Anatomy of the Upper Extremities: Muscles of the Shoulder and the Upper Arm

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The human shoulder is the most mobile joint of the body. Since it is a muscle-guided and muscle-stabilized joint, it is susceptible to instability and inflammation. It is essential for doctors to learn about the muscular stabilization of the shoulder joint and its functional anatomy. We can imagine how tiring (if not impossible) a life without a properly functioning shoulder joint would be. The muscle groups of the shoulder are distinguished by location and origin: the muscles of the shoulder and the muscles of the upper arm.
Rotator Cuff: The Anatomy

The rotator cuff is a group of muscles and tendons, surrounding the shoulder joint, that are essential for the mobility and the stability of the shoulder joint.

This group of muscles includes four skeletal muscles, which can be memorized, using the mnemonic “SITS”.

- the Supraspinatus muscle,
- the Infraspinatus muscle,
- the Teres minor muscle, and
- the Subscapularis muscle.

The flat tendons of these muscles are connected to the capsular ligament apparatus, stabilizing the shoulder joint.

Supraspinatus Muscle

The supraspinatus muscle runs from the supraspinatus fossa and inserts into the greater tubercle of the humerus. It is supplied by the suprascapular nerve (C5-C6), that arises from the upper trunk of Brachial plexus.

Functions of the Supraspinatus Muscle

The main functions of supraspinatus muscle include the abduction at the shoulder joint and humeral head depression. It plays an essential role in the scapulohumeral balance of the rotator cuff. It centers the humeral head in the glenoid cavity and, along with the deltoid muscle, prevents downward (inferior) subluxation of humerus.

Characteristics of the Supraspinatus Muscle

The anterior fibers of the supraspinatus tendon are connected to the subacromial bursa, while the deep fibers are grown into fibrous membrane and the surface parts of the Coracohumeral ligament. This allows the muscle to have a significant influence on the many structures of the capsular ligament. Therefore, the muscle reacts to the lesions of the structures to which it is connected. As a result, patients are often diagnosed with a muscle disorder, even though the muscle itself is not what caused the primary problem.
The muscle is often affected by the so-called **tendinopathy**. Tendinopathy is a non-inflammatory degenerative disease of tendons and tendon insertions, which may occur due to vascularisation disorders.

Tendons are supplied via a branch of the **humeral circumflex artery (distal)** and via the **suprascapular artery**.

Motions of the shoulder such as extreme adduction or abduction can lead to increased pressures to the head of humerus. This may lead to vascular congestion resulting in decreased blood supply to the structures. This should be taken into consideration if a patient has to spend a long period of time in a fixed position.

Another cause of tendinopathy is the damage of the tendon tissue by an abnormal abrasion at the narrowed subacromial space.

The so-called **calcific tendinitis** causes calcification in the shoulder joint; however, this phenomenon usually affects the supraspinatus tendon. In some cases, calcium may infiltrate the subacromial bursa or the joint capsule, resulting in pain and restriction of movements.
Infraspinatus Muscle

The **infraspinatus muscle** arises from the **infraspinous fossa** of the scapula and attaches to the middle facet of the greater tubercle of the humerus. It is innervated by the **suprascapular nerve (C5-C6)** that arises from the upper trunk of Brachial plexus.

**Characteristics of the Infraspinatus Muscle**

The insertion area of the **infraspinatus muscle** is fused together with the fibers of the **teres minor**, thus separating the **teres major**.

**Function of the Infraspinatus Muscle**

The **infraspinatus muscle** is the main external (lateral) rotator at the shoulder joint. It can perform both **adduction and abduction** and it reinforces the shoulder by connecting to the dorsal capsule, while centering the head of the humerus in the glenoid.

**Clinical Significance of the Infraspinatus Muscle**

Sudden movements, like reaching backward suddenly or breaking a fall can irritate the **infraspinatus muscle** and cause pain. Patients describe pain during extension and lateral rotation or are no longer able to lie on the affected side. A patient with such symptoms should be advised to protect the affected side and find a position of ease when sleeping.

