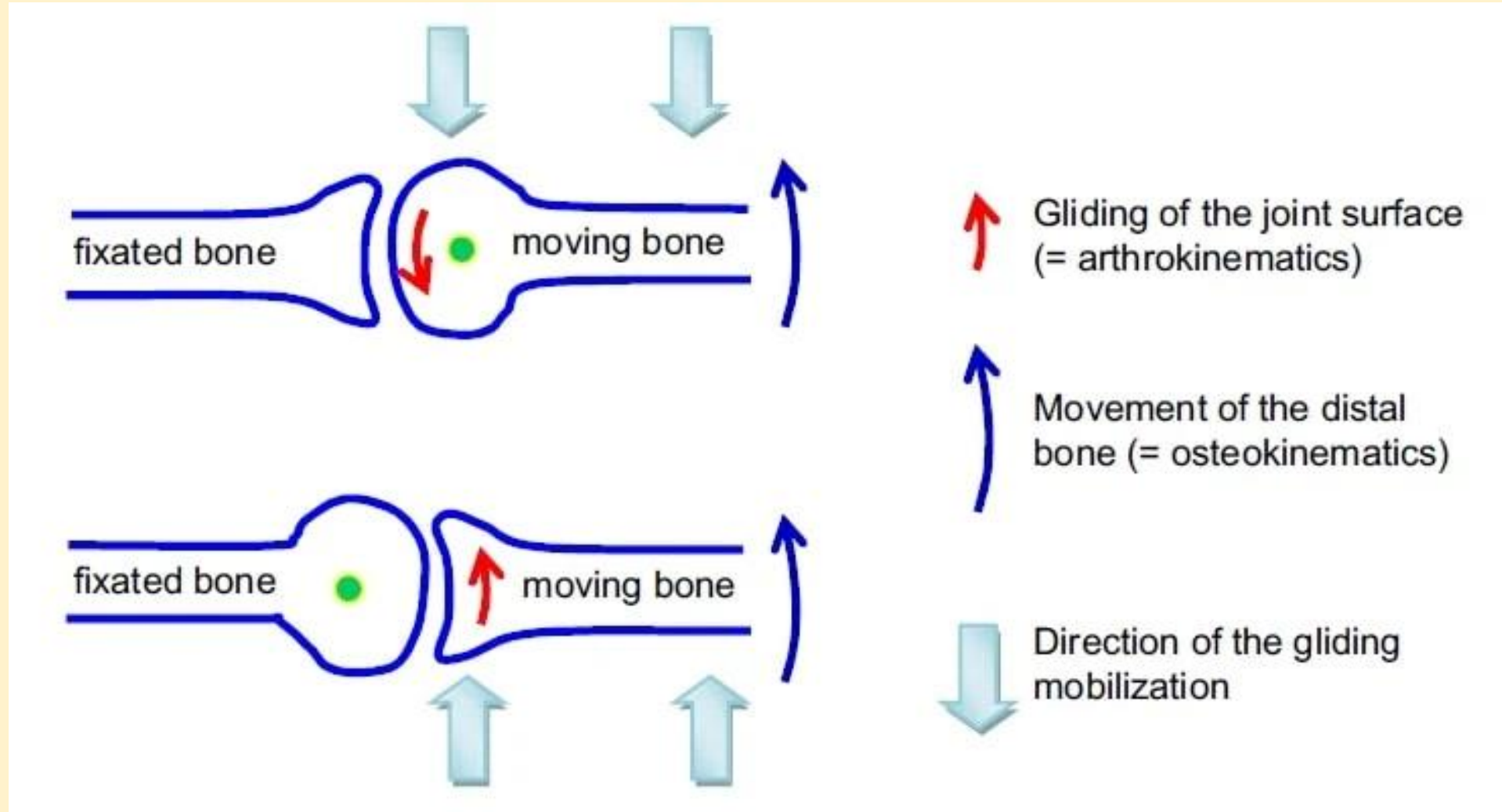
Objectives

- By the end of this lecture, students should understand and be able to describe the basic biomechanics of the following joints:
 - Sternoclavicular joint
 - Acromioclavicular joint
 - Scapulothoracic joint
 - Glenohumeral joint

