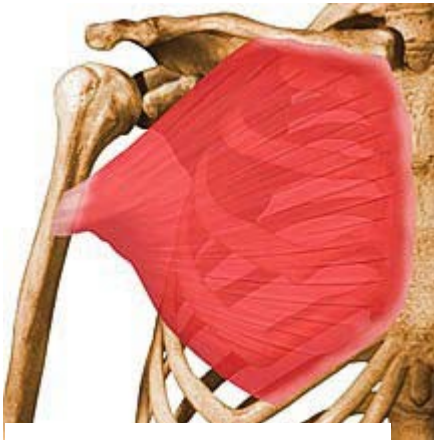


1. MUSCLES OF UPPER EXTERMITY

1.1 Thoracohumeral muscles



PECTORALIS MAJOR MUSCLE

→ medial part of the clavicle (*clavicular part*); ventral surface of the sternum together with adjacent parts of the first six ribs (*sternocostal part*); aponeurosis of the external oblique muscle (*abdominal part*)

→| crest of the major tubercle of the humerus

⇄ ventral flexion of the arm (mostly *clavicular part*); adduction + medial rotation of the arm (mostly *sternocostal part*); it raises chest in fixed extremity (auxiliary inspiratory muscle)

⚡ medial and lateral pectoral nerve

✂ lower edge of the muscle forms **anterior axillary fold** – one of the borders of the **axillary fossa** (see topography)



PECTORALIS MINOR MUSCLE

→ 3rd – 5th rib (often 2nd – 4th rib)

→| coracoid process of the scapula

⇄ **protraction + depression of the scapula** – rotates the glenoid cavity of the shoulder joint ventrally (position in arm flexion). It has function of an auxiliary inspiratory muscle when the shoulder girdle is fixed

⚡ medial and lateral pectoral nerve



SUBCLAVIUS MUSCLE

→ 1st rib and cartilage junction

→| subclavian groove of the clavicle

⇄ **pulls the clavicle downwards**; fixates clavicle in the sternoclavicular joint; elevates 1st rib when the shoulder girdle is fixed (very weak auxiliary inspiratory muscle)

⚡ nerve to subclavius

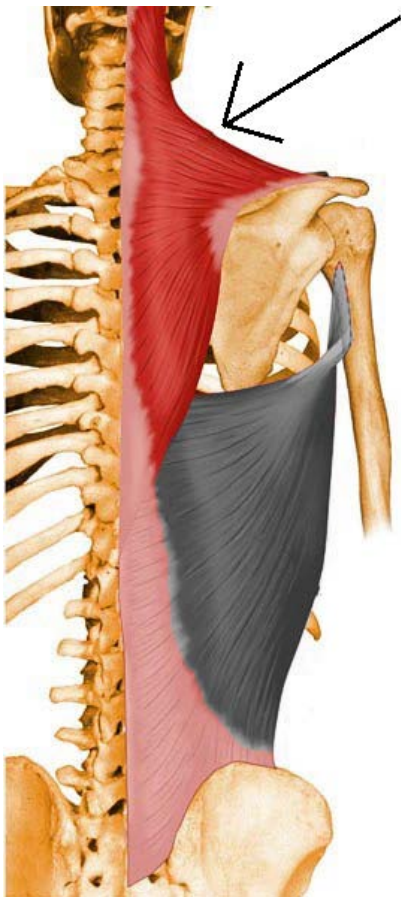


SERRATUS ANTERIOR MUSCLE

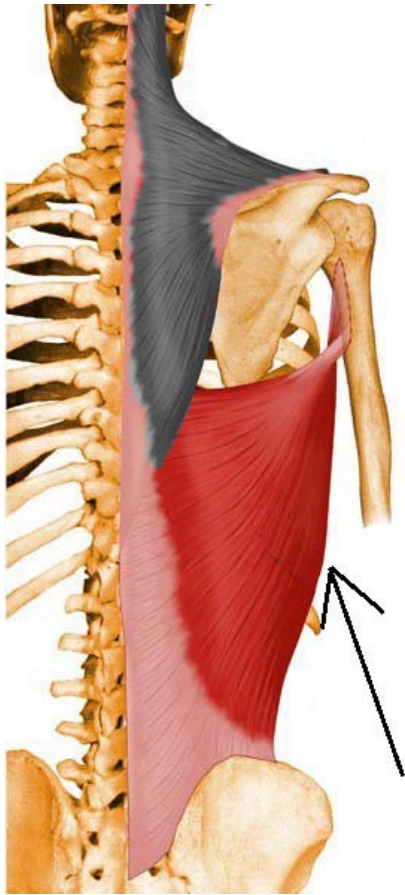
- ↳ 8 - 10 fleshy slips from the first 9 ribs
- medial margin of the scapula + inferior angle of the scapula
- ⇌ pulls the scapula towards the chest; lateral rotation of the inferior angle of the scapula, thus enabling abduction of the arm above horizontal; it elevates ribs when the scapula is fixed (auxiliary inspiratory muscle)
- ⚡ long thoracic nerve

1.2 Spinohumeral muscles

TRAPEZIUS MUSCLE



- ↳ medial third of the superior nuchal line + external occipital protuberance + by nuchal ligament to spinous processes of C1 – C6 (*descendent part*); spinous processes C7 – T3 (*transversal part*); spinous processes T4 – T12 (*ascendent part*)
- lateral third of the clavicle; acromion; spine of the scapula
- ⇌ fixation of the scapula to the spine; elevation of the scapula (*descendent part*); depression of the scapula (*ascendent part*); action of both *descending part* and *ascending part* at the same time rotates the scapula laterally (synergist of the serratus anterior – see above); extension (bilateral action) or lateroflexion (lateral action) of the head when the shoulder girdle is fixed
- ⚡ accessory nerve (n. XI) + branches from C3 – C4 (proprioception)
- ✂ in area of C7 (vertebra prominens) is located aponeurotic origin of the trapezius muscles of both sides – **speculum rhomboideum**



LATISSIMUS DORSI MUSCLE

↳ spinous processes of T7 – S5; thoracolumbal fascia (posterior lamina); posterior superior iliac spine; external lip of the crest of the ilium; 10th – 12th ribs

