2  Shoulder & Arm
Bones of the Upper Limb

Fig. 2.1 Bones of the upper limb
Right limb. The upper limb is subdivided into three regions: arm, forearm, and hand. The shoulder girdle (clavicle and scapula) joins the upper limb to the thorax at the sternoclavicular joint.

A Anterior view.  
B Posterior view.
Fig. 2.2 Bones of the shoulder girdle in normal relation to those of the trunk
Clavicle & Scapula

The shoulder girdle (clavicle and scapula) connects the bones of the upper limb to the thoracic cage. Whereas the pelvic girdle (paired hip bones) is firmly integrated into the axial skeleton (see p. 558), the shoulder girdle is extremely mobile.

Fig. 2.4 Clavicle
Right clavicle. The S-shaped clavicle is visible and palpable along its entire length (generally 12 to 15 cm). Its medial end articulates with the sternum at the sternoclavicular joint. Its lateral end articulates with the scapula at the acromioclavicular joint (see Fig. 2.3).

A Superior view.

B Inferior view.
**Fig. 2.5 Scapula**
Right scapula. In its normal anatomical position, the scapula extends from the 2nd to the 7th rib.

**Clinical box 2.1**
Scapular foramen
The superior transverse ligament of the scapula (see Fig. 2.14) may become ossified, transforming the scapular notch into an anomalous bony canal, the scapular foramen. This can lead to compression of the suprascapular nerve as it passes through the canal (see p. 89).
Fig. 2.6 Humerus
Right humerus. The head of the humerus articulates with the scapula at the glenohumeral joint (see p. 10). The capitulum and trochlea of the humerus articulate with the radius and ulna, respectively, at the elbow (cubital) joint (see p. 34).
Extra-articular fractures and intra-articular fractures are often accompanied by injuries of the blood vessels that supply the humeral head (anterior and posterior circumflex humeral arteries), with an associated risk of post-traumatic avascular necrosis.

Fractures of the surgical neck can damage the axillary nerve and fractures of the humeral shaft and distal humerus are frequently associated with damage to the radial nerve.
Joints of the Shoulder

**Fig. 2.7 Joints of the shoulder: Overview**
Right shoulder, anterior view.

**Fig. 2.8 Joints of the shoulder girdle**
Right side, superior view.

**Fig. 2.9 Scapulothoracic joint**
Right side, superior view. In all movements of the shoulder girdle, the scapula glides on a curved surface of loose connective tissue between the serratus anterior and the subscapularis muscles. This surface can be considered a scapulothoracic joint.
Fig. 2.10 **Sternoclavicular joint**  
Anterior view with sternum coronally sectioned (left). *Note:* A fibrocartilaginous articular disk compensates for the mismatch of surfaces between the two saddle-shaped articular facets of the clavicle and the manubrium.

Fig. 2.11 **Acromioclavicular joint**  
Anterior view. The acromioclavicular joint is a plane joint. Because the articulating surfaces are flat, they must be held in place by strong ligaments, greatly limiting the mobility of the joint.

**Clinical box 2.3**  
Injuries of the acromioclavicular joint  
A fall onto the outstretched arm or shoulder frequently causes dislocation of the acromioclavicular joint (often known as a “shoulder separation”) and damage to the coracoclavicular ligaments.

A. Stretching of acromio-clavicular ligaments.  
B. Rupture of acromioclavicular ligament.  
C. Complete dislocation of acromioclavicular joint. Note rupture of acromioclavicular and coracoclavicular ligaments.
Joints of the Shoulder: Glenohumeral Joint

Fig. 2.12 Glenohumeral joint: Bony elements
Right shoulder.

A Anterior view.

B Posterior view.

Fig. 2.13 Glenohumeral joint cavity
**Fig. 2.14 Glenohumeral joint: Capsule and ligaments**
Right shoulder.

**Fig. 2.15 Ligaments reinforcing capsule**
Schematic representation of the ligaments reinforcing the capsule after removal of the humeral head.
Right shoulder.
Subacromial Space & Bursae

**Fig. 2.16 Subacromial space**
Right shoulder.

**Fig. 2.17 Subacromial bursa and glenoid cavity**
Right shoulder, lateral view of sagittal section with humerus removed.

A Lateral view.

