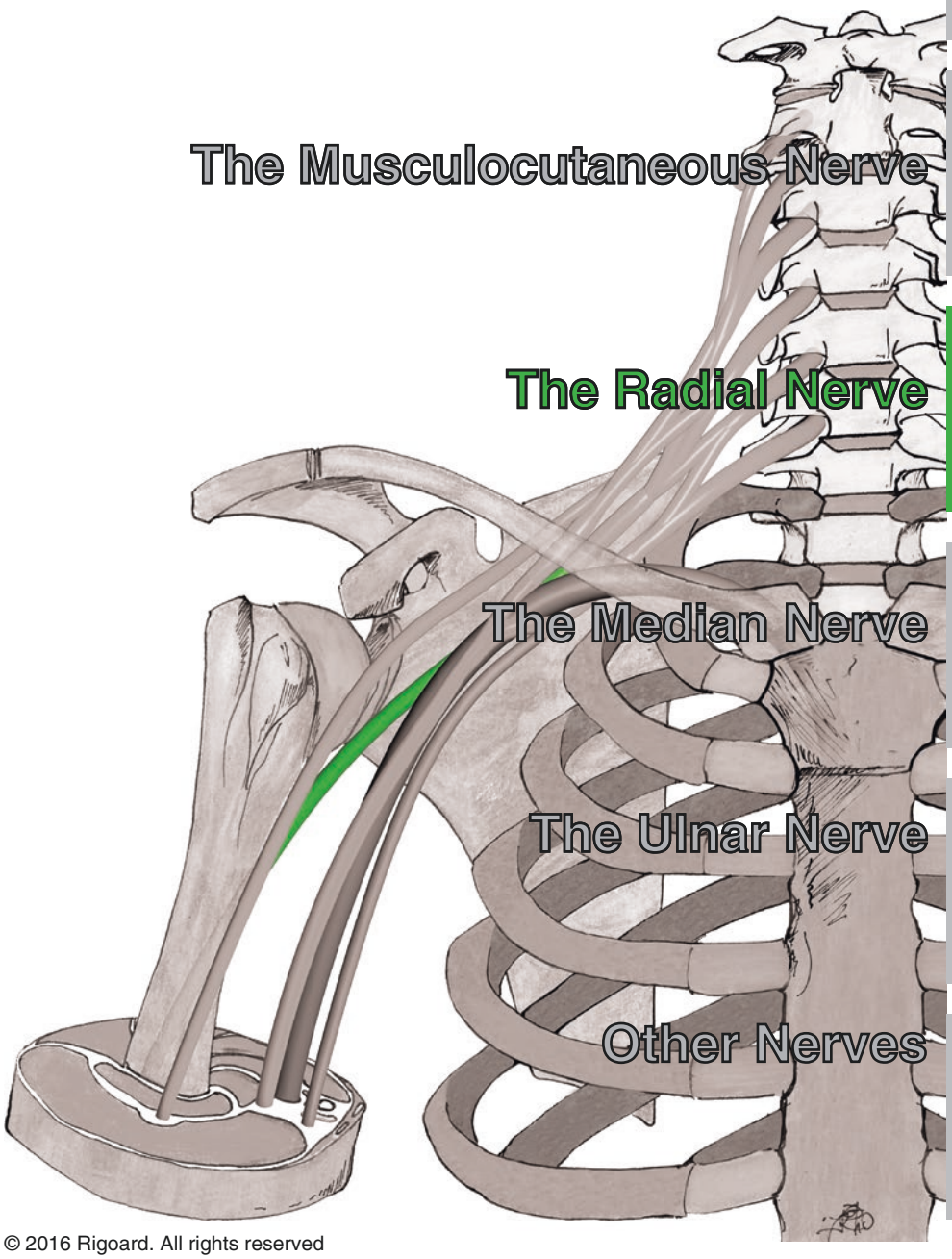


Morphological Data

The radial nerve corresponds to the most voluminous terminal branch of the brachial plexus. It receives branches from all three of the brachial plexus trunks (Figure R1).

Origin

The radial nerve constitutes of nerve fibres coming from the C5, C6, C7, C8 and T1 roots (Figures R1 and R2). It forms the main terminal branch of the posterior bundle, which gave rise to the axillary nerve slightly above. It is situated at the level of the posterior bundle's origin, behind the axillary artery. At this point, the median nerve is found in front of the artery, and the musculocutaneous nerve is situated laterally. The radial nerve leans against the subscapularis muscle (Figure Ax3) then crosses, in order from top to bottom, the tendons of the latissimus dorsi and the teres major (Figures R3, R4 and R10).

Path

The radial nerve enters the posterior compartment of the arm going through the lower axillary space, accompanied by the brachial artery, between the long head of the triceps brachii and its lateral head. It obliquely crosses the posterior aspect of the humerus in a specific groove (Figures R2 and R11) whilst being under the lateral head of the triceps brachii (Figure R3). The insertions of the lateral and medial heads of the triceps brachii are above and below the humeral groove of the radial nerve, respectively.

This particularly sensitive area of the nerve corresponds to the most common nerve injury that occurs in diaphyseal fractures of the humerus (Figures R12 and R13).

At the end of this groove, it goes through the lateral intermuscular septum in order to penetrate the anterior compartment of the arm, between the brachioradialis muscle laterally and the brachialis medially (Figures R3, R8 and R12).

At the lateral epicondyle, the radial nerve is situated at the level of the lateral bicipital groove, in relation with the biceps brachialis and brachialis muscle medially and the brachioradialis muscle and the extensor carpi radialis longus laterally. At that level or several centimetres below, it divides into two terminal branches (Figures R3, R5 and R13).

Neurovascular Relations

At its origin, the radial nerve faces the axillary artery in front.

In the arm, it initially follows the path of the deep brachial artery and faces it laterally. At the midsection of the arm, it is crossed behind by the medial collateral artery, which is a branch of the profunda brachii artery. Then, the radial nerve follows the path of the radial collateral artery, which is a prolongation of the profunda brachii artery (Figure R4).

In the elbow, it faces the lateral epicondyle and the radial recurrent artery medially (Figure R6).

In the middle of the forearm, the superficial branch of the radial nerve joins the path of the radial artery that it faces