→| crest of the minor tubercle of the humerus

⇔ medial rotation, adduction and dorsal flexion in the shoulder joint; it elevates the trunk when the extremities are fixed; fixation of the caudal ribs (supports the diaphragm)

⏚ thoracodorsal nerve

✂ its tendon merges together with tendon of **teres major** (see below); in some cases is inserted to inferior angle of the scapula



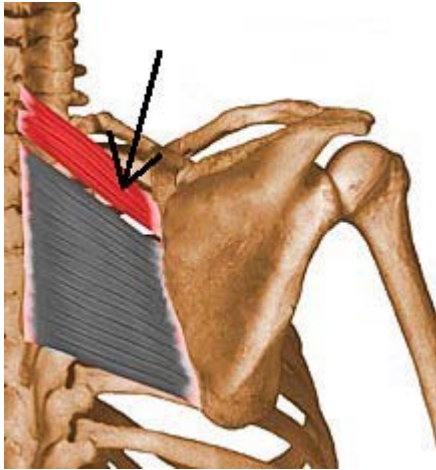
LEVATOR SCAPULAE MUSCLE

↳ transverse processes of C1 – C2 + posterior tubercle of the transverse processes of C3 – C4

→| superior angle of the scapula

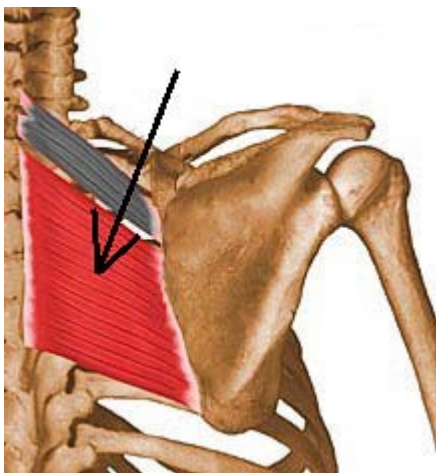
⇔ elevation of the scapula; rotation of the inferior angle of the scapula inwards – medial rotation of the scapula (antagonist of serratus anterior and trapezius); lateroflexion of cervical vertebrae in fixed scapula

⏚ dorsal scapular nerve (C5) + muscular branches C3 – C4



RHOMBOID MINOR MUSCLE

- ↳ spinous process of C6 – C7
- upper 1/3 of medial margin of the scapula
- ⇔ pulls the scapula mediocranially (elevation + retraction of the scapula)
- ⌞ dorsal scapular nerve
- ✎ often united with **rhomboid major** (see below)



RHOMBOID MAJOR MUSCLE

- ↳ spinous process of T1 – T4
- lower 2/3 medial margin of the scapula
- ⇔ pulls scapula mediocranially (elevation + retraction of the scapula)
- ⌞ dorsal scapular nerve
- ✎ often united with **rhomboid minor** (see above)

1.3 Muscles of the shoulder

DELTOID MUSCLE



- ↳ lateral part of the spine of the scapula (spinal part); acromion (acromial part); lateral part of the clavicle (clavicular part)
- deltoid tuberosity on the humerus
- ⇔ abduction in the shoulder joint; fixation of the head of the humerus in the glenoid cavity; dorsal flexion in the shoulder joint (only the spinal part); ventral flexion in the shoulder joint (only the clavicular part)
- ⌞ axillary nerve
- ✎ between the muscle and the capsule of the shoulder joint lies the **subacromial bursa**



SUPRASPINATUS MUSCLE

- ↳ supraspinatous fossa of the scapula
- greater tubercle of the humerus (the uppermost part of the tubercle)
- ⇔ lateral rotation + abduction in the shoulder joint
- ⬇️ suprascapular nerve
- ✂️ part of the rotator cuff (see below)



INFRASPINATUS MUSCLE

- ↳ infraspinatous fossa of the scapula
- greater tubercle of the humerus (the middle part of the tubercle)
- ⇔ lateral rotation + adduction in the shoulder joint
- ⬇️ suprascapular nerve
- ✂️ part of the rotator cuff (see below)



TERES MINOR MUSCLE

- ↳ lateral (cranial) part of the lateral margin of the scapula
- greater tubercle of the humerus (the lowest part of the tubercle)
- ⇔ lateral rotation + adduction in the shoulder joint
- ⬇️ axillary nerve (+ variatory innervation by the suprascapular nerve)
- ✂️ part of the rotator cuff (see below)



TERES MAJOR MUSCLE

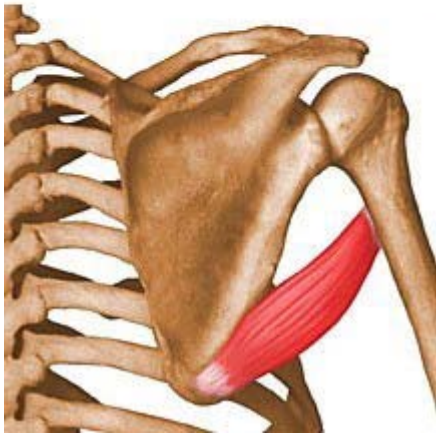
→ medial (caudal) part of the lateral margin of the scapula + inferior angle of the scapula

→ crest of the lesser tubercle of the humerus

⇄ adduction / dorsal flexion + medial rotation in the shoulder joint

⊥ subscapular nerve

↘ It's tendon merges with tendon of **latissimus dorsi** (see above)



SUBSCAPULARIS MUSCLE

→ costal surface of the scapula, subscapular fossa

→ lesser tubercle of the humerus

⇄ medial rotation + adduction in the shoulder joint

⊥ subscapular nerve

↘ part of the **rotator cuff** (see below)

1.4 Upper arm muscles

1.4.1 Upper arm muscles – ventral group

BICEPS BRACHII MUSCLE



- *long head*
- *short head*

↳ supraglenoid tubercle + glenoid lip (*long head*); coracoid process of the scapula (*short head*)

→ radial tuberosity + by the bicipital aponeurosis (lacertus fibrosus) into the fascia of the forearm on the ulnar side

⇔ flexion in the elbow joint + supination of the forearm; abduction in the shoulder joint (only *long head*); ventral flexion + auxiliary adduction in the shoulder joint (only *short head*)

⚡ musculocutaneous nerve

✂ the tendon of the long head divides muscles of the rotator cuff to medial and lateral rotators; tendon runs through the intertubercular groove of the humerus covered by the intertubercular synovial sheath

