Anatomy of the Upper Limb: Axilla and Brachial Plexus

The axilla is the entrance to the upper limb, providing a smooth transition between the neck and the arm. This article provides an overview of the structure and contents located within the axilla.

Structure of the Axilla

The axilla is a pyramid-shaped space located between the upper thoracic wall and the arm:

- The base of the pyramid is made by the hair and sweat gland-bearing axillary skin.
- The apex of the pyramid is the axillary inlet, located between the first rib, the scapula, and the clavicle.
- The pyramid has four converging walls: anterior, medial, lateral, posterior

The apex of the axilla is continuous with the neck superiorly whereas the lateral part of the base continues into the arm.
Boundaries of the Axilla

Axillary inlet

Also called the apex of the axilla, it is directed upwards and medially into the root of the neck. This narrow space is bound:

- medially by the outer border of the first rib
- anteriorly by the posterior surface of the clavicle
- posteriorly by the upper border of the scapula

Major vessels and nerves enter the axilla from the neck by passing through the axillary inlet and hence, this passage is also called the cervicoaxillary canal.

Anterior wall of the axilla

The anterior wall is formed by:

- superficially, the pectoralis major
- the pectoralis minor and subclavius muscles, both enclosed by the clavipectoral fascia. All these structures lie deep to the pectoralis major.

The lower margin of the pectoralis major muscle forms the anterior axillary fold, that marks the anteroinferior margin of the axilla.

The clavipectoral fascia is a strong, thick sheet of connective tissue that attaches to the clavicle, splits to enclose the pectoralis minor and subclavius muscles and then continues as the suspensory ligament of the axilla to join the axillary skin in forming the base of the axilla.

Medial wall of the axilla

It is formed by:

- the upper four ribs and their intercostal muscles
- the upper part of the serratus anterior muscle.

The intercostobrachial nerve traverses the medial wall into the axilla. This nerve is the lateral cutaneous branch of the second intercostal nerve and supplies the skin of the upper posteromedial part of the arm.

The long thoracic nerve descends through the cervicoaxillary canal posterior to the brachial plexus and the axillary artery and vein, resting on the outer surface of the serratus anterior. It extends along the side of the thorax to the lower border of that muscle, supplying filaments to each of its digitations.

Identification of the two nerves is very important during the dissection of the medial wall of the axilla for lymph node removal in breast cancer.

Lateral wall of the axilla

It is formed by:

- the upper part of the shaft of the humerus (near the intertubercular sulcus)
- the coracobrachialis and short head of the biceps brachii muscles.
Posterior wall of the axilla

The posterior wall is formed by:

- the **subscapularis** muscle above
- the **latissimus dorsi** and **teres major** muscles below.

The lower margin of the latissimus dorsi and teres major muscles forms a prominent ridge called the **posterior axillary fold**.

Floor of the axilla

The base of the axilla is formed by the skin and axillary fascia stretching between the inferior margins of the anterior and posterior walls.

Contents of the Axilla

Embedded in the axillary fat, the contents include:

1. the **axillary artery** and its branches
2. the **axillary vein** and its tributaries
3. branches of the **brachial plexus**
4. the **axillary lymph nodes** and associated lymphatics.

The **axillary sheath** is the extension of the prevertebral layer of the deep cervical fascia into the axilla and encloses the axillary vessels and brachial plexus.

Muscles Related to the Axilla

Muscles connecting the upper limb to the thoracic wall

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Nerve Supply</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pectoralis Major</td>
<td>Medial half of clavicle; Manubrium and body of the sternum; Upper six costal cartilages</td>
<td>Lateral lip of intertubercular sulcus of humerus</td>
<td>Medial and lateral pectoral nerves</td>
<td>Flexes, adducts and medially rotates the arm</td>
</tr>
<tr>
<td>Pectoralis Minor</td>
<td>Third, fourth and fifth ribs</td>
<td>Coracoid process of scapula</td>
<td>Medial pectoral nerve</td>
<td>Depresses scapula; elevates ribs</td>
</tr>
<tr>
<td>Subclavius</td>
<td>Junction between the first rib and costal cartilage</td>
<td>Inferior surface of the clavicle</td>
<td>Nerve to subclavius</td>
<td>Depresses the lateral part of the clavicle</td>
</tr>
<tr>
<td>Serratus Anterior</td>
<td>Upper eight ribs</td>
<td>Medial border and inferior angle of scapula</td>
<td>Long thoracic nerve</td>
<td>Protraction and rotation of scapula (Transaction leads to a winged scapula)</td>
</tr>
</tbody>
</table>

Muscles connecting the scapula to the humerus (scapulohumeral muscles)