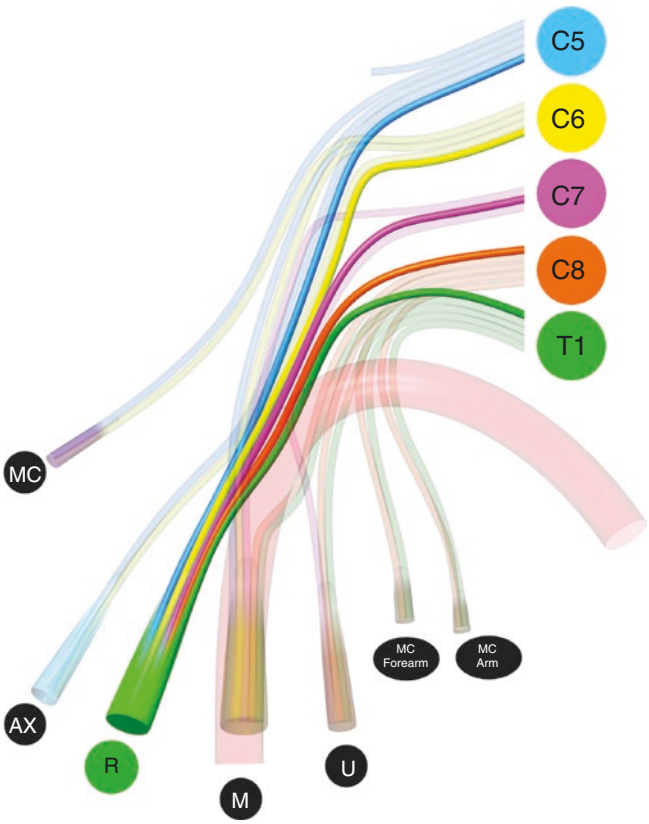


Figure R1. Origin of the radial nerve

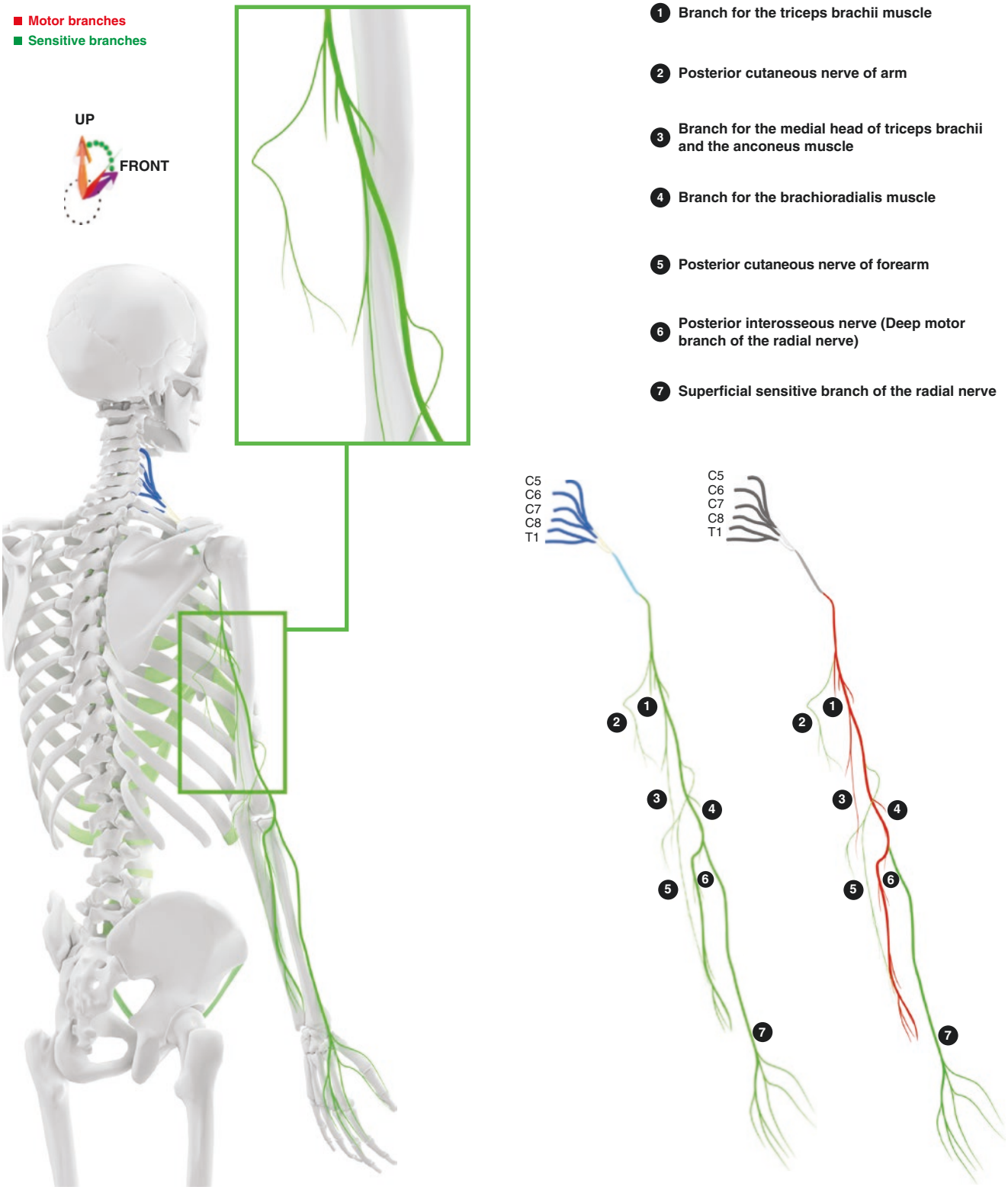


Figure R2. Topographical distribution of the radial nerve and its relations with bones

The Radial Nerve

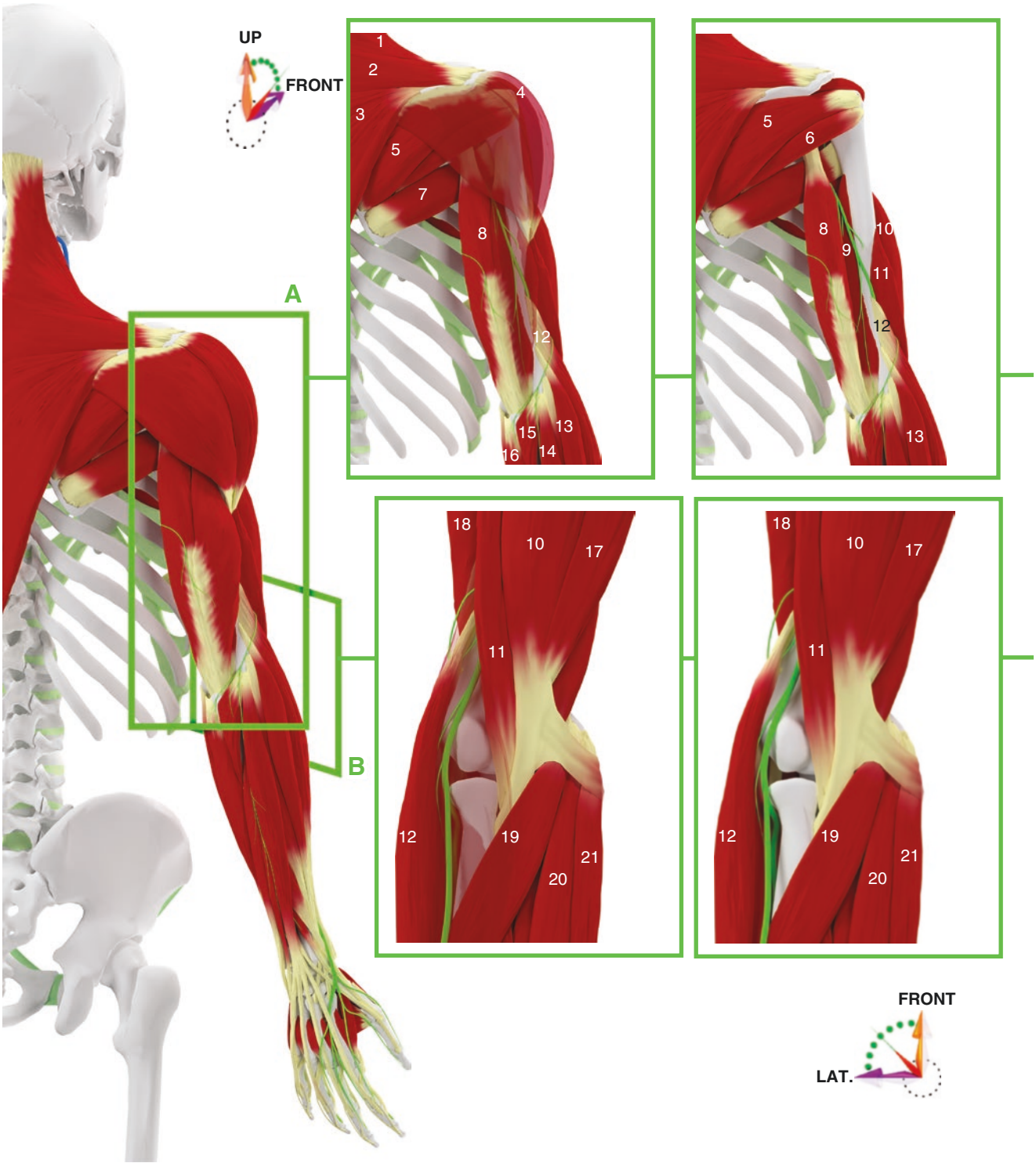
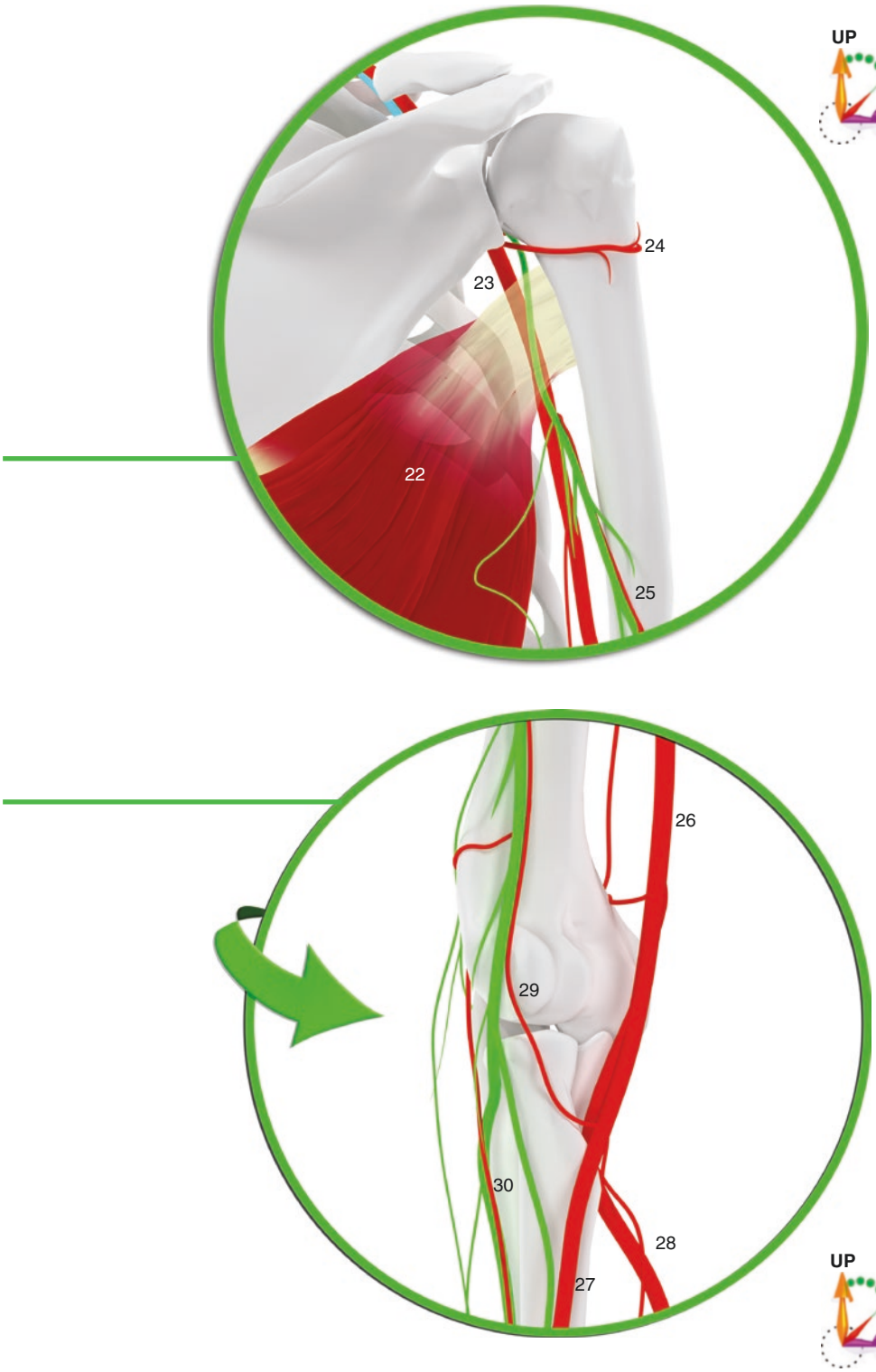