Teres Minor Muscle

The **Teres Minor** arises from the middle section of the **scapula** and is inserted into the caudal impression on the great tubercle. It is innervated by the **axillary nerve (C5-C6)**, arises from the posterior cord of the brachial plexus.

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Nerve supply</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infraspinatus</td>
<td>Infraspinous fossa</td>
<td>Middle facet of greater tubercle of humerus</td>
<td>Suprascapular nerve (C5)</td>
<td>Laterally rotates shoulder joint.</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>Holds head of humerus in glenoid cavity</td>
</tr>
<tr>
<td>Teres minor</td>
<td>Later border of scapula, middle portion</td>
<td>Inferior facet of greater tubercle of humerus</td>
<td>Axillary nerve (C6)</td>
<td></td>
</tr>
</tbody>
</table>

**Characteristics of the Teres Minor Muscle**
Some of the deep fibers fuse together with the joint capsule just near the point of muscle attachment and are directly connected to the infraspinatus muscle. Thus, they share the functions of extension and external rotation. It forms one of the boundaries of the quadrangular space that serves as an outer opening for the axillary nerve and the posterior circumflex humeral artery with accompanying veins and lymphatic vessels.

**Function of the Teres Minor Muscle**

Besides helping hold the humeral head in the glenoid cavity of the scapula and stabilizing the shoulder joint, it also performs the external rotation and the adduction of the arm at the shoulder joint.

**Clinical Significance of the Teres Minor Muscle**

Since Teres Minor forms one of the boundaries of the Quadrangular space, any morphological change, trauma or edema can narrow the space and cause irritation of the passing structures. The irritation of the axillary nerve results in the restriction of mobility of the teres muscle and the deltoid muscle affecting the abduction of the arm. Long-term complications include disorders of the skin sensitivity of the lateral shoulder region.

**Subscapularis Muscle**
The **subscapularis muscle** arises from the **subscapular fossa** of the **scapula** and inserts into the **lesser tubercle** of the humerus.

Innervation of the **subscapularis** is via the **upper and lower subscapular nerves** (C5-C6).

**Characteristics of the Subscapularis Muscle**

The name, the origin, and the innervation of the muscle are identical to the medical term “subscapularis” and therefore are easy to memorize. Some deep fibers are fused together with the ventral capsular ligament, which provides stability. Another characteristic of this muscle is that it forms an intermediate tendon in its center, from which the muscle fibers arise. This is where the muscle gains its wide and flat anatomy.

**Function of the Subscapularis Muscle**

The subscapularis muscle is the only muscle to allow for **internal rotation** with the rotator cuff. Aside from preventing the displacement of the humeral head and the ventral dislocation, it also fixates the biceps tendon in the intertubercular groove. It also allows for **adduction** of the arm at the shoulder joint.

**Clinical Significance of the Subscapularis Muscle**

When the innervation of the subscapularis muscle is impaired, the upper extremity falls into an unnatural position of external rotation.

**Rotator Cuff: A Look at the Pathology**

Rotator cuff tear is the most common clinical manifestation of this muscle group. It usually occurs around the age of 50 to 60 years, commonly due to circulatory disorders, chronic inflammatory processes or injury. About 95% of partial and full-thickness tears affect the supraspinatus muscle. There are several types of rotator cuff tear, according to the scale of severity and form, as classified by Ellman.