Overview

- Upper limb comprises one of the most mobile and complex joints of the body
- Biomechanics of each of the joints will be presented based on the following:
 - Articulations
 - Arthrokinematics
 - Osteokinematics
 - Muscles acting on the joint
- Kaltenborn concave-convex rule will be used to describe the joint kinematics

Overview



Kaltenborn concave-convex rule

Biomechanics of shoulder complex

- Shoulder region consists of four interdependent joints, hence the term shoulder complex
- Shoulder complex include:
 - Sternoclavicular joint (SC)
 - Acromioclavicular joint (AC)
 - Scapulothoracic joint (ST)
 - Glenohumeral joint (GH)

Biomechanics of shoulder complex

Sternoclavicular (SC)

Articulations:

- Medial end of the clavicle articulates with the sternum and the cartilage of the first rib

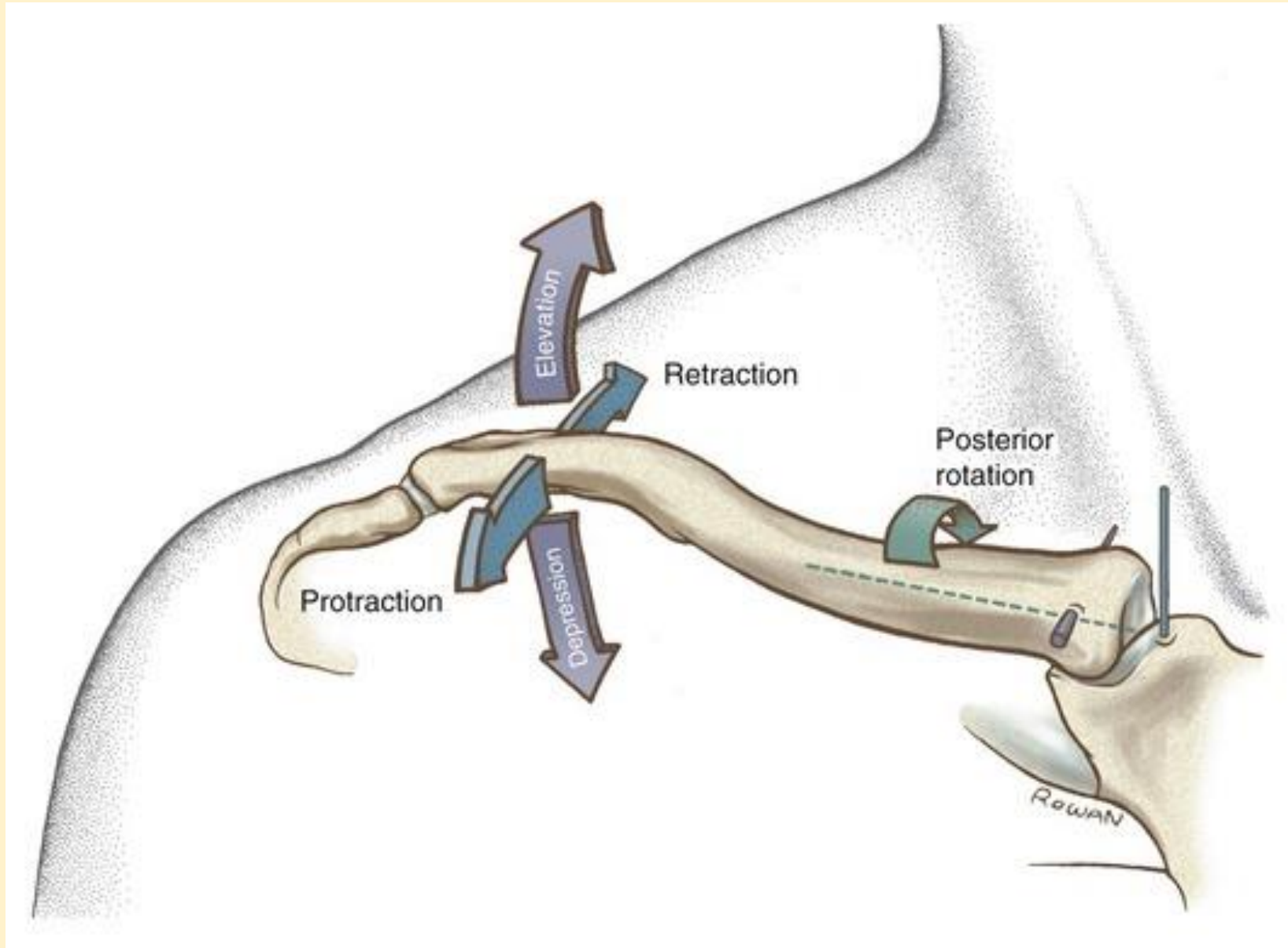
Osteokinematics:

- SC joint has 3 degrees of freedom, and motion consists of movement of the clavicle on the sternum.
- Clavicular motions include
 - Elevation–depression in the frontal plane,
 - Protraction–retraction in the horizontal plane, and
 - Anterior–posterior rotation around the longitudinal axis through the length of the clavicle

Biomechanics of shoulder complex

Arthrokinematics:

- In elevation and depression, the convex portion of the joint surface of the clavicle slides on the concave manubrium in the opposite direction and rolls in the same direction as movement of the lateral end of the clavicle
- In protraction and retraction, the concave portion of the clavicular joint surface slides and rolls on the convex surface of the manubrium in the same direction as the lateral end of the clavicle.
- In rotation, the clavicular joint surface spins on the opposing joint surface
- Thus, the clavicle slides inferiorly in elevation, superiorly in depression, anteriorly in protraction, and posteriorly in retraction



AC Kinematics

Biomechanics of shoulder complex

Muscles acting on the joint:

- No muscles have immediate action on SC joint, movement at this joint relies primarily on the motion of the scapula and the pectoral girdle
- Several muscles have attachment to the clavicle and thus influence movement of the SC joint
- They include:
 - Subclavius
 - Deltoid
 - Pectoralis
 - Trapezius
 - Sternocleidomastoid

Biomechanics of shoulder complex

Acromioclavicular Joint (AC)

Articulations:

- Lateral end of the clavicle (slightly convex) articulates with the acromion (shallow concave facet) of the scapula

Osteokinematics:

- AC joint has 3 degrees of freedom and permits angular movement of the scapula on the clavicle in three planes
- Tilting (tipping) is movement of the scapula in the sagittal plane around a coronal axis
- Upward and downward rotations of the scapula occur in the frontal plane around an anterior–posterior axis

Biomechanics of shoulder complex

- Protraction and retraction (internal and external rotation) of the scapula occur in the transverse plane around a vertical axis.

Arthrokinematics:

- Concave acromial facet slides and rolls on the lateral end of the clavicle in the same direction as the osteokinematic movement of the scapula

Muscles acting on the joint:

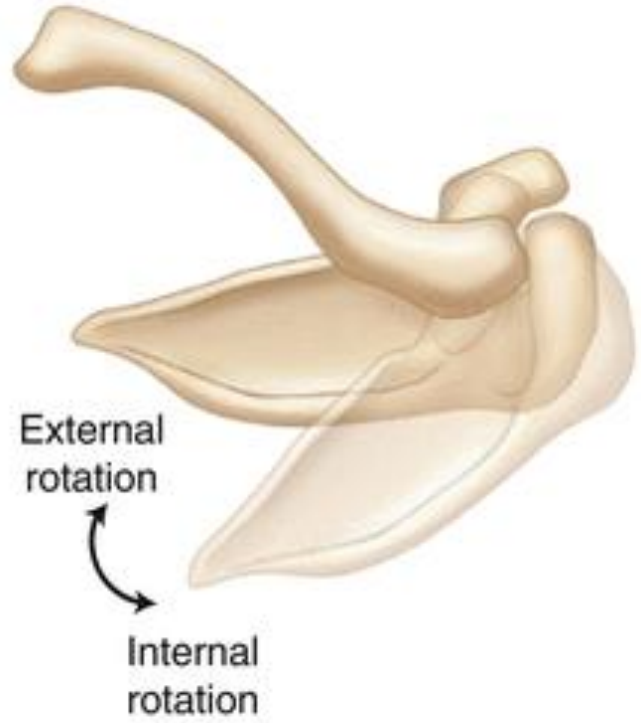
- No direct muscle action, movements within the AC joint are completely passive, and depend on the movements of the scapula and clavicle
- Muscles acting on scapula and clavicle influence the AC joint