CORACOBRACHIALIS MUSCLE



↳ coracoid process of the scapula

→ body of humerus in the continuation of the crest of the lesser tubercle

⇔ auxiliary adduction + auxiliary ventral flexion in the shoulder joint

⚡ musculocutaneous nerve

✂ the muscle is penetrated by the musculocutaneous nerve



BRACHIALIS MUSCLE

↳ anterior surface of the humerus from the deltoid tuberosity to the elbow joint capsule

→| ulnar tuberosity

⇌ flexion in the elbow joint

⌞ musculocutaneous nerve

✎ deep fibres of the muscle (**articular muscle**) insert into the elbow joint capsule, preventing capsule lesion during flexion

1.4.2 Upper arm muscles – dorsal group

TRICEPS BRACHII MUSCLE

- *long head*
- *lateral head*
- *medial head*

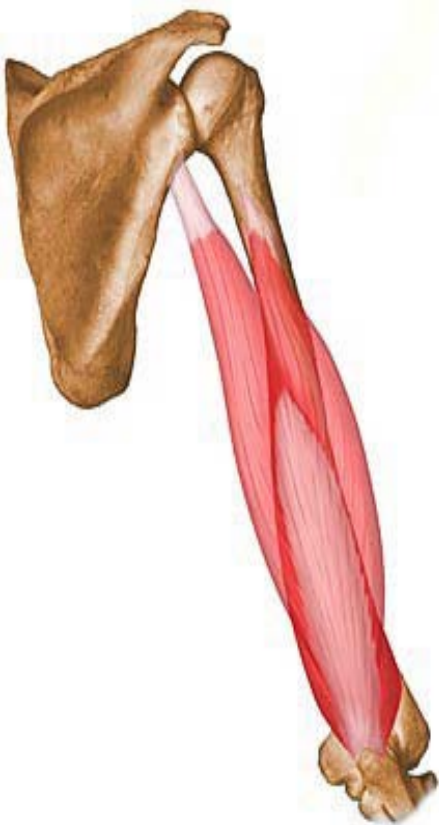
↳ infraglenoid tubercle (*long head*); dorsal surface of the humerus proximal to the groove for the radial nerve (*lateral head*); dorsal surface of the humerus distal to the groove for the radial nerve (*medial head*)

→| olecranon of the ulna

⇌ extension in the elbow joint; dorsal flexion + adduction in the shoulder joint (only *long head*)

⌞ radial nerve

✎ radial nerve runs between the *medial head* and the *lateral head* together with the **deep brachial vessels** in the **groove for the radial nerve**; deep fibres of the muscle (**articular muscle**) insert into the elbow joint capsule, preventing incarceration during extension (similar function to the **anconeus muscle** – see below); between the insertion of the muscle and the **olecranon of the ulna** is inserted the **subtendineous bursa of triceps brachii**





ANCONEUS MUSCLE

- ↳ lateral epicondyle of the humerus + radial collateral ligament
- olecranon of the ulna (distal to the insertion of the triceps brachii)
- ⇔ extension in the elbow joint; deep fibres prevent incarceration of the joint capsule during extension of the elbow joint
- ⬇ radial nerve

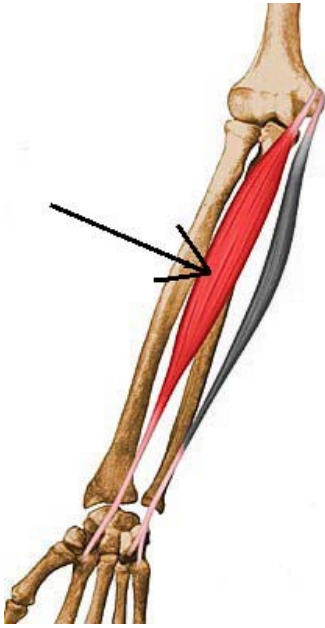
1.5 Muscles of the forearm

1.5.1 Muscles of the forearm – anterior group (first layer)

PRONATOR TERES MUSCLE



- *humeral head*
- *ulnar head*
- ↳ medial epicondyle of the humerus - „common ulnar head“ (*humeral head*); coronoid process of the ulna (*ulnar head*)
- middle third of the lateral side of the radius (pronator tuberosity)
- ⇔ pronation of the forearm; auxiliary flexion in the elbow joint (only *humeral head*)
- ⬇ median nerve
- ✂ between the *humeral head* and the *ulnar head* (pronator canal) runs median nerve



FLEXOR CARPI RADIALIS MUSCLE

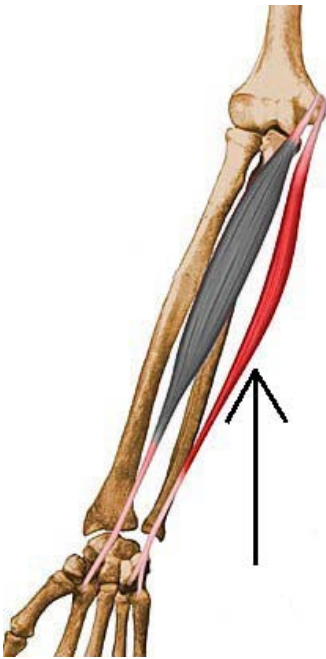
- ↳ medial epicondyle of the humerus - „common ulnar head“
- base of the 2nd metacarpal (partly also the 3rd metacarpal)
- ⇔ auxiliary flexion in the elbow joint; flexion in the radiocarpal joint; radial abduction
- ⚠ median nerve
- ✂ all muscles containing „carpi“ in their name perform adduction of the hand; it runs through radial part of the **carpal canal**; insertion tendon is covered by the **tendon sheath of the flexor carpi radialis**



PALMARIS LONGUS MUSCLE

- ↳ medial epicondyle of the humerus - „common ulnar head“
- flexor retinaculum + palmar aponeurosis
- ⇔ auxiliary flexion in the elbow joint; flexion in the radiocarpal joint; stretches palmar aponeurosis
- ⚠ median nerve
- ✂ runs ventrally from **flexor retinaculum**; in 15% cases is missing

FLEXOR CARPI ULNARIS MUSCLE



- *humeral head*
- *ulnar head*

↳ medial epicondyle of the humerus - „common ulnar head“ (*humeral head*); olecranon + posterior margin of the ulna (*ulnar head*)