**Classification of the Partial tears by Ellman:**

| Ellman Grade I | Thickness < 1/4 oder < 3mm |
Classification of the Full-Thickness Tears by Bateman:

| Bateman Grade I | < 1cm |
| Bateman Grade II | 1-3cm |
| Bateman Grade III | 3-5cm |
| Bateman Grade IV | > 5cm |

Classification of Full-Thickness Tears by Ellman:

<table>
<thead>
<tr>
<th>Transverse Tear at the insertion location</th>
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</thead>
<tbody>
<tr>
<td>Crescent Transverse tear with the deformation through SSC/ISP</td>
</tr>
<tr>
<td>L-shaped Transverse tear with an expansion into the interval between SSP and ISP</td>
</tr>
<tr>
<td>Reverse L Transverse tear with an expansion into rotator interval</td>
</tr>
<tr>
<td>Trapezoidal L-shaped + Reverse L</td>
</tr>
<tr>
<td>Massive Tear Full-Thickness Rotator Cuff Tears Expansion into the teres minor or into the anterior SSC</td>
</tr>
</tbody>
</table>

Shoulder Muscles at the End of the Humerus

This muscle group includes the skeletal muscles that are attached to the head of the humerus which perform direct and indirect functions of the shoulder joints. However, their origin is found in the osseous structures and they are not to be included in the rotator cuff.

Deltoid Muscle

The deltoid originates in three distinct sets of fibers: **acromial**, **clavicular**, and **spinal**. All three fibers converge toward their insertion on the deltoid tuberosity and are innervated by the **axillary nerve (C5-C6)**. They are all involved in arm abduction and prevent the dislocation of the humeral head. However, the origin and the secondary
functions, such as synergistic movements, of the three fibers should be distinguished.

**Acromial fibers** arise from the lateral acromion, **clavicular fibers** arise from the lateral and caudal clavicle, and **spinal fibers** arise from the caudal part of the spine of the scapula.

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
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</tr>
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</table>
| Deltoid      | **Clavicular head:** lateral third of clavicle  
  **Acromial head:** acromium  
  **Spinal head:** spine of scapula | Deltoid tuberosity of humerus | Axillary nerve (C5) | Clavicular head: flexes and medially rotates shoulder joint  
  Acromial head: abducts shoulder  
  Spinal head: extends and laterally rotates shoulder joint |
| Supraspinatus | Supraspinous fossa                          | Superior facet of greater tubercle of humerus | Suprascapular nerve (C5,6) | Initiates and assists deltoid in abduction |

**Characteristics of the Deltoid Muscle**

The deltoid muscle is the reference muscle for the **C5 dermatome**.

**Function of the Deltoid Muscle**

Due to their extensive origin and routes, the three fibers of the deltoid muscle can perform various secondary functions and synergistic movements. Acromial fibers do not have any secondary functions.

| Clavicular fibers | • Internal rotation of the shoulder joint by adduction  
  • Flexion in front of the body  
  • Adduction in front of the body |
| Spinal fibers     | • External rotation of the shoulder joint by internal rotation  
  • Extension and adduction behind the back |
| Clavicular fibers + spinal fibers | • The last third part of the adduction of the shoulder joint  
  • Abduction of the shoulder joint |
| Spinal fibers + Acromial fibers | • Flexion of the shoulder joint  
  • Extension of the shoulder girdle |

**Clinical Significance of the Deltoid Muscle**

Atrophy or weakness of the deltoid muscle, is almost always neurological, likely due to a lesion of the **C5 root** or its branches.

**Coracobrachialis muscle**

The Coracobrachialis arises from the apex of the **coracoid process** under the **short head of the biceps brachii**. It is inserted into an impression at the middle of the medial surface and border of the body of the humerus between the origins of triceps brachii and **brachialis**. It is innervated by the **musculocutaneous nerve** (C6-C7).

**Characteristics of the Coracobrachialis muscle**

The muscle creates an outlet opening for the musculocutaneous nerve.
Function of the Coracobrachialis muscle

The Coracobrachialis muscle is the weak flexor and adductor of the arm. It is also responsible for preventing the dislocation of the humerus.

Clinical Significance of the Coracobrachialis muscle

The musculocutaneous nerve can get trapped in the outlet opening if the muscle is morphologically impaired or altered. The continuous irritation of the nerve can lead to the motor dysfunction of biceps brachii and brachial (i.e. weakness). Patients will experience disturbances in sensation to the skin on the radial part of the forearm.