Biomechanics of shoulder complex

- The muscles include:
 - Trapezius
 - Levator scapulae
 - Pectoralis minor
 - Serratus anterior
 - Rhomboid major
 - Rhomboid minor

a

Superior view



Posterior view



Lateral view



Biomechanics of shoulder complex

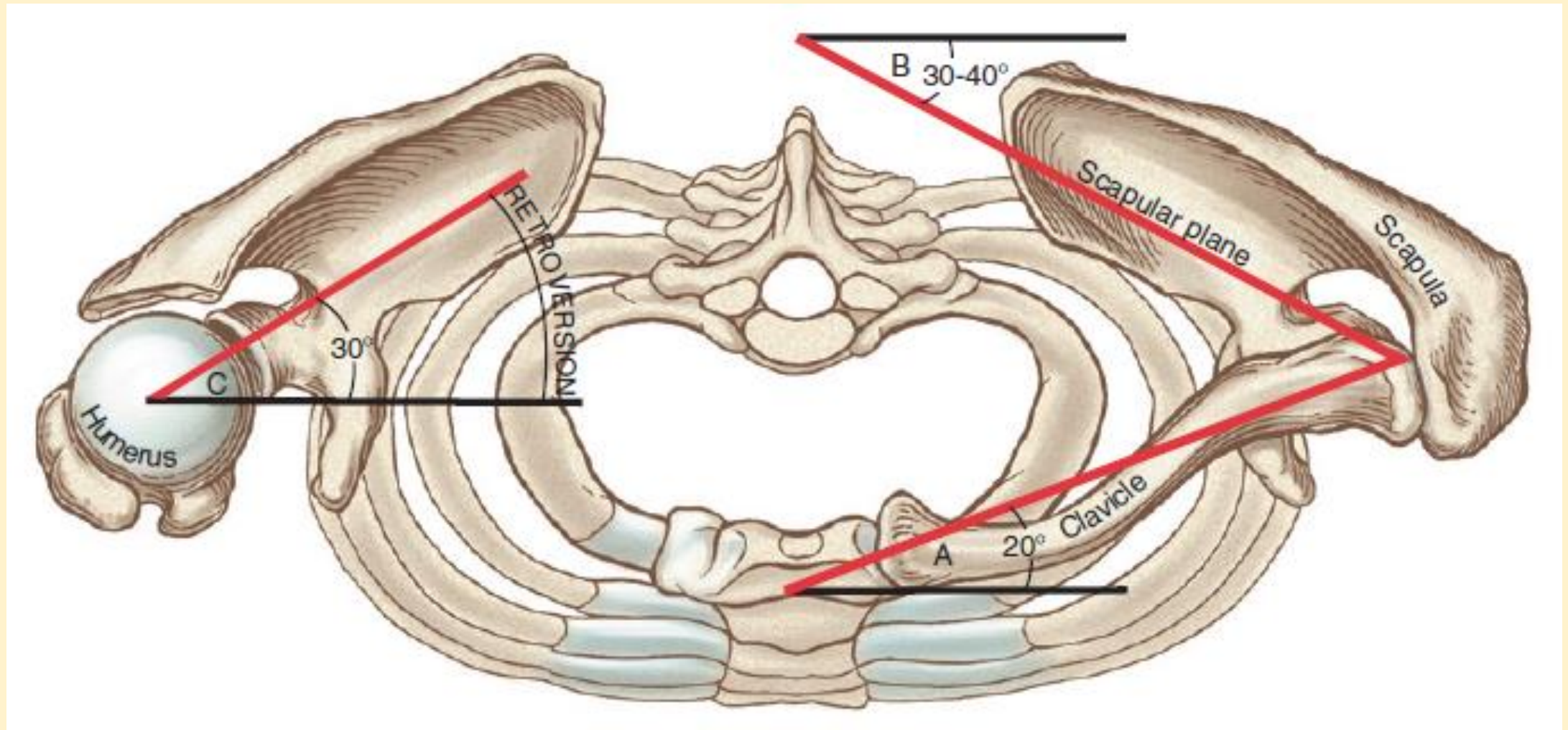
Glenohumeral (GH)