Figure R3. Path and relations of the radial nerve in the arm and elbow



1- Superior fibres of the trapezius muscle
2- Middle fibres of the trapezius muscle
3- Inferior fibres of the trapezius muscle
4- Deltoid muscle
5- Infraspinatus muscle
6- Teres minor muscle
7- Teres major muscle
8- Long head of the triceps brachii muscle
9- Medial head of the triceps brachii muscle
10- Lateral head of the biceps brachii muscle
11- Brachialis muscle
12- Brachioradialis muscle
13- Extensor carpi radialis longus muscle
14- Extensor digitorum muscle
15- Anconeus muscle
16- Flexor carpi ulnaris muscle
17- Medial head of the biceps brachii muscle
18- Lateral head of the triceps brachii muscle
19- Pronator teres muscle
20- Flexor carpi radialis muscle
21- Palmaris longus muscle
22- Latissimus dorsi muscle
23- Axillary artery
24- Posterior humeral circumflex artery
25- Deep brachial artery
26- Brachial artery
27- Radial artery
28- Ulnar artery
29- Radial recurrent artery
30- Posterior interosseous artery

Figure R4. Vascular relations of the radial nerve in the arm and elbow

The Radial Nerve

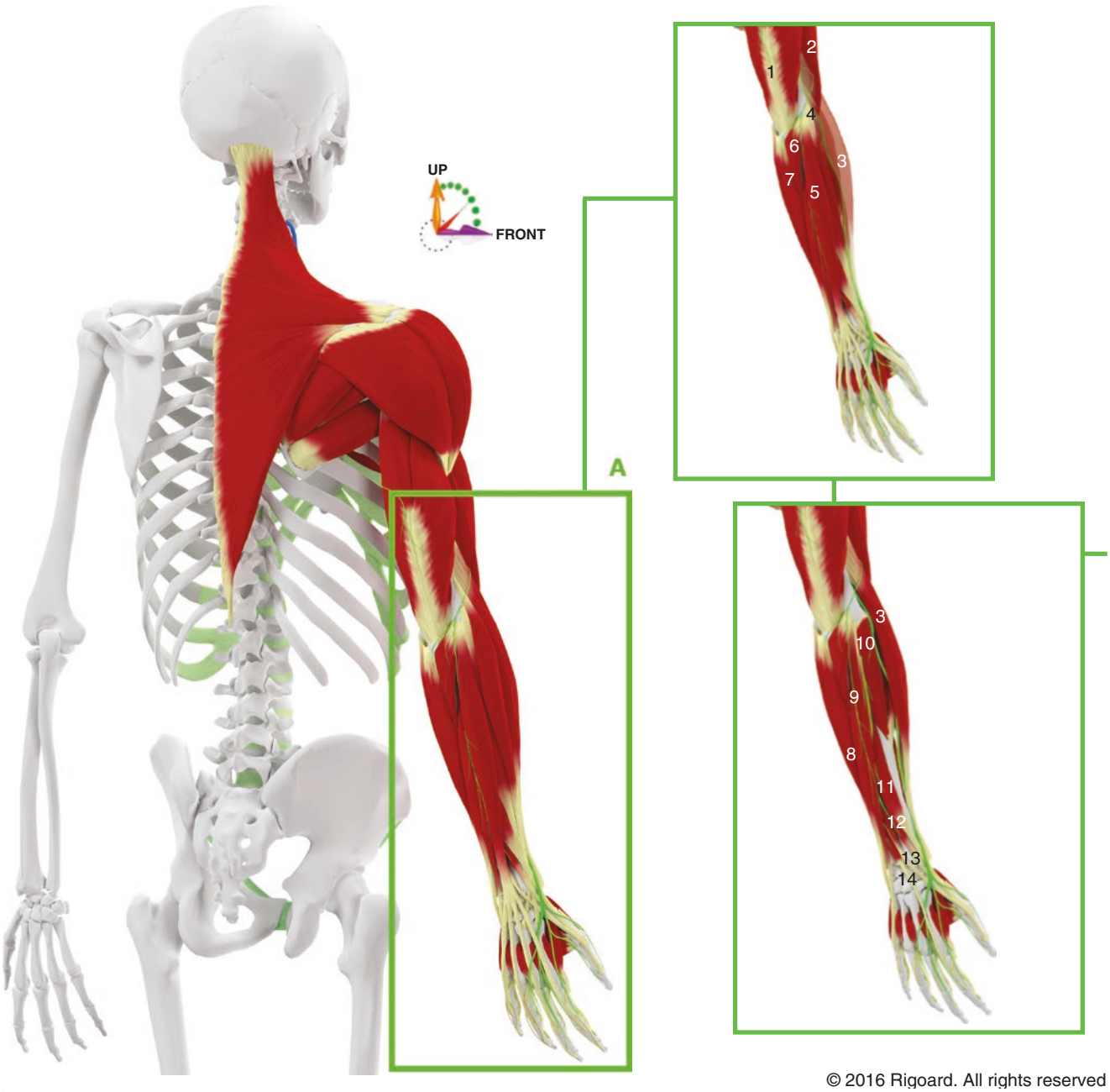


Figure R5. Path and relations of the radial nerve and its terminal branches in the forearm

1- Triceps brachii muscle
2- Brachialis muscle
3- Brachioradialis muscle
4- Extensor carpi radialis brevis muscle
5- Extensor digitorum muscle
6- Anconeus muscle
7- Flexor carpi ulnaris muscle
8- Extensor carpi ulnaris muscle
9- Extensor digiti minimi muscle
10- Supinator muscle
11- Abductor pollicis longus muscle
12- Extensor pollicis brevis muscle
13- Extensor pollicis longus muscle
14- Extensor indicis muscle
15- Basilic vein
16- Cephalic vein
17- Accessory cephalic vein
18- Dorsal venous network of the hand
19- Posterior interosseous artery