Pectoralis Major Muscle

Just like the deltoid muscle, the pectoralis major muscle originates in three distinct sets of fibers: clavicular fibers, sternal fibers, and abdominal fibers. From this extensive origin the fibers converge toward their insertion into the lateral lip of the bicipital groove of the humerus. The Pectoralis Major muscle, is innervated by the medial pectoral nerve and the lateral pectoral nerve (C5-T1). Its functions include flexion, adduction, and internal rotation.

The clavicular fibers arise from the medial end of the clavicle; the sternal fibers arise from the anterior surface of the sternum to as low as cartilage of the sixth rib; the abdominal fibers arise from the ventral leaf of the rectus sheath.

<table>
<thead>
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<th>Origin</th>
<th>Insertion</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Pectoralis major</td>
<td>Clavicular head: Anterior surface of medial clavicle&lt;br&gt;Sternocostal head: sternum and superior six costal cartilages</td>
<td>Lateral lip of intertubercular sulcus</td>
<td>Lateral and medial pectoral nerves (C5, C6-clavicular head; C7, C8-sternocostal head)</td>
<td>Adducts and medially rotates shoulder joint; pulls scapula anteriorly and inferiorly</td>
</tr>
<tr>
<td>Pectoralis minor</td>
<td>Ribs 3–5</td>
<td>Coracoid process of scapula</td>
<td>Medial pectoral nerves (C8, T1)</td>
<td>Stabilises scapula and pulls it anteriorly and inferiorly</td>
</tr>
<tr>
<td>Subclavius</td>
<td>Rib 1 and sternum junction</td>
<td>Middle third of clavicle</td>
<td>Subclavian nerve (C5)</td>
<td>Stabilises and depresses clavicle</td>
</tr>
</tbody>
</table>
Characteristics of the Pectoralis Major Muscle

The pectoralis major muscle forms the axilla, and its fibers rotate 180 degrees. When the arm is lifted, the fascial layer loosens and shifts back to neutral when the arm is dropped, to avoid restraining. The bicipital groove is located between the clavicular fibers and the sternal fibers and can be identified by palpation.

Function of the Pectoralis Major Muscle

The main functions of pectoralis major are flexion, adduction, and internal rotation of the arm. At the fixed end of the humerus, the pectoralis major muscle pulls the shoulder girdle in the ventral direction. Due to its location, it belongs to the chest (pectoral) muscle group.

Clinical Significance of the Pectoralis Major Muscle

In post-traumatic damage of the brachial plexus, the pectoralis major muscle can be transposed surgically in a partial manner to restore arm function.

Teres Major Muscle

The teres major muscle arises from the oval area on the dorsal surface of the inferior angle of the scapula and inserts into the medial lip of the intertubercular sulcus of the humerus near the insertion area of the latissimus dorsi muscle. It is innervated by the thoracodorsal nerve (C6-C7). It is responsible for the extension, adduction and internal rotation of the arm.

<table>
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</thead>
<tbody>
<tr>
<td>Teres major</td>
<td>Later border of scapula, inferior portion</td>
<td>Medial lip of intertubercular groove</td>
<td>Lower subscapular nerve (C6)</td>
<td>Adducts and medially rotates shoulder joint</td>
</tr>
<tr>
<td>Subscapularis</td>
<td>Subscapular fossa</td>
<td>Lesser tubercle of humerus</td>
<td>Upper and lower subscapular nerves (C6)</td>
<td>Medially rotates and adducts shoulder joint. Holds head of humerus in glenoid cavity</td>
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**Characteristics of the Teres Major Muscle**

The Teres Major muscle is often called ‘the younger brother of latissimus’. It’s function is synergistic with that of the latissimus dorsi muscle.

**Function of the Teres Major Muscle**

The main functions of Teres Major are the extension, adduction and internal rotation of the arm. **At the fixed end** of the arm, the teres major pulls the scapula outwards.