→| pisiform bone and extends by the pisohamate ligament onto hamulus of the hamate bone and by pisometacarpal ligament to the base of the 5th metacarpal

≡ auxiliary flexion in the elbow joint (only *humeral head*); flexion in the radiocarpal joint; ulnar adduction of the hand

⚠ ulnar nerve

✂ all muscles containing „carpi“ in their name perform adduction of the hand; **pisiform bone** is a sesamoid bone in the insertion tendon of the muscle; between its heads (**cubital canal**) runs **ulnar nerve**

1.5.2 Muscles of the forearm – anterior group (second layer)

FLEXOR DIGITORUM SUPERFICIALIS MUSCLE



- *humeral head*
- *radial head*

↳ medial epicondyle of the humerus - „common ulnar head“ + ulnar collateral ligament + ulnar tuberosity (*humeral head*); along pronator tuberosity (*radial head*)

→| by 4 tendons, each divided into two slips (chiasma tendinum), inserted onto the sides of the bases of the middle phalanges of the 2nd to 5th fingers

≡ flexion in proximal interphalangeal joints; flexion in the metacarpophalangeal joints; flexion in the radiocarpal joints; auxiliary flexion in the elbow joint (only *humeral head* – parts which origin on „common ulnar head“)

⚠ median nerve

✂ **median nerve** runs between the heads of the muscle to the depth of the forearm (through **pronator canal**); common tendon sheath with **flexor digitorum profundus** – common tendon sheath of the flexor muscles and the fibrous and synovial sheath of fingers (see below) **vagina communis tendinum mm. flexorum** and **vaginae fibrosae et synoviales digitorum manus** on the hand fingers (see below)

1.5.3 Muscles of the forearm – anterior group (third layer)



FLEXOR DIGITORUM PROFUNDUS MUSCLE

↳ anterior surface of the ulna + interosseous membrane (between insertion of brachialis and the proximal edge of pronator quadratus)

→| bases of the terminal phalanges of 2nd – 5th finger

⇔ flexion in the proximal and distal interphalangeal joints; flexion in the metacarpophalangeal joints; flexion in radiocarpal joints

⬇ part for 2nd and 3rd finger by median nerve; part for 4th and 5th finger by ulnar nerve

✂ insertion tendons run through **chiasma tendinum of flexor digitorum superficialis** with which they have common tendon sheaths and the fibrous and synovial sheath of fingers (see above)



FLEXOR POLLICIS LONGUS MUSCLE

↳ anterior surface of the radius + interosseous membrane (between insertion of pronator teres and pronator quadratus)

→| basis of the terminal phalanx of the thumb

⇔ flexion in the interphalangeal joint of the thumb; flexion in the first metacarpophalangeal joint; flexion in the radiocarpal joint

⬇ median nerve

✂ course of the tendon divides the innervation regions for the muscles of the thumb (see below); insertion tendon is covered by **tendon sheath of flexor pollicis longus**

1.5.4 Muscles of the forearm – anterior group (fourth layer)



PRONATOR QUADRATUS MUSCLE

↳ distal quarter of the anterior surface of the ulna

→| distal quarter of the anterior surface of the radius

⇔ pronation of the forearm

⬇ median nerve (anterior interosseous branch)

1.5.5 Muscles of the forearm – lateral group (superficial layer)



BRACHIORADIALIS MUSCLE

↳ distal third of the lateral margin of the humerus + lateral supracondylar crest + lateral intermuscular septum

→| suprastyloideal crest

⇌ auxiliary flexion in the elbow joint; pronation of the flexed forearm; supination in the extended forearm

⬇ radial nerve



EXTENSOR CARPI RADIALIS LONGUS MUSCLE

↳ lateral supracondylar crest of the humerus

→| dorsal surface of the base of the 2nd metacarpal

⇌ dorsal flexion in the radiocarpal joint; radial adduction of the hand

⬇ radial nerve

✎ common tendon sheath with **extensor carpi radialis brevis** - **vagina tendinum mm. extensorum carpi radialis** (see below); all muscles containing „carpi“ in their name perform adduction of the hand



EXTENSOR CARPI RADIALIS BREVIS MUSCLE

↳ lateral epicondyle of the humerus + radial collateral ligament

→| dorsal surface of the base of the 3rd metacarpal

⇌ dorsal flexion in the radiocarpal joint; radial adduction of the hand

⬇ radial nerve (deep branch)

✎ common tendon sheath with **extensor carpi radialis longus** - **vagina tendinum mm. extensorum carpi radialis** (see above); all muscles containing „carpi“ in their name perform adduction of the hand

1.5.6 Muscles of the forearm – lateral group (deep layer)



SUPINATOR MUSCLE

- ↳ lateral epicondyle of the humerus + radial collateral ligament + anular radial ligament (*superficial layer*); supinator crest of the ulna (*deep layer*)
- lateral and proximal side to the pronator tuberosity of the radius
- ⇔ supination of the forearm
- ⬇ radial nerve (deep branch)
- ✎ between the two layers is located **supinator canal**, which contains **radial nerve** together with **recurrent radial artery**

1.5.7 Muscles of the forearm – dorsal group (superficial layer)



EXTENSOR DIGITORUM MUSCLE

- ↳ lateral epicondyle of the humerus
- dorsal aponeurosis of the hand + dorsal surface of basis of middle and terminal phalanges of 2nd to 5th fingers
- ⇔ extension in proximal and terminal interphalangeal joints; extension in metacarpophalangeal joints; dorsal flexion in radiocarpal joints
- ⬇ radial nerve (deep branch)
- ✎ on the dorsal surface of the hand **intertendinous connections** are present between the individual tendons; common tendon sheath with **extensor indicis – vagina tendinum m. extensoris digitorum et extensoris indicis** (see below)



EXTENSOR DIGITI MINIMI MUSCLE

- ↳ lateral epicondyle of the humerus
- dorsal aponeurosis of the fifth finger + bases of middle and terminal phalanges of the fifth finger
- ⇔ common with extensor digitorum – only for 5th finger
- ⬇ radial nerve (deep branch)
- ✎ insertion tendon is divided into two and merges with tendon of **extensor digitorum** in dorsal aponeurosis of the 5th finger – has its own tendon sheath (**vagina tendinis m. extensoris digiti minimi**)