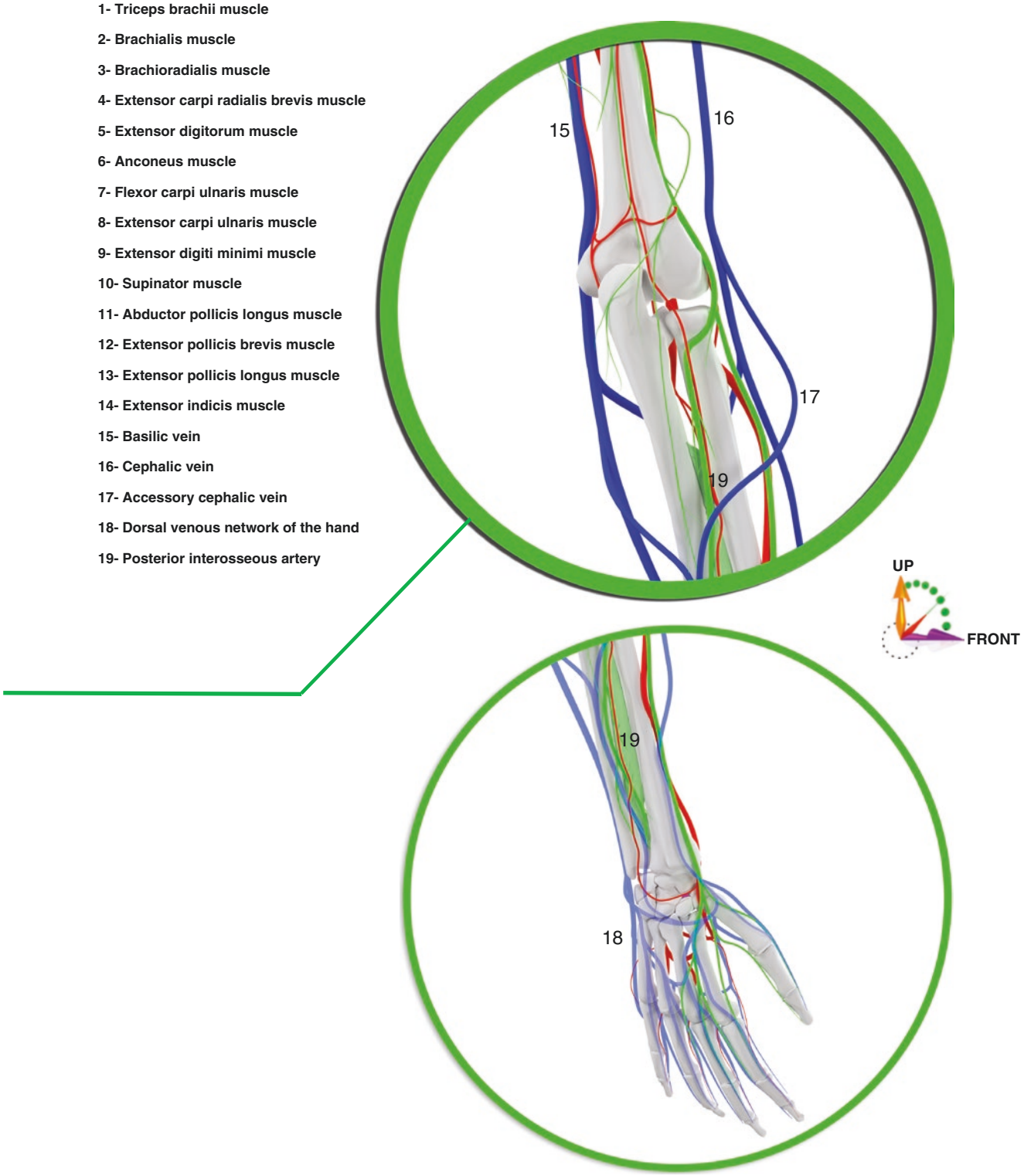


Figure R6. Vascular relations of the radial nerve in the forearm

medially before moving away from it at the distal third of the forearm.

In the posterior face of the forearm, the deep branch of the radial nerve faces the posterior interosseous nerve of the forearm medially (Figure R6).

Collateral Branches

The radial nerve gives rise to cutaneous and muscular collateral branches (Figure R2):

- Muscular branches: superior and inferior nerves of the medial head of the triceps brachii, nerves of the anconæus muscle, long head of the triceps brachii, lateral head of the triceps brachii, brachioradialis and extensor radialis carpi longus (Figures R3 and R5)
- Cutaneous branches: posterior cutaneous nerve of the arm, heading towards the upper third of the posterior face of the arm; inferior lateral cutaneous nerve of the arm, heading towards the lower third of the posterior lateral face of the arm; and posterior cutaneous nerves of the forearm (Figures R3 and R5)

These cutaneous ramifications innervate the posterior face of the arm between the territory of the axillary nerve laterally and the medial cutaneous nerve of the arm and forearm medially.

Terminal Branches

A few centimetres above the elbow pit, the radial nerve divides itself into two branches: anterior and posterior (Figure R2).

The anterior branch is sensitive. It goes under the brachioradialis muscle in its sheath along the forearm. It faces the radial artery medially in the two superior thirds of the forearm. Behind, it successively faces the supinator muscle, pronator teres and flexor digitorum superficialis. At the lower third of the forearm, it separates from the radial artery and goes towards the forearm's posterior area (Figures R3 and R6).

It divides itself at the same level as or above the distal epiphysis of the radius into three branches: lateral, intermediate and medial. The lateral ramus is headed towards the lateral part of the thenar eminence and the intermediate ramus towards its medial part as well as the lateral part of the index finger at the level of its first phalange. The medial ramus is headed towards the second interosseous space, at the dorsal faces of the first phalanges of the index and middle fingers (Figures R5, R9 and R11).

The posterior branch, which is a motor branch, is also called posterior interosseous nerve. It goes through the fibrous arch of the superficial bundle of the supinator muscle, also known as arcade of Frohse, in order to join the posterior compartment of the forearm. It goes down behind and laterally, between the two heads of the supinator muscle, which is innervated by this posterior branch. This spot is an anatomical landmark, situated two centimetres under the elbow's pit (Figure R3).

Near its origin, the nerve is crossed by the lateral branches of the radial recurrent artery and vein. The posterior interosseous nerve goes down before the radiohumeral joint, and under the superficial fibres of the supinator muscle, of which the proximal part of the aponeurosis represents the arcade of Frohse. After crossing it, the nerve goes in the posterior compartment of the forearm then around the external border of the radius and goes out between the fibres of the supinator muscle before continuing towards the distal part of the forearm.

The posterior branch is then situated between the two posterior muscular planes of the forearm. It faces successively the abductor pollicis longus and extensor pollicis brevis in front and then faces the interosseous membrane. In behind, it faces the extensor pollicis longus and the extensor indicis (Figure R5).

The terminal posterior branch of the radial nerve gives rise to muscular branches heading towards the posterior compartment of the forearm. After going 4 cm under and along the supinator muscle, the nerve gives off seven branches for the extensor carpi ulnaris, extensor digitorum brevis, extensor digitorum, extensor pollicis longus and brevis, extensor digiti minimi and extensor indicis. It sometimes gives off branches for both extensor radialis carpi muscles (Figures R5, R9 and R14).

Motor Function

The posterior branch innervates all of the extensor muscles in the wrist and fingers except the extensor radialis carpi longus, which is innervated by the radial nerve's trunk itself.

1- Triceps brachii muscle
- 1a- Medial head
- 1b- Lateral head
- 1c- Long head

2- Brachioradialis muscle
3- Extensor carpi radialis longus muscle
4- Extensor carpi radialis brevis muscle
5- Anconeus muscle
6- Extensor carpi ulnaris muscle
7- Extensor digitorum muscle
8- Abductor pollicis longus muscle
9- Extensor pollicis brevis muscle
10- Extensor digiti minimi muscle
11- Extensor pollicis longus muscle