**Clinical Significance of the Teres Major Muscle**

The teres major muscle forms the boundaries of both the **quadrangular** and **triangular axillary spaces**. The **circumflex scapular artery** and the **axillary nerve** pass through the quadrangular space, while the **profunda brachii artery** and **radial nerve** pass through the triangular axillary space.

**Latissimus Dorsi Muscle**

The latissimus dorsi muscle originates in four distinct sets of fibers: **scapular fibers**, **costal fibers**, **vertebral fibers** and **iliac fibers**. All four fibers converge toward their insertion at the **middle of the medial surface and border of the body of the humerus**. They are innervated by the **thoracodorsal nerve** (C6-C8). The muscle performs extension, adduction and internal rotation.

The scapular fibers arise from the inferior angle of the scapula; the costal fibers originate between the tenth and the twelfth ribs, while the vertebral fibers arise from the **thoracolumbar fascia** and **vertebrae T7- T12** and **L1-L5**.
**Trapezius**

**Descending part:** superior nuchal line and external occipital protuberance  
**Transverse part:** nuchal ligament  
**Ascending part:** C7-T12 spinous processes

<table>
<thead>
<tr>
<th>Latissimus dorsi</th>
<th>T6–12 spinous processes, thoracolumbar fascia and iliac crest</th>
<th>Floor of intertubercular groove</th>
<th>Thoracodorsal nerve (C6, C7)</th>
<th>Extends, adducts and medially rotates shoulder joint</th>
</tr>
</thead>
</table>

**Characteristics of the Latissimus Dorsi Muscle**

Together with teres major, Latissimus dorsi rotates 180 degrees from its insertion point.

**Function of the Latissimus Dorsi Muscle**

The Latissimus dorsi muscle performs extension, adduction and internal rotation of the arm.

At the fixed end of the arm, the scapular fibers pull the scapula outwards. The costal fibers assist as an accessory muscle of inspiration and prevent the rib cage from expanding during coughing. Due to its location, it belongs to a group of pelvic wall muscles.

**Clinical Significance of the Latissimus Dorsi Muscle**

The Latissimus dorsi muscle is used for the breast reconstruction surgery in the so-called latissimus dorsi flap procedure.

**Muscles of the Upper Arm**

Compared to the group of shoulder muscles, the group of upper arm muscles is significantly smaller. It consists of ventral and dorsal muscle groups, each represented by only one muscle – the biceps brachii muscle as a flexor and the triceps brachii muscle as an extensor, respectively. The muscles of the upper arm are named from their origin on the humerus. However, this can quickly lead to confusion, since the brachioradialis muscle, for example, also originates on the humerus but belongs to the group of the radial muscles of the forearm. Literature provides different information, so medical students should learn from the latest books and muscle tables to avoid misunderstanding and confusion.

**Biceps Brachii Muscle**
The **biceps brachii** is a bifurcated skeletal muscle with fibers of two different origins. The longer head arises from the **supraglenoid tubercle**, while the shorter head arises from the **coracoid process**.

One tendon inserts into the **radial tuberosity**, while the other one, the **bicipital aponeurosis**, attaches to the **antebrachial fascia**. It is supplied by the **musculocutaneous nerve (C5,6)**. Both heads perform flexion and supination of the elbow.

**Characteristics of the Biceps Brachii Muscle**

Both bifurcated heads of the Biceps converge near the insertion of the **deltoid muscle** at the **deltoid tuberosity**.

**Function of the Biceps Brachii Muscle**

Besides their primary functions – flexion and supination of the elbow – both heads can separately perform different movements.