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Nerve Supply</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deltoid</td>
<td>Lateral third of clavicle; acromion; spine of scapula</td>
<td>Deltoid tuberosity of humerus</td>
<td>Axillary nerve</td>
<td>Abducts arm; anterior fibres flex and medially rotate arm; posterior fibres extend and laterally rotate the arm</td>
</tr>
<tr>
<td>Supraspinatus</td>
<td>Supraspinous fossa of the scapula</td>
<td>Greater tubercle of the humerus</td>
<td>Suprascapular nerve</td>
<td>Abducts arm, a muscle of the rotator cuff</td>
</tr>
<tr>
<td>Infraspinatus</td>
<td>Infraspinous fossa of the scapula</td>
<td>Greater tubercle of the humerus</td>
<td>Suprascapular nerve</td>
<td>L laterally rotates the arm, a muscle of the rotator cuff</td>
</tr>
<tr>
<td>Teres Major</td>
<td>Dorsal surface of the lateral border and inferior angle of the scapula</td>
<td>Medial lip of the intertubercular sulcus of the humerus</td>
<td>Lower subscapular nerve</td>
<td>Medially rotates and adducts the arm</td>
</tr>
<tr>
<td>Teres Minor</td>
<td>Upper portion of the lateral border of the scapula</td>
<td>Greater tubercle of the humerus</td>
<td>Axillary nerve</td>
<td>L laterally rotates the arm, a muscle of the rotator cuff</td>
</tr>
<tr>
<td>Subscapularis</td>
<td>Subscapular fossa</td>
<td>Lesser tubercle of the humerus</td>
<td>Upper and lower subscapular nerves</td>
<td>Medially rotates and adducts arm, a muscle of the rotator cuff</td>
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A musculotendinous **rotator cuff** is formed around the **shoulder joint** by 4 scapulohumeral muscles, namely the **supraspinatus**, the **infraspinatus**, the **teres minor** and the **subscapularis** muscle. They serve as important dynamic stabilizers of the joint.
Muscles that pass through the axilla

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<tbody>
<tr>
<td>Coracobrachialis</td>
<td>Apex of coracoid process</td>
<td>Midshaft of humerus</td>
<td>Musculocutaneous nerve</td>
<td>Flexes and adducts the arm</td>
</tr>
<tr>
<td>Biceps brachii</td>
<td>Long head- supraglenoid tubercle of scapula; Short head- Apex of coracoid process</td>
<td>Tuberosity of radius</td>
<td>Musculocutaneous nerve</td>
<td>Flexes and supinates the forearm; flexes the arm</td>
</tr>
</tbody>
</table>

Axillary Artery

The central structure of the axilla, the **axillary artery** supplies the walls of the axilla. It begins as the continuation of the **subclavian artery** at the outer border of the first rib and ends at the lower border of the teres major muscle where it continues as the **brachial artery**.


It is divided into three parts by the **pectoralis minor** muscle in the axilla:

- first part: proximal to the pectoralis minor
- second part: underneath the pectoralis minor
- third part: distal to the pectoralis minor.

In total, the axillary artery gives six branches. They are as follows:

- 1 branch from the first part: the **superior thoracic artery**
- 2 branches from the second part: the **thoraco-acromial** and **lateral thoracic artery**
- 3 branches from the third part: the **subscapular**, the **anterior circumflex** and **posterior circumflex arteries**.

The **superior (or supreme) thoracic artery** supplies the muscles in the first and second anterior intercostal spaces.

The **thoraco-acromial artery** pierces the clavipectoral fascia and has deltoid, pectoral, clavicular and acromial branches.

The **lateral thoracic artery** supplies the pectoralis major, pectoralis minor, serratus anterior and the breast.

The **subscapular artery** is the largest branch of the axillary artery and its terminal branches are:
- **thoraco-dorsal artery**, which runs with the thoracodorsal nerve to supply the latissimus dorsi muscle.

- **circumflex scapular artery**, which passes posteriorly through the triangular space bounded by the teres minor and subscapularis above, the teres major below and the long head of the biceps brachii laterally. It anastomoses with the dorsal scapular and suprascapular arteries to create the scapular anastomosis.

A small branch called the **anterior circumflex artery** passes anteriorly to the surgical neck of the humerus to anastomose with its posterior counterpart.

The **posterior circumflex artery** runs posteriorly along with the axillary nerve to enter the quadrangular space bounded by teres major, the teres minor, the long head of triceps and humerus. It goes around the surgical neck of the humerus to anastomose with the anterior circumflex humeral artery, profunda brachii, suprascapular, and thoraco-acromial arteries.

**Axillary Vein**

The axillary vein begins as the continuation of the basilic vein at the lower border of the teres major muscle. It continues in the axilla medial to the axillary artery and crosses the outer border of the first rib to become the subclavian vein.

The tributaries of the axillary vein are:

1. Most tributaries generally follow the branches of the axillary artery.
2. the **brachial veins**, which follow the brachial artery.
3. the **cephalic veins** which run laterally in the arm and pierce the clavipectoral fascia to end in the axillary vein.

By receiving the thoraco-epigastric veins, the axillary vein serves as a collateral circulation in cases of **inferior vena cava obstruction**.
Brachial Plexus

The brachial plexus is a somatic nerve plexus derived from the lower cervical and upper thoracic spinal cord. After originating in the neck, it passes over the first rib and into the axilla to supply most of the innervation of the upper limb.