B Superior view. Note the position of the subacromial bursa between the supraspinatus muscle and the coracoacromial arch.
**Fig. 2.18 Subacromial and subdeltoid bursae**
Right shoulder, anterior view.

A Location of bursae.

B Coronal section. The arrows are pointing at the supraspinatus tendon, which is frequently injured in a “rotator cuff tear” (for rotator cuff, see p. 25).
Fig. 2.19 Anterior muscles of the shoulder and arm
Right side, anterior view. Muscle origins are shown in red, insertions in blue.

A Superficial dissection.
B Deep dissection. Removed: Sternocleidomastoid, trapezius, pectoralis major, deltoid, and external oblique muscles.
Anterior Muscles of the Shoulder & Arm (II)

Fig. 2.20 Anterior muscles of the shoulder and arm: Dissection
Right arm, anterior view. Muscle origins are shown in red, insertions in blue.


B Removed: Latissimus dorsi and serratus anterior.

D *Removed:* Biceps brachii, coracobrachialis, and teres major.
Posterior Muscles of the Shoulder & Arm (I)

Fig. 2.21 Posterior muscles of the shoulder and arm
Right side, posterior view.

A Superficial dissection.
Intrinsic back muscles, thoracolumbar fascia, posterior layer

Trapezius (cut)

Latissimus dorsi (cut)

Infraspinatus

Scapula, medial border

Infraspinatus

Teres minor

Scapula, medial border

Teres major

Latissimus dorsi (cut)

Serratus anterior

Serratus posterior inferior

External oblique

Superior nuchal line

Sternocleidomastoid

Semispinalis capitis

Splenius capitis

Splenius cervicis

Rhomboid minor

Levator scapulae

Rhomboid major

Clavicle

Acromion

Supraspinatus

Scapular spine

Scapula, medial border

Infraspinatus

Teres minor

Teres major

Latissimus dorsi (cut)

Serratus anterior

Serratus posterior inferior

External oblique

Thoracolumbar fascia, posterior layer

Internal oblique

B Deep dissection. Partially removed: Trapezius and latissimus dorsi.
Posterior Muscles of the Shoulder & Arm (II)

**Fig. 2.22 Posterior muscles of the shoulder and arm: Dissection**
Right arm, posterior view. Muscle origins are shown in red, insertions in blue.

A Removed: Rhomboids major and minor, serratus anterior, and levator scapulae.

B Removed: Deltoid and forearm muscles.
C Removed: Supraspinatus, infraspinatus, and teres minor. Partially removed: Triceps brachii.

D Removed: Triceps brachii and teres major.
**Muscle Facts (I)**

The actions of the three parts of the deltoid muscle depend on their relationship to the position of the humerus and its axis of motion. At less than 60 degrees, the muscles act as adductors, but at greater than 60 degrees, they act as abductors. As a result, the parts of the deltoid can act antagonistically as well as synergistically.

**Fig. 2.23 Deltoid**
Right shoulder.

**Table 2.1 Parts of the deltoid**

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Innervation</th>
<th>Action *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deltoid</td>
<td>① Clavicular (anterior) part</td>
<td>Lateral one third of clavicle</td>
<td>Humerus (deltoid</td>
<td>Flexion, internal rotation,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>tuberosity)</td>
<td>adduction</td>
</tr>
<tr>
<td></td>
<td>② Acromial (lateral) part</td>
<td>Acromion</td>
<td>Axillary n. (C5, C6)</td>
<td>Abduction</td>
</tr>
<tr>
<td></td>
<td>③ Spinal (posterior) part</td>
<td>Scapular spine</td>
<td></td>
<td>Extension, external rotation,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>adduction.</td>
</tr>
</tbody>
</table>

* Between 60 and 90 degrees of abduction, the clavicular and spinal parts assist the acromial part with abduction.
**Fig. 2.24 Rotator cuff**
Right shoulder. The rotator cuff consists of four muscles: supraspinatus, infraspinatus, teres minor, and subscapularis.