<table>
<thead>
<tr>
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<th>Origin</th>
<th>Insertion</th>
<th>Nerve supply</th>
<th>Function</th>
</tr>
</thead>
</table>
| **Biceps brachii** | **Long head:** supraglenoid tubercle  
**Short head:** coracoid process | Tuberosity of radius and forearm fascia via bicipital aponeurosis | Musculocutaneous nerve (C6) | Supinates forearm, and once supinated flexes elbow joint. Flexes shoulder |
| **Brachialis**  | Distal half of humerus           | Coronoid process and tuberosity of ulna       | Musculocutaneous nerve (C6) | Flexes elbow joint                            |
| **Coracobrachialis** | Coracoid process               | Middle third of humerus                       | Musculocutaneous nerve (C6) | Flexes and adducts shoulder joint             |

**Clinical Significance of the Biceps Brachii Muscle**

The most common injuries of the biceps brachii are the **tears in the muscles**. Two types of ruptures are distinguished: the proximal rupture and less commonly, distal rupture. Proximal rupture can be surgically repaired: the torn tendon is fixated to the brachialis muscle.
The triceps brachii is a three-headed skeletal muscle with fibers of three different origins.

The long head arises from the infraglenoid tubercle of the scapula.

The lateral head arises from the dorsal surface of the surgical neck of the humerus up to the deltoid tuberosity, from the lateral radial sulcus and the lateral intermuscular septum.

The medial head arises from the dorsal surface of the humerus, from the medial and distal radial sulcus to the olecranon fossa and from the medial and lateral intermuscular septum.

All three heads converge toward their insertion onto the olecranon process of the ulna and are innervated by the radial nerve (C6-C8). Their primary function is the extension of the elbow.

<table>
<thead>
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<th>Origin</th>
<th>Insertion</th>
<th>Nerve supply</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triceps brachii</td>
<td>Long head: infraglenoid tubercle</td>
<td>Olecranon</td>
<td>Radial nerve (C7, C8)</td>
<td>Extensor of elbow joint</td>
</tr>
<tr>
<td></td>
<td>Lateral head: posterior humerus, superior to</td>
<td></td>
<td></td>
<td>Long head also extends shoulder joint</td>
</tr>
<tr>
<td></td>
<td>radial groove</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Medial head: posterior humerus, inferior to</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>radial groove</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anconeus</td>
<td>Lateral epicondyle of humerus</td>
<td>Olecranon (lateral)</td>
<td>Radial nerve</td>
<td></td>
</tr>
</tbody>
</table>

Characteristics of the Triceps brachii muscle

The long head of the triceps brachii is a part of various axillary spaces. The largest part creates the quadrangular space, which carries the axillary nerve, and the triangular space, through which the radial nerve and the deep artery of the arm (profunda...
Function of the Triceps brachii muscle

The primary function of triceps brachii muscle is **extension** of the elbow. Along with its primary function, the long head of the triceps brachii is synergistic with the latissimus dorsi and teres major, which act as adductors and extensors of the arm at the shoulder joint. It is, however, also capable of the external rotation of the shoulder joint.

Clinical Significance of the Triceps brachii muscle

Similar to the biceps brachii, the triceps is also prone to tears. These tears can be repaired surgically.

The Characteristics of the Upper Extremities:

Common Exam Questions

Answer Key can be found below, after References.

1. **Which of the following muscles do not belong to the rotator cuff?**
   A. The supraspinatus muscle
   B. The infraspinatus muscle
   C. The teres minor muscle
   D. The subscapularis muscle
   E. The biceps brachii muscle

2. **Which of the following muscles is most frequently affected by the rotator cuff tear?**
   A. The supraspinatus muscle
   B. The infraspinatus muscle
   C. The teres minor muscle
   D. The subscapularis muscle
   E. The biceps brachii muscle

3. **Which of the following functions does the biceps brachii muscle not perform?**
   A. Flexion of the elbow
   B. Supination of the elbow
   C. Extension of the shoulder joint
   D. Flexion of the shoulder joint
   E. External rotation of the shoulder joint

References


Arbeitsgemeinschaft der medizinischen Fachgesellschaften. Rotatorenmanschettenruptur (Leitlinien)


**Correct answers:** 1A, 2A, 3E

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