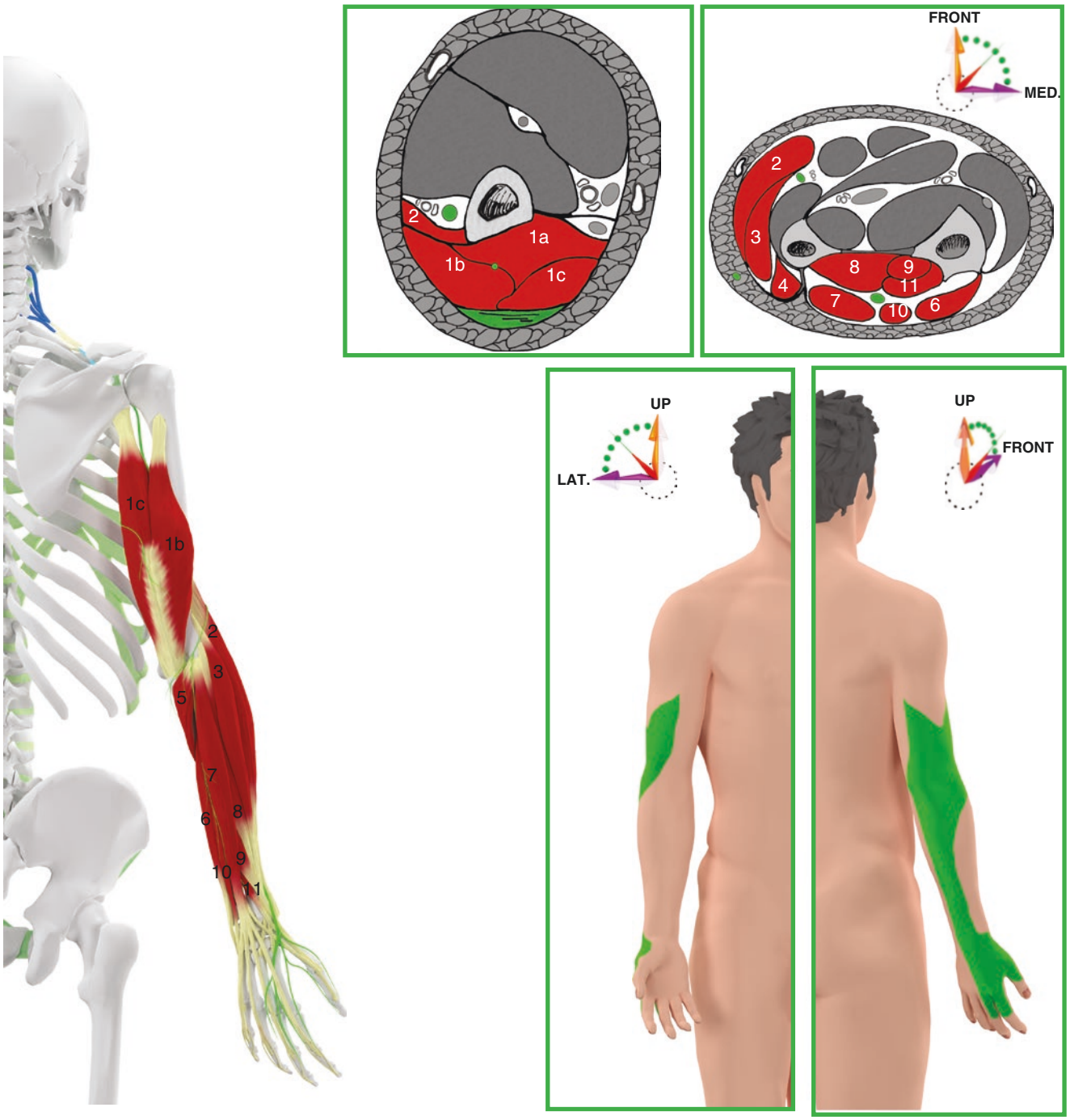


Figure R7. Motor and sensitive innervation of the radial nerve

The Radial Nerve

1- Pectoralis major muscle

2- Pectoralis minor muscle

3- Cephalic vein

4- Deltoid muscle

5- Short head of the biceps brachii muscle

6- Coracobrachialis muscle

7- Tendon of the long head of the biceps brachii muscle

8- Latissimus dorsi muscle

9- Humerus

10- Teres major muscle

11- Lateral head of the triceps brachii muscle

12- Circumflex artery and nerve

13- Long head of the triceps brachii muscle

14- Teres minor muscle

15- Infraspinatus muscle

16- Scapula

17- Medial cutaneous nerve of arm

18- Median nerve

19- Medial cutaneous nerve of forearm

20- Ulnar nerve

21- Radial nerve

22- Musculocutaneous nerve

23- Subscapularis muscle

24- Brachial vein

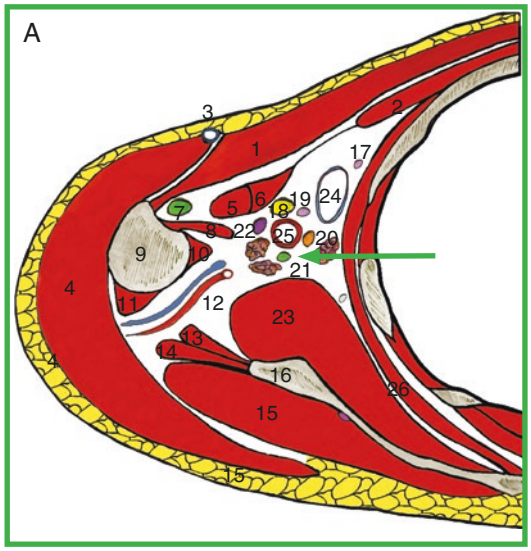
25- Brachial artery

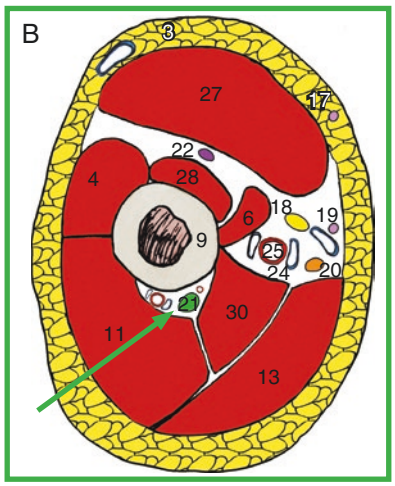
26- Serratus anterior muscle

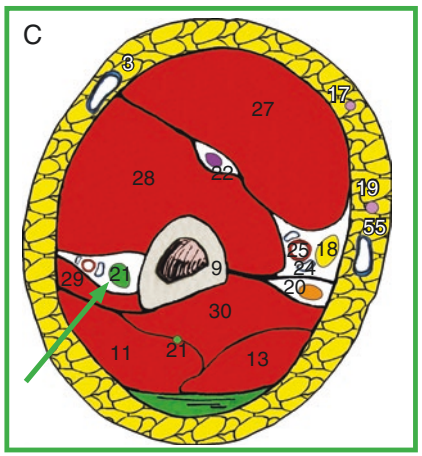
27- Biceps brachii muscle

28- Brachialis muscle

29- Brachioradialis muscle







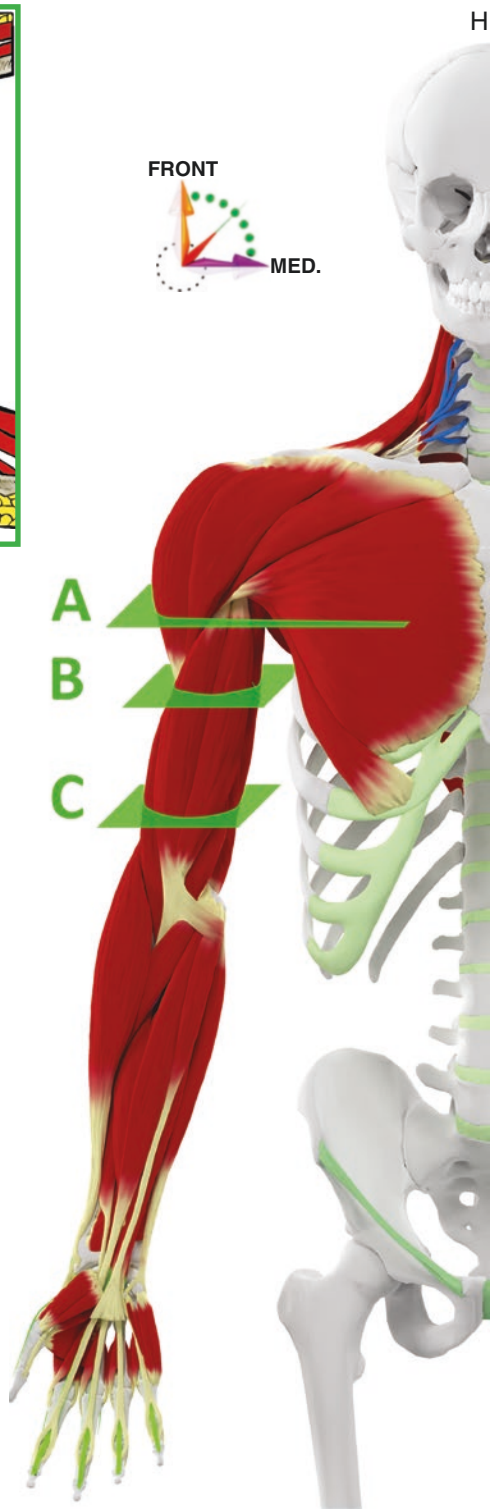


Figure R8. Relations of the radial nerve in the arm, axial sections

30- Medial head of the triceps brachii muscle
31- Extensor carpi radialis longus muscle
32- Extensor carpi radialis brevis muscle
33- Tendon of epicondyle muscles
34- Anconeus muscle
35- Olecranon
36- Tendon of the triceps brachii muscle
37- Tendon of the median epycondylian muscles
38- Pronator teres muscle
39- Ulna
40- Radius
41- Palmaris longus muscle
42- Flexor carpi radialis muscle
43- Flexor digitorum superficialis muscle
44- Flexor digitorum profundus muscle
45- Flexor pollicis longus muscle
46- Flexor carpi ulnaris muscle
47- Abductor pollicis longus muscle
48- Extensor pollicis brevis muscle
49- Extensor pollicis longus muscle
50- Extensor digitorum muscle
51- Extensor digiti minimi muscle
52- Extensor carpi ulnaris muscle
53- Extensor indicis muscle
54- Median vein of the forearm
55- Basilic vein
56- Radial artery and vein
57- Ulnar artery and vein
58- Pronator quadratus muscle