EXTENSOR CARPI ULNARIS MUSCLE

- *humeral head*
- *ulnar head*

↳ lateral epicondyle of the humerus (*humeral head*); posterior margin of the ulna distal to the insertion of anconeus (*ulnar head*)

→ dorsal surface of the base of the 5th metacarpal

⇔ dorsal flexion in the radiocarpal joint; ulnar adduction of the hand

⬇ radial nerve (deep branch)

🔪 all muscles containing „carpi“ in their name perform adduction of the hand; tendon sheath is covered by **vagina tendinis m. extensoris carpi ulnaris**

1.5.8 Muscles of the forearm – posterior group (deep layer)



ABDUCTOR POLLICIS LONGUS MUSCLE

↳ dorsal surface of the radius, ulna and interosseous membrane

→ radial surface of the base of the 1st metacarpal

⇔ abduction in the first carpometacarpal joint (abduction of the thumb)

⬇ radial nerve (deep branch)

🔪 common tendon sheath with **extensor pollicis brevis** – **vagina tendinum m. abductoris pollicis longi et extensoris pollicis brevis** (ventral margin of the **radial foveola** – see below)



EXTENSOR POLLICIS BREVIS MUSCLE

↳ dorsal surface of the radius + interosseous membrane distal to the origin of the abductor pollicis longus

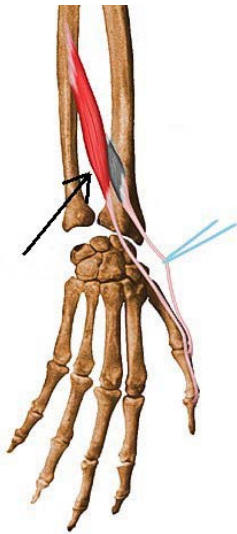
→ dorsal surface of the proximal phalanx of the thumb

⇔ extension in the metacarpophalangeal joint of the thumb

⬇ radial nerve (deep branch)

🔪 common tendon sheath with **abductor pollicis longus** - **vagina tendinum m. abductoris pollicis longi et extensoris pollicis brevis** (ventral margin of **radial foveola** – see below)

EXTENSOR POLLICIS LONGUS MUSCLE



↳ dorsal surface of the ulna + interosseous membrane distal to the origin of abductor pollicis longus

→ dorsal surface of the base of the terminal phalanx of the thumb

⇔ extension in the interphalangeal joint of the thumb; extension in the metacarpophalangeal joint of the thumb; extension in the carpometacarpal joint of the thumb; auxiliary adduction in carpometacarpal joint of the thumb (only when the thumb is abducted)

⬇ radial nerve (deep branch)

✂ insertion tendon is covered by **vagina tendinis m. extensoris pollicis longi**

EXTENSOR INDICIS MUSCLE



↳ dorsal surface of the ulna + interosseous membrane distal to origins of the thumb extensors

→ dorsal aponeurosis of the index (usually as far as terminal phalanx)

⇔ extension in the 2nd proximal and terminal interphalangeal joint; extension in the 2nd metacarpophalangeal joint; dorsal flexion in the radiocarpal joint

⬇ radial nerve (deep branch)

✂ common tendon sheath with **extensor digitorum** - **vagina tendinum m. extensoris digitorum et extensoris indicis** (see above)

1.6 Muscles of the hand

1.6.1 Muscles of the hand – thenar group



ABDUCTOR POLLICIS BREVIS MUSCLE

↳ radial carpal eminence (scaphoid tubercle + lateral part of the flexor retinaculum)

→ radial surface of the base of the proximal phalanx of the thumb + radial sesamoid bone

⇔ abduction of the thumb

⬇ median nerve

FLEXOR POLLICIS BREVIS MUSCLE



- *superficial head*
- *deep head*

↳ **radial carpal eminence** (tubercle of the trapezium + lateral part of the flexor retinaculum; *superficial head*); **trapezoid + capitate + palmar intercarpal ligament** (*deep head*)

→ **lateral surface of the base of the proximal phalanx of the thumb + radial sesamoid bone** (both heads)

≡ **flexion in the 1st metacarpophalangeal ligament**

⊥ **median nerve** (*superficial head*) + **deep branch of the ulnar nerve** (*deep head*)

✂ **between both heads runs tendon of flexor pollicis longus**, dividing muscles of the thumb to 2 innervation areas (**median nerve** and **ulnar nerve**)

OPPONENS POLLICIS MUSCLE



↳ **radial carpal eminence** (tubercle of the trapezium + lateral part of the flexor retinaculum)

→ **radial margin of the 1st metacarpal** (crista musculi opponens)

≡ **opposition of the thumb + flexion in the carpometacarpal joint of the thumb**

⊥ **median nerve**

✂ **the muscle is covered by abductor pollicis brevis**; other muscles of the thenar group also take action during opposition of the thumb (**abductor pollicis longus and brevis; adductor pollicis; 1st dorsal interosseous**) – **opponens pollicis** performs only rotation, which puts the thumb to opposition



ADDUCTOR POLLICIS MUSCLE

- *oblique head*
- *transverse head*

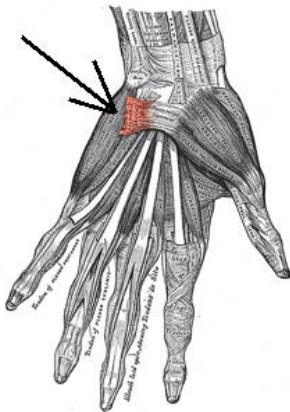
↳ capitate + trapezoid + base of the 2nd and 3rd metacarpal + intercarpal palmar ligaments (*oblique head*); distal 2/3 of the 3rd metacarpal (*transverse head*)

→ medial surface of the base of the proximal phalanx of the thumb + ulnar sesamoid bone

⇄ adduction of the thumb

⬇ ulnar nerve (deep branch)

1.6.2 Muscles of the hand – hypothenar group



PALMARIS BREVIS MUSCLE

↳ ulnar margin of the palmar aponeurosis + ulnar part of flexor retinaculum

→ skin of the hypothenar

⇄ insignificant (it forms a groove in the palm when contracts)

⬇ ulnar nerve (superficial branch)