From medial to lateral, the parts of the brachial plexus are:

1. Roots

The roots of the brachial plexus are derived from the ventral rami of C5, C6, C7, C8 and T1. The roots pass between the *scalenus anterior* and *scalenus medius* muscles (interscalene groove) in the neck.

Though the most common origin of the roots is C4, C5, C6, C7, C8 and T1, the terms **prefixed and post-fixed plexus** indicate the shifting of the origin of the plexus by one segment either upward or downward respectively. For example, in a pre-fixed plexus, the contribution by C4 is large and T2 is absent and vice-versa in a post-fixed plexus.

2. Trunks

Upon leaving the roots, the brachial plexus organizes itself into trunks. Tree trunks are formed:

1. **upper trunk**, formed by the union of roots C5 and C6
2. **middle trunk**, formed by root C7
3. **lower trunk**, formed by the union of roots C8 and T1.
3. Divisions

Each trunk divides into ventral and dorsal divisions, that supply the anterior and posterior compartments of the limb respectively.

4. Cords

The three cords are:

1. **lateral cord**, formed by the union of the Ventral Divisions of the Upper and Middle Trunk (C5-C7)
2. **medial cord**, formed by the Ventral Division of the Lower Trunk (C8-T1)
3. **posterior cord**, formed by the union of the Dorsal Divisions of all three trunks (C5-T1).

Branches of the brachial plexus

1. **Branches of the roots**
   
   A. **Dorsal scapular nerve (C5)**, which supplies the rhomboid major and minor muscles and frequently the levator scapulae muscles.
   
   B. **Long thoracic nerve (C5-7)**, which supplies the serratus anterior muscles.

2. **Branches of the trunks**

   These nerves originate from the upper trunk.

   A. **Suprascapular nerve (C5-6)**, which supplies the supraspinatus and infraspinatus muscles. It passes through the posterior triangle of the neck, where it is accompanied by the suprascapular artery.
   
   B. **Nerve to subclavius (C5-6)**, which supplies the subclavius muscle and the sternoclavicular joint.

3. **Branches of the cords**

   A. From the lateral cord

      a. **Lateral pectoral nerve (C5-7)**, which supplies the pectoralis major muscle after piercing the clavipectoral fascia.

      b. **Musculocutaneous nerve (C5-7)**, which pierces the coracobrachialis muscle, moving between the biceps brachii and brachialis muscles, and supplies all three muscles to terminate as the **lateral cutaneous nerve of forearm**.

      c. **Lateral root of the median nerve (C5-7)**, which joins a similar branch from the medial cord to form the median nerve. The median nerve is responsible for opposition of the thumb (it innervates the tenor eminence) and for inducing the flexion of the first three fingers.

   B. From the medial cord

      a. **Medial pectoral nerve (C8, T1)**, which supplies the pectoralis major and minor muscles.

      b. **Medial cutaneous nerve of the arm (medial brachial cutaneous nerve) (C8, T1)**, which supplies the skin on the medial side of the arm and may communicate with the intercostobrachial nerve.
c. Medial cutaneous nerve of the forearm (medial antebrachial cutaneous nerve) (C8, T1), which supplies the skin on the medial side of the forearm.

d. Medial root of the median nerve (C8, T1), which joins with the lateral root to form the median nerve.

e. Ulnar nerve (C7-T1), a large nerve, that does not branch in the arm. The ulnar nerve is responsible for inducing flexion of the fourth and fifth finger.

C. From the posterior cord

a. Upper subscapular nerve (C5-6), which supplies the upper part of the subscapularis muscle.

b. Thoracodorsal nerve (C6-8), which supplies the latissimus dorsi muscle.

c. Lower subscapular nerve (C5-6), which supplies the lower part of the subscapularis and teres major muscles.

d. Axillary nerve (C5-6), which supplies both the deltoid and teres minor muscles.

e. Radial nerve (C5-T1), which is the largest terminal branch of the posterior cord. The radial nerve is responsible for extension of the wrist and fingers.

Injuries to roots, trunks, and cords of the brachial plexus produce characteristic deformities. These include:

- **Erb's palsy**: an undue separation of the head from the shoulder results in injury to the upper trunk, called Erb's palsy and is due to damage of the upper trunk C5–C6 nerves. The arm is adducted and medially rotated, with the forearm pronated and extended because of paralysis of the suprascapular nerve, musculocutaneous nerve, and the axillary nerve. The deformity is known as ‘policeman's tip hand’ or ‘porter’s tip hand’ because of paralysis and atrophy of the deltoid, biceps, and brachialis muscles. It is often due to dystocic delivery with the undue traction of the head away from the shoulder.

- **Klumpke’s paralysis**: this is caused by an undue abduction of the arm resulting in injury to the lower trunk of the brachial plexus.

Axillary Lymph Nodes

These group of lymph nodes receives lymphatics from the upper limb, the chest, mammary gland, shoulder, and neck. They are 20-30 in number and are divided into five groups, based on location:

1. anterior or pectoral
2. posterior or scapular
3. lateral
4. central
5. apical or infraclavicular: these drains all other nodes.

Efferent lymphatics from the apical group converge to form the subclavian trunk, that drains into the thoracic duct.

References