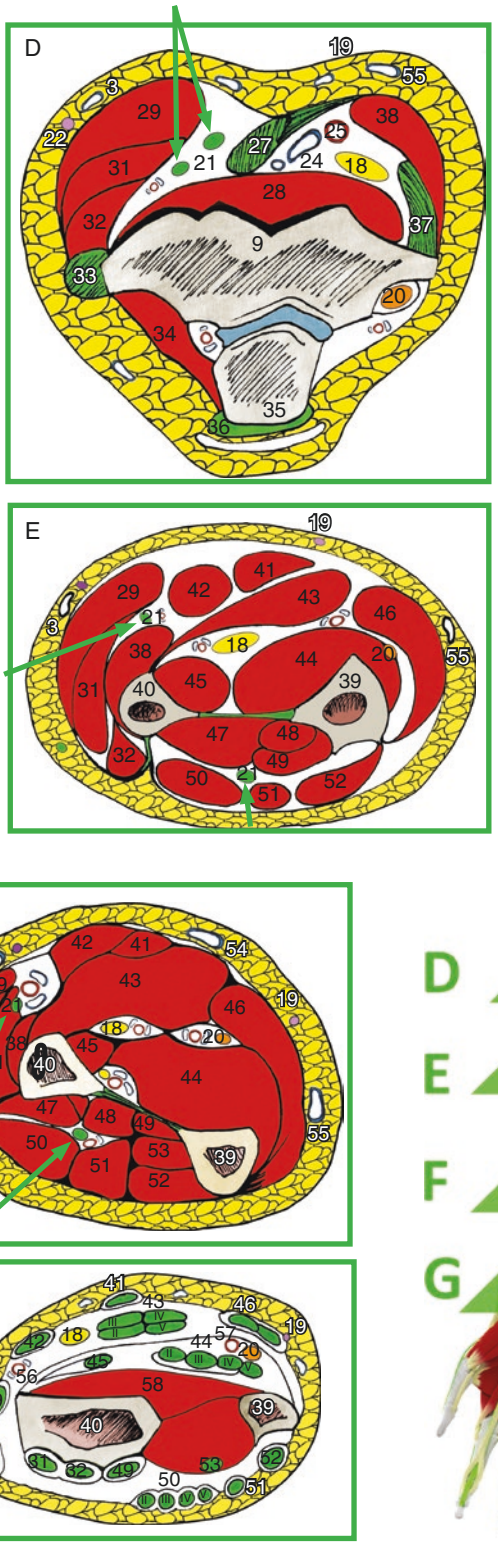


Figure R9. Relations of the radial nerve in the elbow and forearm, axial sections

The deficit caused by a compression of the posterior branch of the nerve leaves the wrist in a persisting extension, making it appear laterally inclined.

In the end, the radial nerve is responsible for the extension of the forearm on the arm, of the wrist on the forearm and of the fingers (Figure R7).

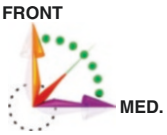
Sensitive Function

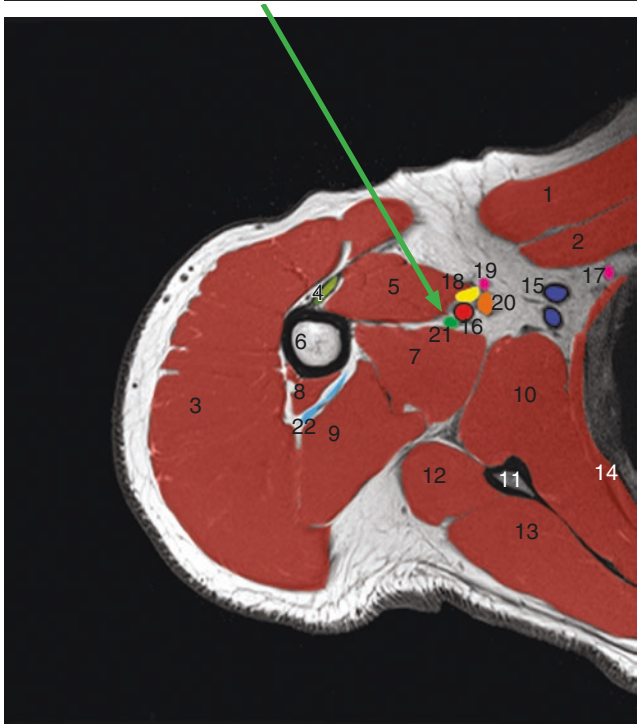
The sensitive function is situated at the level of the superficial branch. It innervates the dorsal face of the first commissure at the level of the hand, the dorsal face of the thumb and the dorsal faces of the index and middle fingers until the junction between the second and third phalanges (Figure R7).

Anastomoses

With:

- The musculocutaneous nerve
- The median nerve at the level of the thumb
- The ulnar nerve in the dorsal face of the hand
- The medial cutaneous nerves of the forearm and arm

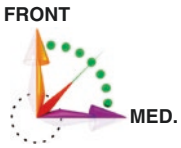


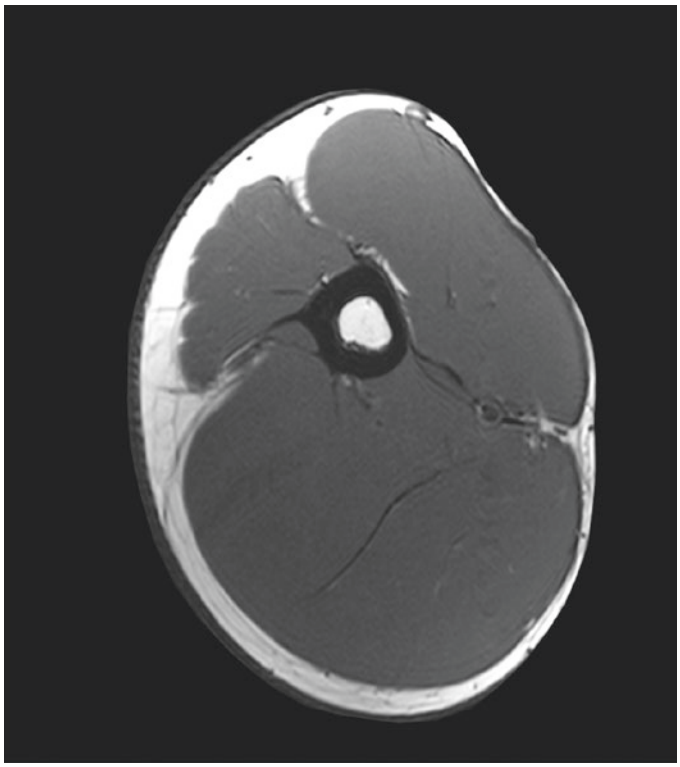


1- Pectoralis major muscle
2- Pectoralis minor muscle
3- Deltoid muscle
4- Long head of the biceps brachii muscle
5- Latissimus dorsi muscle
6- Humerus
7- Teres major muscle
8- Lateral head of the triceps brachii muscle
9- Medial head of the triceps brachii muscle
10- Subscapularis muscle
11- Scapula
12- Teres minor muscle
13- Infraspinatus muscle
14- Serratus anterior
15- Brachial vein
16- Brachial artery
17- Medial cutaneous nerve of arm
18- Median nerve
19- Medial cutaneous nerve of forearm
20- Ulnar nerve
21- Radial nerve
22- Axillary nerve

Figure R10. MRI scans in the shoulder through the radial nerve

The Radial Nerve





1- Deltoid muscle

2- Humerus

3- Lateral head of the triceps brachii muscle

4- Medial head of the triceps brachii muscle

5- Brachial artery

6- Median nerve

7- Medial cutaneous nerve of forearm

8- Ulnar nerve

9- Cephalic vein

10- Basilic vein

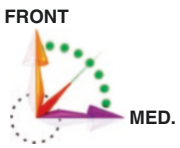
11- Radial nerve

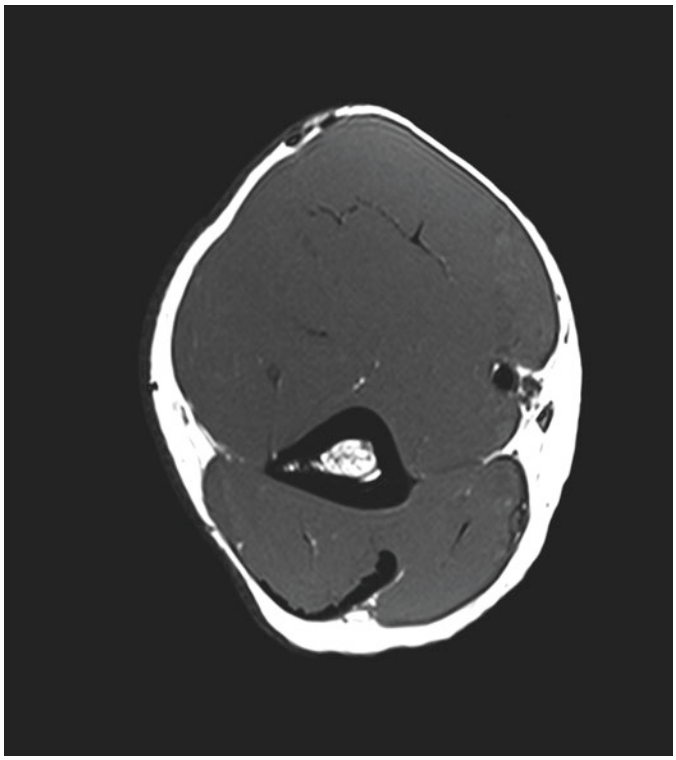
12- Musculocutaneous nerve

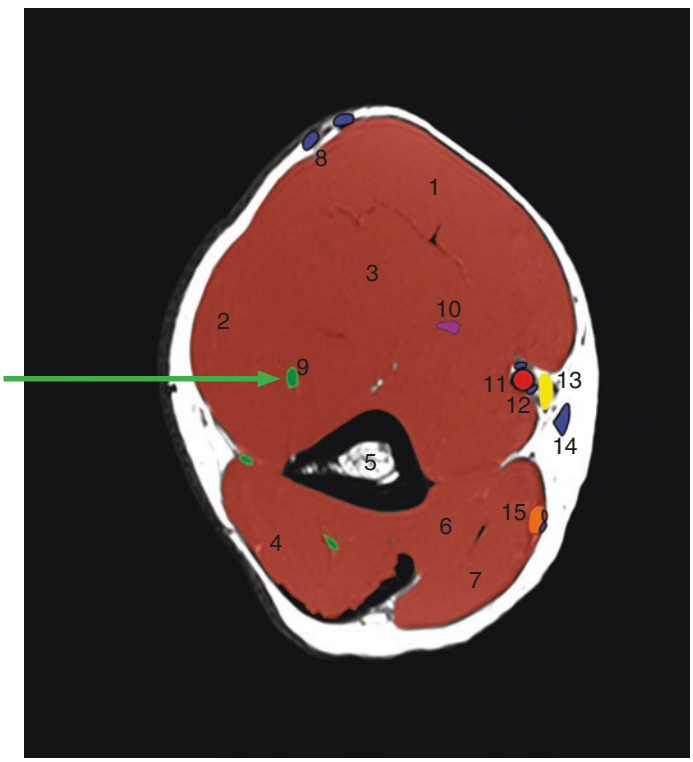
13- Long head of the triceps brachii muscle