Articulations:

- Formed by **convex head of the humerus**, which faces medially, superiorly, and posteriorly with respect to the shaft of the humerus (20 degrees retroversion and 135 degrees inclination) and shallow **concave glenoid cavity** (deepened by glenoid labrum) facing laterally, superiorly, and anteriorly

Osteokinematics:

- GH joint has 3 degrees of freedom
- The motions permitted at the joint are
 - Flexion–extension in sagittal plane
 - Abduction–adduction in frontal plane
 - Medial–lateral rotation in transverse plane



- A. Clavicle 20 degrees posterior to frontal plane
- B. Scapula deviated 30-40 degrees anterior to frontal plane
- C. Retroversion of the humeral head about 30 degrees posterior to the medial-lateral axis at the elbow

Biomechanics of shoulder complex

Arthrokinematics:

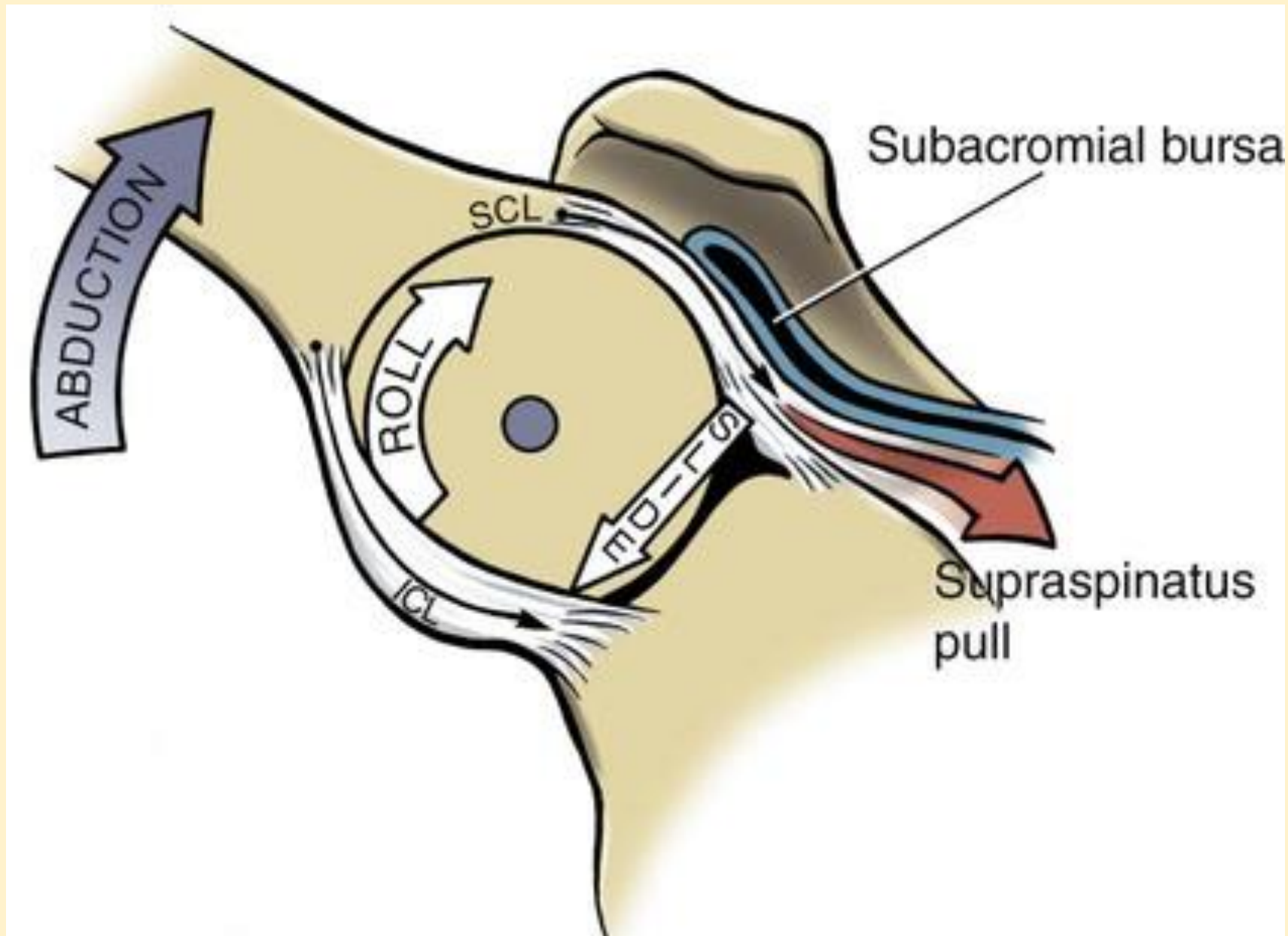
- Motion at the GH joint occurs as a rolling and sliding of the head of the humerus on the glenoid fossa
- Convex joint surface of the head of the humerus slides in the opposite direction and rolls in the same direction as the osteokinematic movements of the shaft of the humerus