✂ subcutaneous muscle bordering the ulnar canal (see below)



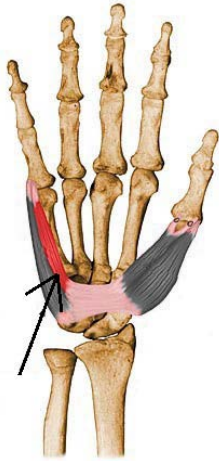
ABDUCTOR DIGITI MINIMI MUSCLE

↳ pisiform + pisohamate ligament + tendon of flexor carpi ulnaris

→ medial surface of the basis of the 5th proximal phalanx

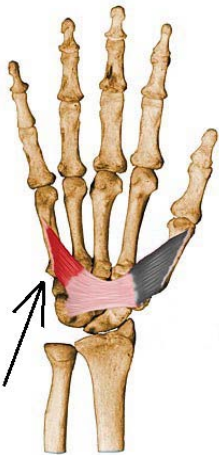
⇄ abduction of the 5th finger

⬇ ulnar nerve (deep branch)



FLEXOR DIGITI MINIMI BREVIS MUSCLE

- ↳ hamulus of the hamate + ulnar part of flexor retinaculum
- medial surface of the base of the 5th proximal phalanx
- ⇔ flexion of the 5th finger
- ⊥ ulnar nerve (deep branch)
- ✂ flexor digiti minimi longus muscle does not exist

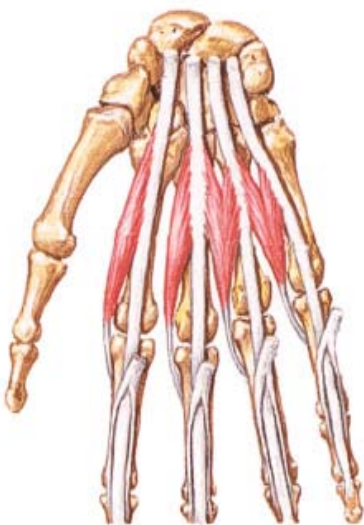


OPPONENS DIGITI MINIMI MUSCLE

- ↳ hamulus of the hamate + ulnar part of the flexor retinaculum
- ulnar margin of the 5th metacarpal
- ⇔ adduction of the 5th finger (opposition function is minimal)
- ⊥ ulnar nerve (deep branch)
- ✂ the muscle is covered by abductor digiti minimi and flexor digiti minimi brevis

1.6.3 Muscles of the hand – muscles of the intermediate space

LUMBRICAL MUSCLES (I - IV)



- ↳ radial margins of the tendons of flexor digitorum profundus in intermetacarpal spaces (I – radial margin of the tendon to the 1st finger; II to IV – on both tendons adjacent to corresponding intermetacarpal space)
- dorsal aponeurosis + bases of the proximal phalanges of corresponding fingers
- ⇔ flexion in the metacarpophalangeal joints; extension in the proximal and terminal interphalangeal joints; adduct fingers to the thumb
- ⊥ median nerve (I + II); ulnar nerve (deep branch) (III + IV)
- ✂ innervations for each fingers is the same as for flexor digitorum profundus, from whose tendons lumbrical muscles origin

PALMAR INTEROSSEOUS MUSCLES (I - III)



↳ 3 muscles in the 2nd to the 4th intermetacarpal spaces on the margins of the metacarpals adjacent to the 3rd finger (I – ulnar margin of the 2nd metacarpal; II radial margin of the 4th metacarpal; III – radial margin of the 5th metacarpal)

→| dorsal aponeurosis + bases of the proximal phalanges (I – ulnar margin of the 2nd finger; II – radial margin of the 4th finger; III – radial margin of the 5th finger)

⇌ adduction of the fingers towards the 3rd finger

⊥ ulnar nerve (deep branch)

✎ axis of the function lies along the 3rd finger (the 3rd finger does not move during adduction of other fingers)

MUSCULI INTEROSSEI DORSALES (I - IV)



↳ 4 muscles, each by two heads from the adjacent sides of the five metacarpal bones

→| dorsal aponeurosis + bases of the terminal phalanges (I – radial margin of the 2nd finger; II – radial margin of the 3rd finger; III – ulnar margin of the 3rd finger; IV – ulnar margin of the 4th finger)

⇌ abduction of the fingers from the 3rd finger

⊥ ulnar nerve (deep branch)

✎ axis of the function lies along 3rd finger (the 3rd finger is not moving during the abduction)

2. MUSCLES OF LOWER EXTREMITY

2.1 Muscles of the hip joint

2.1.1 Muscles of the hip joint – anterior group

ILIOPSOAS MUSCLE



- *psoas major muscle*
- *iliacus muscle*
- *psoas minor muscle*

↳ lateral surfaces of T12 - L5 + their intervertebral discs + costal processes of L1 - L5 (*psoas major*); iliac fossa (*iliacus*); lateral surfaces of T12 - L1 + their intervertebral discs (*psoas minor*)

→ lesser trochanter (*psoas major + iliacus*); iliopubic eminence (*psoas minor*)

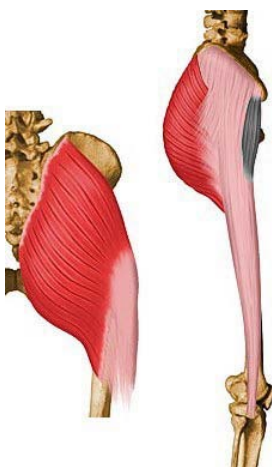
⇔ flexion + lateral rotation in the hip joint; auxiliary adduction in the hip joint; *psoas minor* is a weak trunk flexor

⚠ femoral nerve + direct branches from the lumbar plexus L1 – L3, which is located directly under *psoas major*

✂ *psoas minor* is missing in 40% cases; muscle paralysis makes walking practically impossible (lifting the leg forward is not possible); between muscle and bone is located the **subtendineous iliac bursa**

2.1.2 Muscles of the hip joint – posterior group (superficial layer)

GLUTEUS MAXIMUS MUSCLE



↳ ala of the ilium dorsal to the posterior gluteal line + external lip of the iliac crest + thoracolumbal fascia + margin of the sacrum + coccyx + sacrotuberal ligament