14- Biceps brachii muscle

Figure R11. MRI scans at the proximal third of the arm through the radial nerve







1- Biceps brachii muscle

2- Brachioradialis muscle

3- Brachialis muscle

4- Lateral head of the triceps brachii muscle

5- Humerus

6- Long head of the triceps brachii muscle

7- Medial head of the triceps brachii muscle

8- Cephalic vein

9- Radial nerve

10- Musculocutaneous nerve

11- Brachial artery

12- Brachial vein

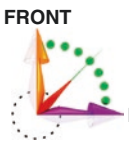
13- Median nerve

14- Basilic vein

15- Ulnar nerve

Figure R12. MRI scans at the distal third of the arm through the radial nerve

The Radial Nerve



1- Brachioradialis muscle

2- Extensor carpi radialis longus muscle

3- Extensor carpi radialis brevis muscle

4- Biceps brachii muscle

5- Tendon of the long head of biceps

6- Brachialis muscle

7- Pronator teres muscle

8- Tendon of the median epycondylian muscles

9- Humerus

10- Anconeus muscle

11- Ulna

12- Triceps brachii muscle

13- Medial vein at the elbow

14- Brachial vein

15- Brachial artery

16- Median nerve

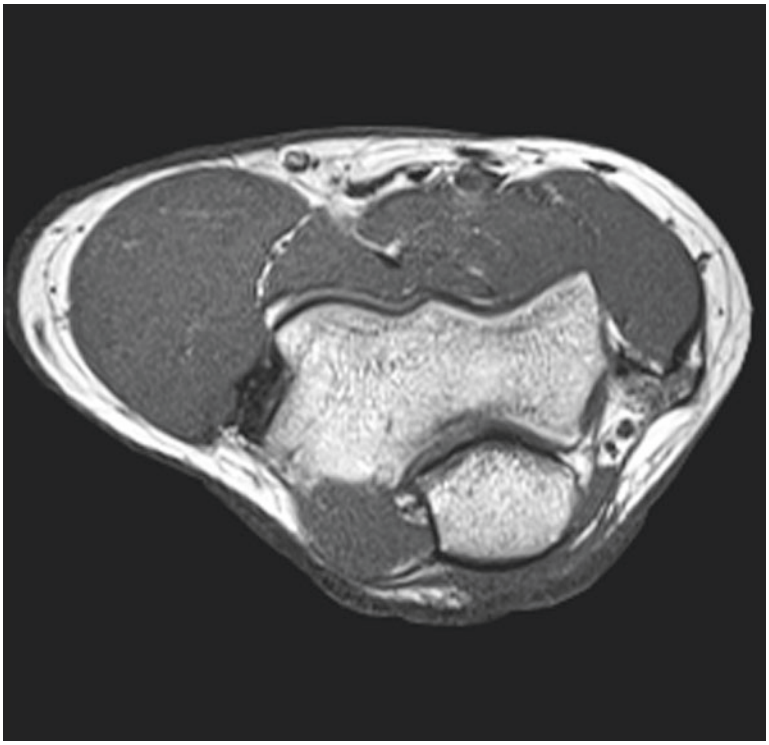
17- Musculocutaneous nerve

18- Cephalic vein

19- Basilic vein

20- Radial nerve

21- Ulnar nerve



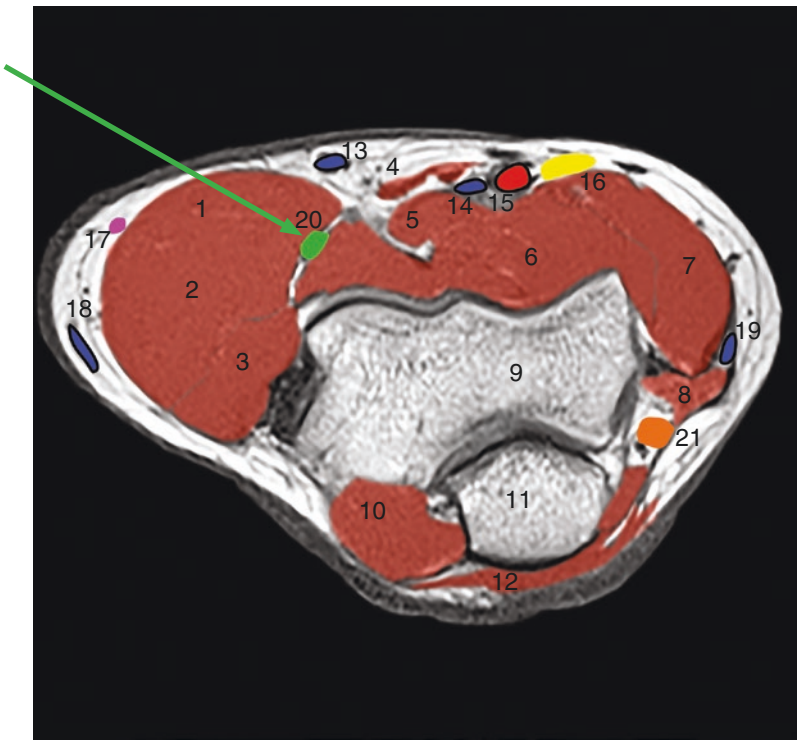
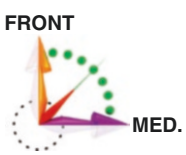
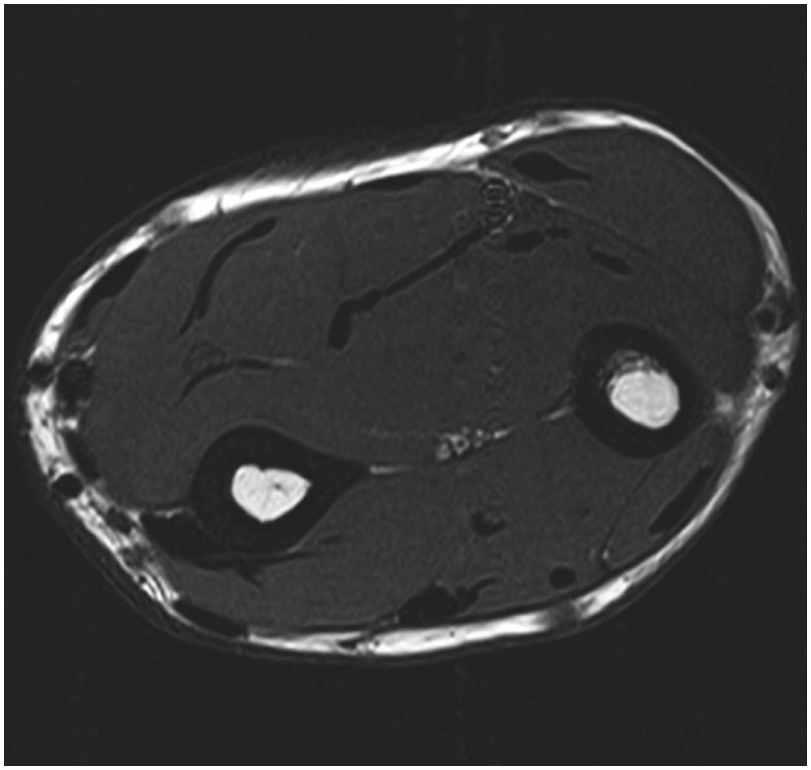
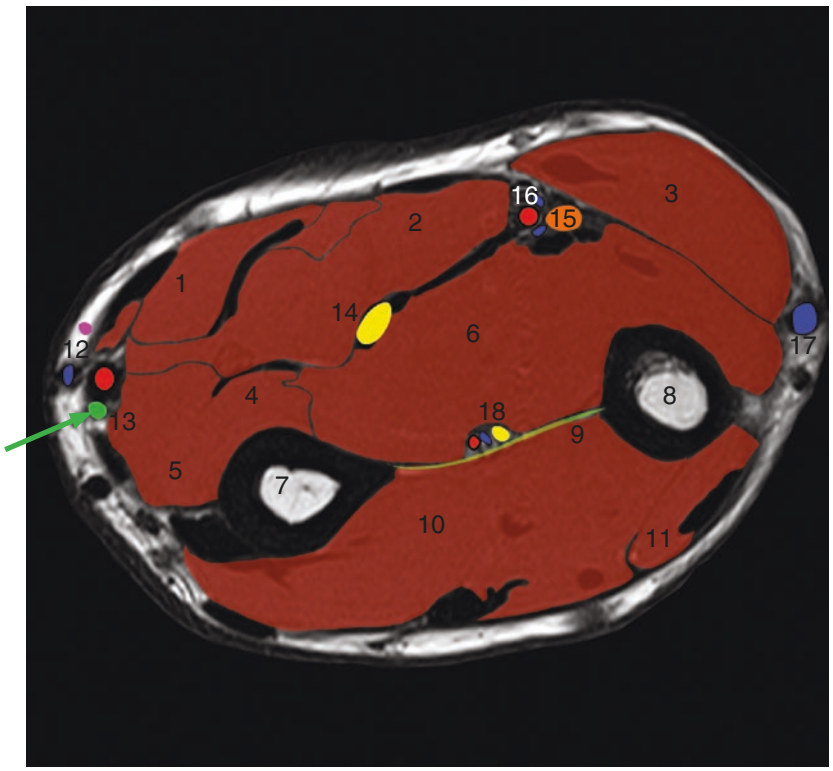