**Table 2.2 Muscles of the rotator cuff**

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Innervation</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Supraspinatus</td>
<td>Scapula</td>
<td>Supraspinous fossa</td>
<td>Humerus (greater tubercle)</td>
<td>Suprascapular n. (C4–C6)</td>
</tr>
<tr>
<td>2 Infraspinatus</td>
<td>Scapula</td>
<td>Infraspinous fossa</td>
<td>Humerus</td>
<td>Axillary n. (C5, C6)</td>
</tr>
<tr>
<td>3 Teres minor</td>
<td>Scapula</td>
<td>Lateral border</td>
<td>Humerus (lesser tubercle)</td>
<td>Upper and lower subscapular nn. (C5, C6)</td>
</tr>
<tr>
<td>4 Subscapularis</td>
<td>Scapula</td>
<td>Subscapular fossa</td>
<td>Humerus</td>
<td></td>
</tr>
</tbody>
</table>
**Fig. 2.25** Pectoralis major and coracobrachialis
Anterior view.

**A** Schematic.

**B** Pectoralis major in neutral position (left) and elevation (right).

<table>
<thead>
<tr>
<th>Table 2.3</th>
<th>Pectoralis major and coracobrachialis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Muscle</strong></td>
<td><strong>Origin</strong></td>
</tr>
<tr>
<td>Pectoralis major</td>
<td>① Clavicular part</td>
</tr>
<tr>
<td>② Sternocostal part</td>
<td>Sternum and costal cartilages 1–6</td>
</tr>
<tr>
<td>① Abdominal part</td>
<td>Rectus sheath (anterior layer)</td>
</tr>
<tr>
<td>① Coracobrachialis</td>
<td>Scapula (coracoid process)</td>
</tr>
</tbody>
</table>
**Fig. 2.26 Subclavius and pectoralis minor**  
Right side, anterior view.

**Fig. 2.27 Serratus anterior**  
Right lateral view.

---

**Table 2.4 Subclavius, pectoralis minor, and serratus anterior**

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Innervation</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subclavius</td>
<td>1st rib</td>
<td>Clavicle (inferior surface)</td>
<td>N. to subclavius (C5, C6)</td>
<td>Steadies the clavicle in the sternoclavicular joint</td>
</tr>
<tr>
<td>Pectoralis minor</td>
<td>3rd to 5th ribs</td>
<td>Coracoid process</td>
<td>Medial pectoral n. (C8, T1)</td>
<td>Draws scapula downward, causing inferior angle to move posteromedially; rotates glenoid inferiorly; assists in respiration</td>
</tr>
<tr>
<td>Serratus anterior</td>
<td>Superior part</td>
<td>Scapula (costal and dorsal surfaces of superior angle)</td>
<td>Long thoracic n. (C5–C7)</td>
<td>Superior part: lowers the raised arm</td>
</tr>
<tr>
<td></td>
<td>Intermediate part</td>
<td>Scapula (costal surface of medial border)</td>
<td></td>
<td>Entire muscle: draws scapula laterally forward; elevates ribs when shoulder is fixed</td>
</tr>
<tr>
<td></td>
<td>Inferior part</td>
<td>Scapula (costal surface of medial border and costal and dorsal surfaces of inferior angle)</td>
<td></td>
<td>Inferior part: rotates inferior angle of scapula laterally forward (allows elevation of arm above 90°)</td>
</tr>
</tbody>
</table>
**Fig. 2.28 Trapezius**
Posterior view.

**Fig. 2.29 Levator scapulae with rhomboids major and minor**
Right side, posterior view.

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Innervation</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>① Trapezius</td>
<td>Occipital bone; spinous processes of C1–C7</td>
<td>Clavicle (lateral one third)</td>
<td>Accessory n. (CN XI); C3–C4 of cervical plexus</td>
<td>Draws scapula obliquely upward; rotates glenoid cavity superiorly; tilts head to same side and rotates it to opposite</td>
</tr>
<tr>
<td>② Trapezius</td>
<td>Aponeurosis at T1–T4 spinous processes</td>
<td>Acromion</td>
<td></td>
<td>Draws scapula medially</td>
</tr>
<tr>
<td>③ Trapezius</td>
<td>Spinous processes of T5–T12</td>
<td>Scapular spine</td>
<td></td>
<td>Draws scapula medially downward</td>
</tr>
<tr>
<td>④ Levator scapulae</td>
<td>Transverse processes of C1–C4</td>
<td>Scapula (superior angle)</td>
<td>Dorsal scapular n. and cervical spinal nn. (C3–C4)</td>
<td>Draws scapula medially upward while moving inferior angle medially; inclines neck to same side</td>
</tr>
<tr>
<td>⑤ Rhomboid minor</td>
<td>Spinous processes of C6, C7</td>
<td>Medial border of scapula above (minor) and below (major) scapular spine</td>
<td></td>
<td>Steadies scapula; draws scapula medially upward</td>
</tr>
<tr>
<td>⑥ Rhomboid major</td>
<td>Spinal processes of T1–T4 vertebrae</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CN, cranial nerve.
Fig. 2.30 Latissimus dorsi and teres major
Posterior view.