→ gluteal tuberosity of the femur + iliotibial tract of fascia lata

⇔ extension + lateral rotation in the hip joint; adduction in the hip joint (only distal part); abduction in the hip joint (only proximal part); auxiliary fixing extension in the knee joint (by tensing iliotibial tract)

⚠ inferior gluteal nerve

✂ between insertions of gluteal muscles and greater trochanter of the femur lie **intertrochanteric bursae**

GLUTEUS MEDIUS MUSCLE



↳ ala of the ilium between posterior and anterior gluteal lines + external lip of the iliac crest

→ greater trochanter of the femur

⇔ abduction in the hip joint; medial rotation in the hip joint (only anterior fibres); lateral rotation in the hip joint (only posterior fibres)

⬇ superior gluteal nerve

✂ performs all movements in the hip joint except abduction; between insertions of **the gluteal muscles** and **the greater trochanter of the femur** lie **intertrochanteric bursae**

GLUTEUS MINIMUS MUSCLE



↳ ala of the ilium between the anterior and inferior gluteal lines

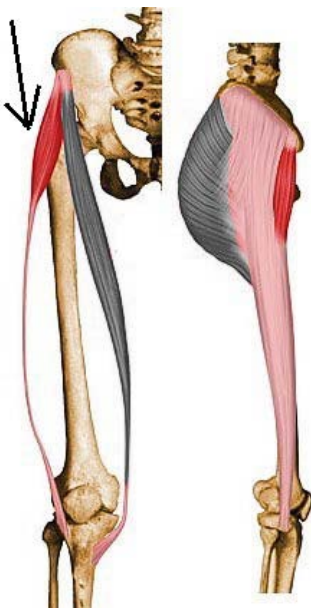
→ greater trochanter of the femur

⇔ identical with gluteus medius (see above), but with lesser effect

⬇ superior gluteal nerve

✂ performs all movements in the hip joint except abduction; between insertions of the **gluteal muscles** and **the greater trochanter of the femur** lie **intertrochanteric bursae**

TENSOR FASCIAE LATAE MUSCLE



↳ anterior superior iliac spine + adjacent part of the external lip of the iliac crest

→ iliotibial tract (longitudinal fibrous reinforcement of the fascia lata, on the lateral side inserting to the lateral tibial condyle – *tuberositas tractus iliotibialis Gerdyi*)

⇔ auxiliary flexion, abduction and medial rotation in the hip joint; keeps extension in knee joint (by tensing iliotibial tract)

⬇ superior gluteal nerve

2.1.3 Muscles of the hip joint – posterior group (deep layer)



PIRIFORMIS MUSCLE

- ↳ pelvic surface of the sacrum
- greater trochanter of the femur
- ⇄ lateral rotation in the hip joint in an extended extremity; abduction in the hip joint in a flexed extremity
- ⚡ direct branches from the sacral plexus
- ✂ divides major sciatic foramen to suprapiriform and infrapiriform foramen



SUPERIOR GEMELLUS MUSCLE

- ↳ ischial spine
- little facet above the trochanteric fossa
- ⇄ lateral rotation in the hip joint in an extended extremity; abduction in the hip joint in a flexed extremity
- ⚡ direct branches from the sacral plexus



OBTURATOR INTERNUS MUSCLE

- ↳ inner surface of the obturator membrane + adjacent bone edges
- little facet above the trochanteric fossa
- ⇄ lateral rotation in the hip joint in an extended extremity; abduction in the hip joint in a flexed extremity
- ⚡ direct branches from the sacral plexus



INFERIOR GEMELLUS MUSCLE

- ↳ upper part of the the ischial tuberosity
- little facet above the trochanteric fossa
- ⇔ lateral rotation in the hip joint in an extended extremity; abduction in the hip joint in a flexed extremity
- ⚡ direct branches from the sacral plexus

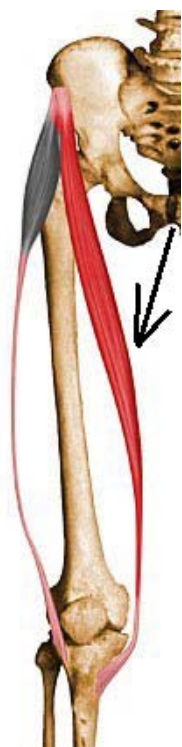


QUADRATUS FEMORIS MUSCLE

- ↳ lateral border of the ischial tuberosity
- quadrate tubercle on the intertrochanteric crest
- ⇔ lateral rotation in the hip joint
- ⚡ direct branches from the sacral plexus

2.2 Muscles of the thigh

2.2.1 Muscles of the thigh – anterior group



SARTORIUS MUSCLE

- ↳ anterior superior iliac spine
- medial condyle of the tibia by pes anserinus major
- ⇔ flexion, abduction and lateral rotation in the hip joint; flexion and medial rotation in the knee joint
- ⚡ femoral nerve
- ✂ pes anserinus major („goose’s foot“) is a common insertion of three muscles (sartorius, gracilis and semitendinosus) to the **medial condyle of the tibia** next to **tibial tuberosity**; between **medial condyle of the tibia** and **pes anserinus major** lies **bursa anserina**; contains the longest muscle fibres in the human body

QUADRICEPS FEMORIS MUSCLE



- *rectus femoris (straight head and reflected head)*
- *vastus medialis*
- *vastus lateralis*
- *vastus intermedius*

↳ anterior inferior iliac spine + supraacetabular groove (*rectus femoris – straight head and reflected head*); medial lip of the linea aspera + distal (medial) part of the intertrochanteric line (*vastus medialis*); lateral lip of the linea aspera + proximal (lateral) part of the intertrochanteric line (*vastus lateralis*); anterior surface of the femur distal to the intertrochanteric line (*vastus intermedius*)

→ tibial tuberosity by the patellar ligament

⇌ extension in the knee joint; flexion in the hip joint (only *rectus femoris*)

⊥ femoral nerve

✎ *vastus intermedius* covers articular muscle of the knee, which inserts to the capsule of the knee joint, preventing its incarceration in extension in the knee joint; several bursae are located near the knee joint (see below)

2.2.2 Muscles of the thigh – adductor group



PECTINEUS MUSCLE

↳ pecten of the pubis

→ pectineal line of the femur

⇌ adduction, lateral rotation and auxiliary flexion in the hip joint

⊥ femoral nerve + obturator nerve (anterior branch)