Figure R13. MRI scans in the elbow through the radial nerve







1- Flexor carpi radialis muscle

2- Flexor digitorum superficialis muscle

3- Flexor carpi ulnaris muscle

4- Flexor pollicis longus muscle

5- Extensor carpi radialis brevis muscle

6- Flexor digitorum profundus muscle

7- Radius

8- Ulna

9- Interosseous membrane of the forearm

10- Posterior compartment of the extensor digitorum muscles

11- Extensor carpi muscle

12- Radial artery and vein

13- Radial nerve

14- Median nerve

15- Ulnar nerve

16- Ulnar artery and vein

17- Basilic vein

18- Anterior interosseous artery, vein and nerve

Figure R14. MRI scans in the forearm through the radial nerve

Pathology

Pathology concerns:
- Direct injuries of the nerve's trunk, at the level of its osteofibrous tunnel in the arm, when a mid-shaft humeral fracture occurs (see above)
- The posterior interosseous nerve syndrome (see below)

Posterior Interosseous Nerve Syndrome

The posterior interosseous nerve, which is the posterior terminal branch of the radial nerve, takes its origin a few centimetres below the elbow pit. Just after its origin, it penetrates between the two planes of fibres of the supinator muscle. At this level, the proximal border of the superficial fibres constitutes the arcade of Frohse. As a reminder, this branch has a motor function for the extensor muscles in the wrist aside from the extensor carpi radialis longus (Figure R15).

Aetiology

- Compression: this is an entrapment neuropathy that happens in most cases when the muscles that surround the origin of the posterior interosseous nerve are overused. These circumstances can be found in repetitive movements of pronation and supination. The compression's most common point is situated at the level of the arcade of Frohse, at the entry point of the nerve in the supinator muscle. This entrapment neuropathy is particularly frequent amongst tennis players.
- Traction: the gestures implicated in this syndrome are also factors of traction on the nerve at this level.

Clinical Signs

Sensitive signs: pain sensation can happen without warning signs. It is dull and generally located at the proximal and lateral part of the forearm. It can appear after a variable amount of time when performing repeated gestures of the distal extremity whilst pronating the forearm, such as repeated mouse clicks whilst working on a computer.

Motor signs: the patient can show a loss of extension of the fingers, especially in the metacarpus and phalanges. Wrist extension is preserved by action of the extensor radialis carpi longus. However, since the extensor carpi ulnaris is innervated by the posterior interosseous nerve, extension of the wrist is accompanied by a lateral deviation.

Clinical Forms

When this syndrome evolves over a large duration of time, an amyotrophy of the posterior compartment of the forearm can develop. It does not impact the brachioradialis or the extensor radialis carpi longus muscles.

An incomplete motor injury can affect only the extension of the fourth and fifth fingers, appearing like an ulnar injury.

Complementary Examinations

Elbow radiographies must be systematically executed:
- An electrophysiological study confirms the injured area.
- An MRI scan also allows for the elimination of differential diagnoses.

Treatment

It is surgical and indicated after 3 months of conservative treatment with no improvement or a worsening of symptomatology. If the cause is an expansive process, then resection is indicated in the first instance in order to limit the potentially irreversible injury of the posterior interosseous nerve. Postsurgical results are positive in a majority of publications.

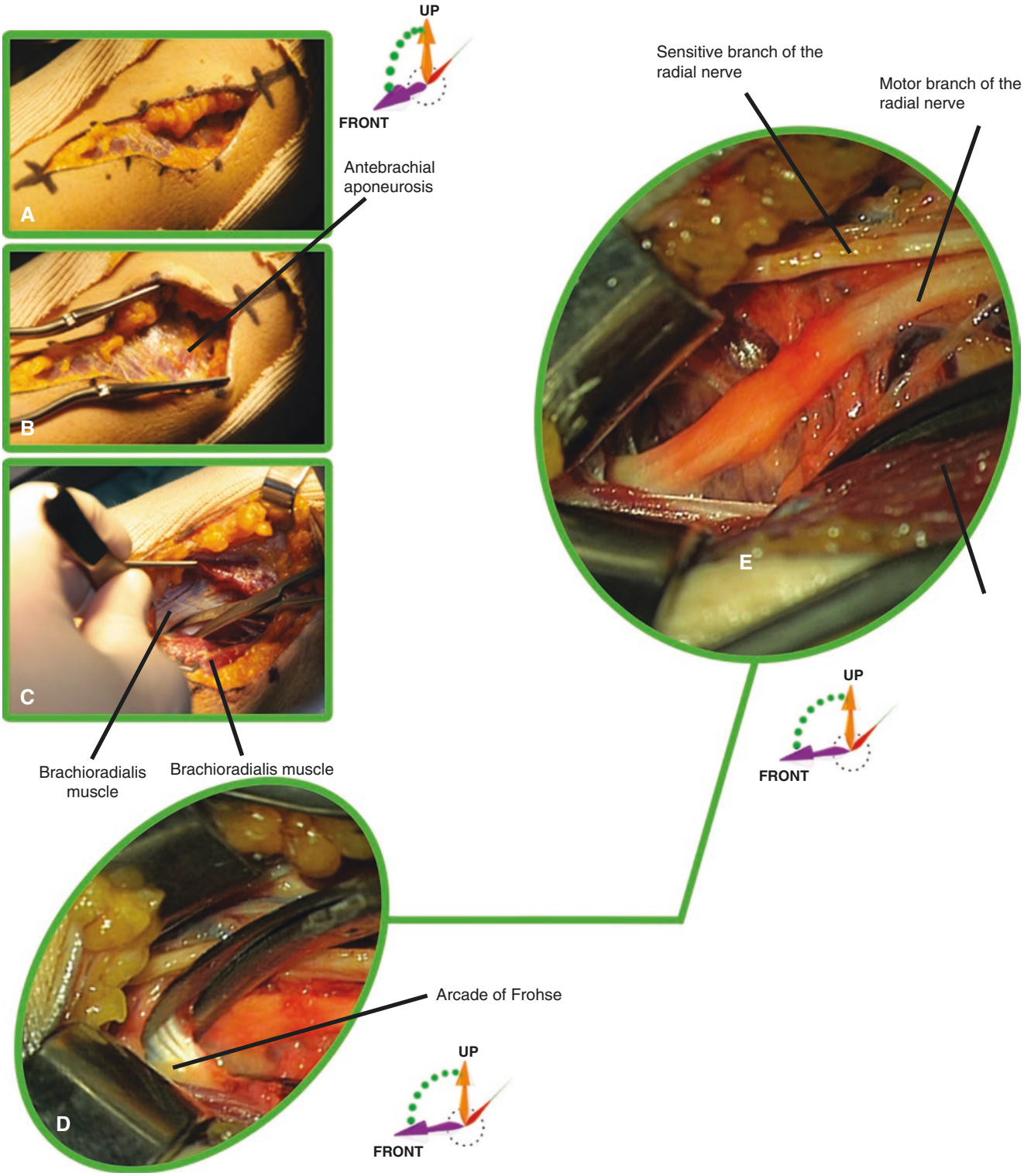


Figure R15. Pathology of the radial nerve - Decompression surgery of the posterior interosseous branch at the level of the arcade of Frohse (**A**: cutaneous incision; **B**: insertion of the retractor; **C**: approach to the radial nerve; **D**: Section of the arcade of Frohse; **E**: decompression of the nerve's motor branch)