Muscles acting on the joint:

- Scapulohumeral and thoracohumeral muscles are responsible for producing movement at the glenohumeral joint

Biomechanics of shoulder complex

Muscles acting on glenohumeral joint	
Flexion	Pectoralis major, deltoid, coracobrachialis, long head of biceps brachii
Extension	Latissimus dorsi, teres major, pectoralis major, deltoid, long head of triceps brachii
Adduction	Coracobrachialis, pectoralis major, latissimus dorsi, teres major
Abduction	Supraspinatus, deltoid
Internal rotation	Subscapularis, teres major, latissimus dorsi, pectoralis major, deltoid
External rotation	Teres minor, infraspinatus, deltoid



Arthrokinematics of GH

Biomechanics of shoulder complex

Scapulothoracic (ST)

Articulations:

- Anterior surface of scapula, superolateral surface of posterior thoracic wall

Osteokinematics:

- Motions that occur at the scapulothoracic joint are caused by the independent or combined motions of the SC and AC joints
- Osteokinematics motions include:
 - Elevation–depression
 - Upward–downward rotation
 - Anterior–posterior tilting (Protraction–retraction)



Elevation



Depression



Adduction (retraction)



Abduction (protraction)

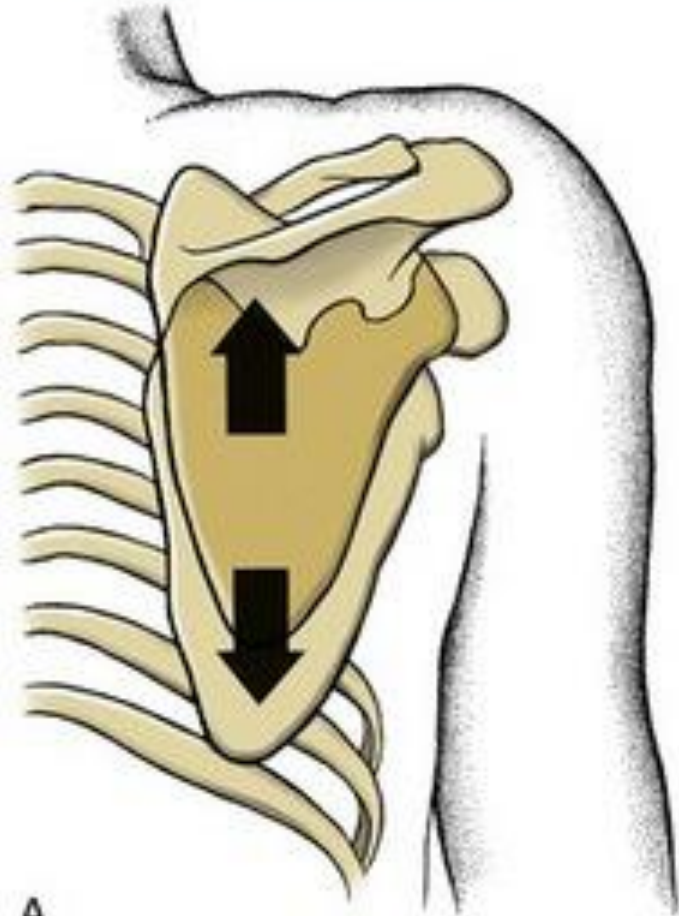


Upward rotation



Downward rotation (return to anatomical position)

Elevation and depression



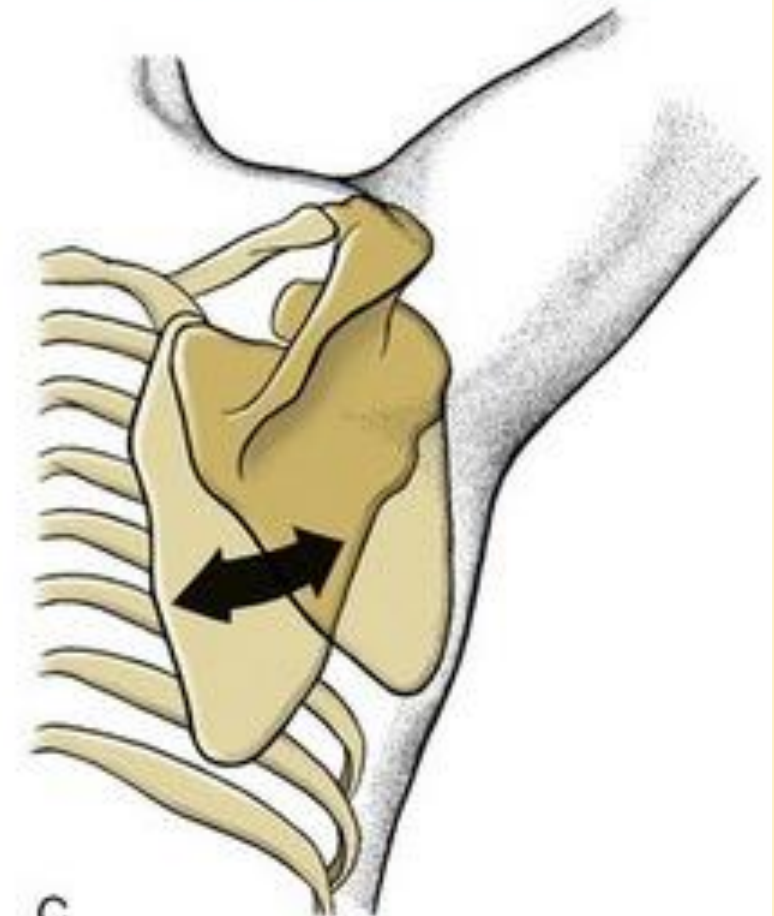
A

Protraction and retraction



B

Upward and downward rotation



C

Biomechanics of shoulder complex

Arthrokinematics:

- Motion consists of a sliding of the scapula on the thorax

Muscles acting on the joint:

- All muscles that are attached to the scapula contribute to its mobility
- The muscles include;
 - Trapezius
 - Levator scapulae
 - Serratus anterior
 - Pectoralis minor
 - Rhomboid major
 - Rhomboids minor

Contributions and Questions



Tishk
International University



References

- Levangie, P. K., & Norkin, C. C. (2005). *Joint Structure and Function: A Comprehensive Analysis* (4th ed.). F. A. Davis Company.
- Neumann, D. A. (2017). *Kinesiology of the Musculoskeletal System: Foundations for Rehabilitation* (3rd ed.). Elsevier.
- Norkin, C. C., & White, D. J. (2016). *Measurement of Joint Motion: A Guide to Goniometry* (5th ed.). F. A. Davis Company.
- Oatis, C. A. (2009). *Kinesiology: The Mechanics and Pathomechanics of Human Movement* (2nd ed.). Lippincott Williams & Wilkins.