A Latissimus dorsi, schematic.

B Latissimus dorsi and teres major.

C Teres major, schematic.

D Insertion of the latissimus dorsi on the floor of the intertubercular groove and the teres major on the crest of the lesser tubercle of the humerus.

Table 2.6 Latissimus dorsi and teres major

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Innervation</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latissimus dorsi</td>
<td>① Vertebral part</td>
<td>Spinal processes of T7–T12 vertebrae; thoracolumbar fascia</td>
<td>Thoracodorsal n. (C6–C8)</td>
<td>Internal rotation, adduction, extension, respiration (“cough muscle”)</td>
</tr>
<tr>
<td></td>
<td>② Scapular part</td>
<td>Scapula (inferior angle)</td>
<td>Floor of the intertubercular groove of the humerus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>③ Costal part</td>
<td>9th to 12th ribs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>④ Iliac part</td>
<td>Iliac crest (posterior one third)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teres major</td>
<td>⑤ Scapula (inferior angle)</td>
<td>Crest of lesser tubercle of the humerus (anterior angle)</td>
<td>Lower subscapular n. (C5, C6)</td>
<td>Internal rotation, adduction, extension</td>
</tr>
</tbody>
</table>
The anterior and posterior muscles of the arm may be classified respectively as flexors and extensors relative to the movement of the elbow joint. Although the coracobrachialis is topographically part of the anterior compartment, it is functionally grouped with the muscles of the shoulder (see p. 26).

**Fig. 2.31 Biceps brachii and brachialis**
Right arm, anterior view.

**Table 2.7 Anterior muscles: Biceps brachii and brachialis**

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Innervation</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biceps brachii</td>
<td>① Long head</td>
<td>Supragnoid tubercle of scapula</td>
<td>Radial tuberosity and bicipital aponeurosis</td>
<td>Musculocutaneous n. (C5–C6) Elbow joint: flexion; supination* Shoulder joint: flexion; stabilization of humeral head during deltoid contraction; abduction and internal rotation of the humerus</td>
</tr>
<tr>
<td></td>
<td>② Short head</td>
<td>Coracoid process of scapula</td>
<td></td>
<td></td>
</tr>
<tr>
<td>① Brachialis</td>
<td>Humerus (distal half of anterior surface)</td>
<td>Ulnar tuberosity</td>
<td>Musculocutaneous n. (C5–C6) and radial n. (C7, minor)</td>
<td>Flexion at the elbow joint</td>
</tr>
</tbody>
</table>

* Note: When the elbow is flexed, the biceps brachii acts as a powerful supinator because the lever arm is almost perpendicular to the axis of pronation/supination.
**Fig. 2.32 Triceps brachii and anconeus**
Right arm, posterior view.

Table 2.8 Posterior muscles: Triceps brachii and anconeus

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Innervation</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triceps brachii</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>① Long head</td>
<td>Scapula (infraglenoid tubercle)</td>
<td>Olecranon of ulna</td>
<td>Radial n. (C6–C8)</td>
<td>Elbow joint: extension</td>
</tr>
<tr>
<td>② Medial head</td>
<td>Posterior humerus, distal to radial groove; medial intermuscular septum</td>
<td></td>
<td></td>
<td>Shoulder joint, long head: extension and adduction</td>
</tr>
<tr>
<td>③ Lateral head</td>
<td>Posterior humerus, proximal to radial groove; lateral intermuscular septum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anconeus</td>
<td>Lateral epicondyle of humerus (variance: posterior joint capsule)</td>
<td>Olecranon of ulna</td>
<td></td>
<td>Extends the elbow and tightens its joint</td>
</tr>
</tbody>
</table>