Ultrasound and Magnetic Resonance anatomy of the arm - emphasis on the nerves

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Learning objectives

· To know the general anatomy of the arm.

· To identify the anatomic structures of the arm with ultrasound and MRI.

· To know the principal nerves of the arm and their locations.
Background

The arm is the part of the upper limb between the shoulder and the elbow. The humerus (arm single bone structure) and the internal and external intermuscular septa, which extend transversely from the internal and external edges of the humerus to the deep fascia of the arm, divide the arm in two compartments - anterior and posterior.

The anterior compartment comprises all the soft tissues situated before the humerus and intermuscular septa: the muscles biceps brachii, brachialis and coracobrachialis, the brachial artery and veins and nerves: musculocutaneous, median and some portions of the ulnar and radial.

Behind humerus and intermuscular septa is the posterior compartment where lies the triceps muscle and some portions of the radial and ulnar nerves.
Magnetic resonance imaging (MRI) is an excellent method to evaluate the neuromuscular structures of the arm. T1 weighted sequences allow depiction of anatomic detail of the muscles and the fascicular structure of the nerves. On T1-weighted images the muscles and the nerves have the same signal intensity (isointense). The axial plane is the most useful for assessment of the structures of the arm because of its longitudinal orientation, particularly the peripheral nerves (fig.1).

Ultrasonography (US) emerges as a first-line modality in the evaluation of the arm, namely the peripheral nerves because of its availability, low cost and higher soft-tissue resolution than MRI. On US normal muscle tissue appears relatively hypoechoic separated by fine hyperechoic septa. Normal peripheral nerves have a fascicular appearance in which the individual nerve fascicles are hypoechoic, surrounded by hyperechoic connective tissue. In short axis, peripheral nerves display a honeycomb or speckled appearance, which allows their identification (fig.2).

As it was mentioned before, the arm comprises the anterior and posterior compartment. In the anterior compartment the muscles are in 2 plans superficial and deep (fig. 3).

In the superficial plane there is the biceps brachii, made up of two heads (or parts) - the short head arises from the coracoid and the long starts in the supraglenoid tubercle of the scapula - which join in the middle third of the arm and inserts into the radial tuberosity. At the superolateral side lays the lower part of the deltoid muscle, inserting on the deltoid tubercle (fig.4).

In the deep plane are the coracobrachialis and brachialis muscles. The coracobrachialis muscle extends from the coracoid process to the middle third of the inner surface of the humerus, located internally to the brachialis. The brachialis muscle is located prior to the humerus and intermuscular septa, occupying the entire deep aspect of the lower half of the arm and inserts in the ulnar tuberosity (fig.4).

In the posterior compartment of the arm the only muscle is the triceps formed by three heads (or parts): long head (from the infraglenoid tubercle of the scapula), lateral head (posterior surface of the humerus superiorly to the radial nerve's groove) and medial head (inferiorly to the radial groove). The triceps muscle end in a tendon that is inserted in the olecranon (fig.5).

The coracobrachialis muscle (on the top half) and brachialis muscle (on the lower half) laterally, the fascia of the arm anterior and medially, biceps brachii superficially and the intermuscular septum deeply, delimit a space called the vasculonervous bundle of the arm (fig.6).
The brachial artery, a continuation of the axillary, begins at the inferior border of the tendon of teres major and ends at the level of the neck of the radius by dividing into the radial and ulnar arteries. The artery is accompanied by two veins satellites, one internal and one external.

In the upper arm the brachial artery, lies behind and internally to the coracobrachialis muscle and in this region is surrounded by the terminal branches of the brachial plexus: the median nerve is anterior and lateral, ulnar nerve is found medial and radial nerve is posterior. The musculocutaneous nerve runs through the coracobrachialis muscle.

The relations of arm nerve trunks change along the arm:

- the median nerve accompanies the brachial artery along the entire path of the arm, laterally to the artery in the upper arm and internally in relation to the artery in the distal arm between the biceps brachii and brachialis muscles (fig.7);
- the ulnar nerve is medial to the brachial artery up to the middle of the arm where it pierces the medial intermuscular septum, penetrating the posterior compartment (accompanied by the superior ulnar collateral artery). Then it descends anterior to the medial head of triceps to the interval between the medial epicondyle and the olecranon (fig.8);
- the radial nerve (along with the deep brachial artery) passes below the lower border of teres major, between the long head of triceps and the humerus. It then spirals obliquely across the back of the humerus in the radial groove. When it reaches the lateral side of the humerus, the radial nerve pierces the lateral intermuscular septum to enter the anterior compartment of the arm. There it lies in the deep groove between brachialis medially and brachioradialis and extensor carpi radialis longus laterally (fig.9);
- the musculocutaneous nerve after crossing the coracobrachialis muscle is positioned between the biceps brachii and the brachialis muscles (fig. 10).
Fig. 1: Axial T1 weighted imaging of the distal arm highlighting muscle (Mu) and nerve (Ne).

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Fig. 2: Ultrasound images of the posterior compartment (a) and the neurovascular bundle of the arm (b) showing the aspect of the muscle (Mu) and nerve (NE).

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Fig. 3: Axial T1 of the middle arm showing the anterior compartment (yellow area), posterior compartment (red area) separated by the humerus and medial (orange line) and lateral (blue line) intermuscular septa.

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Fig. 4: Axial T1 weighted images in different levels showing the anterior compartment muscles: BB (biceps brachii), Br (brachialis), CoB (coracobrachialis) and De (deltoid)

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Fig. 5: Fig. 5 - Axial T1 weighted images in different levels showing the posterior compartment triceps muscle: long head (TLoH), lateral head (TLaH) and medial head (TMH). Triceps Tendon (TT).

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**Fig. 6:** Axial T1 weighted images in different levels showing the vasculonervous bundle. BB (biceps brachii), Br (brachialis), CoB (coracobrachialis), medial head of triceps (TMH), medial intermuscular septum (orange line) and fascia of the arm (F).

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Fig. 7: Axial T1 weighted images in different levels (a, b) and ultrasound image (c) highlighting the median nerve (blue circle).

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**Fig. 8:** Fig. 8 - Axial T1 weighted images in different levels highlighting the ulnar nerve (orange circle).

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**Fig. 9:** Fig. 9 - Axial T1 weighted images in different levels (a, b, c) and ultrasound image (d) highlighting the radial nerve (green circle).

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Fig. 10: Fig. 10 - Ultrasound image (a) highlighting the musculocutaneous nerve (red circle) crossing the coracobrachialis (CoB) muscle. Axial T1 weighted image showing the expected location of the musculocutaneous nerve (red circle) between the biceps brachii (BB) and brachialis (Br).

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Conclusion

The detailed knowledge of the normal anatomy of the arm is fundamental for a correct evaluation of this anatomical structure. Ultrasound and MRI appear as the main methods for evaluating the different compartments of the arm and particularly the nerves.
References