✎ diploneural muscle



ADDUCTOR LONGUS MUSCLE

- ↳ pubis between the pubic tubercle and the pubic symphysis
- middle third of the medial lip of the linea aspera
- ⇌ adduction, lateral rotation and auxiliary flexion in the hip joint
- ⬇ obturator nerve (anterior branch)



GRACILIS MUSCLE

- ↳ caudal part of the body and inferior ramus of the the pubic bone
- medial condyle of the tibia by pes anserinus major („goose’s foot“)
- ⇌ adduction in the hip joint; auxiliary flexion in the knee joint; medial rotation in knee joint in flexed knee joint
- ⬇ obturator nerve (anterior branch)
- ✂ pes anserinus major („goose’s foot“) is a common insertion of three muscles (sartorius, gracilis and semitendinosus) to the **medial condyle of the tibia** next to **tibial tuberosity**; between **medial condyle of the tibia** and **pes anserinus major** lies **bursa anserina**



ADDUCTOR BREVIS MUSCLE

- ↳ inferior ramus of the pubic bone lateral to the pubic symphysis
- proximal third of the medial lip of the linea aspera
- ⇌ adduction, lateral rotation and auxiliary flexion in the hip joint
- ⬇ obturator nerve (anterior branch)

ADDUCTOR MAGNUS MUSCLE



↳ ischiopubic ramus (ramus of ischium + inferior ramus of the pubis; ischial tuberosity)

→ medial lip of the linea aspera (*part originating on the inferior ramus of the pubis and the ramus of the ischium*); adductor tubercle on the medial epicondyle (*part originating on the sciatic tuberosity*)

⇔ adduction in the hip joint (both parts) + auxiliary extension in the hip joint (part inserting to the adductor tubercle); auxiliary lateral rotation in the hip joint (proximal part of the muscle); auxiliary medial rotation in the hip joint (distal part of the muscle)

⊥ obturator nerve (posterior branch) – part inserting to the medial lip of the linea aspera + sciatic nerve / tibial nerve (part originating on the sciatic tuberosity)

✂ diploneural muscle; between both insertion parts of the muscle (ontogenetically these were two separate muscles, which in humans merged together) is tendinous arcade (**adductor hiatus**), which is crossed by **femoral vessels** (see below)

OBTURATOR EXTERNUS MUSCLE



↳ outer surface of the obturator membrane + adjacent bone edges

→ trochanteric fossa

⇔ lateral rotation + auxiliary adduction in the hip joint

⊥ obturator nerve (posterior branch)

2.2.3 Muscles of the thigh – posterior group (hamstring muscles)

BICEPS FEMORIS MUSCLE



- *long head*
- *short head*

↳ sciatic tuberosity (*long head*); middle third of the lateral hip of the linea aspera (*short head*)

→| head of the fibula

⇌ flexion in the knee joint; lateral rotation of the knee joint in a flexed knee joint; auxiliary extension + auxiliary adduction in the hip joint (only *long head*)

⊥ sciatic nerve / tibial nerve (*long head*); sciatic nerve / common fibular nerve (*short head*)

SEMITENDINOSUS MUSCLE



↳ sciatic tuberosity

→| medial epicondyle of the tibia by pes anserinus major („goose’s foot“)

⇌ flexion in the knee joint; medial rotation in the knee joint in a flexed knee joint; auxiliary extension + auxiliary adduction in the hip joint

⊥ sciatic nerve / tibial nerve

✂ pes anserinus major („goose’s foot“) is a common insertion of three muscles (sartorius, gracilis and semitendinosus) to the medial condyle of the tibia next to tibial tuberosity; between medial condyle of the tibia and pes anserinus major lies bursa anserina

SEMIMEMBRANOSUS MUSCLE



↳ sciatic tuberosity

→| 3 insertions (pes anserinus profundus) – anterior to the medial condyle of the tibia + lateral condyle of the femur (as oblique popliteal ligament) + posterior surface of the medial condyle of the tibia

⇌ flexion in the knee joint; medial rotation in the knee joint in a flexed knee joint; auxiliary extension + auxiliary adduction in hip joint

⊥ sciatic nerve / tibial nerve

✂ between medial head of gastrocnemius and muscle insertion of semimembranosus lies gastrocnemio-semimembranosus bursa

2.3 Muscles of the leg

2.3.1 Muscles of the leg – anterior group



TIBIALIS ANTERIOR MUSCLE

- ↳ proximal 2/3 of the lateral surface of the tibia + adjacent interosseous membrane
- plantar surface of the medial cuneiform bone + base of the 1st metatarsal
- ⇄ dorsal flexion + supination of the foot; helps maintaining transverse arch of the foot
- ⬇ deep fibular nerve
- ✍ insertion tendon is covered by the **tendon sheath of tibialis anterior**



EXTENSOR DIGITORUM LONGUS MUSCLE

- ↳ lateral condyle of the tibia + head and anterior crest of the fibula + adjacent part of the interosseous membrane
- dorsal aponeurosis of the 2nd to the 5th digits into the terminal phalanges
- ⇄ dorsal flexion of the leg and toes + pronation of the foot
- ⬇ deep fibular nerve
- ✍ additional, fifth tendon inserting to **base of the 5th metatarsal** with muscle belly is called **fibularis tertius** – it is present in 92% cases; insertion tendons are covered by **tendon sheath of extensor digitorum longus**



EXTENSOR HALLUCIS LONGUS MUSCLE

- ↳ medial surface of the fibula + adjacent interosseous membrane
- dorsal aponeurosis of the 1st digit into the terminal phalanx
- ⇄ extension of the 1st digit + dorsal flexion of the foot
- ⬇ deep fibular nerve
- ✍ insertion tendon is covered by **tendon sheath for extensor hallucis longus**

2.3.2 Muscles of the leg – lateral group

FIBULARIS LONGUS MUSCLE



→ head of the fibula + proximal half of the lateral surface of the fibula

→ plantar surface of the medial cuneiform bone + base of the 1st metatarsal

⇔ pronation, plantar flexion and abduction of the foot; helps maintaining the transverse arch of the foot

⚠ superficial fibular nerve

✂ common tendon sheath with **fibularis brevis** – **vagina communis tendinum mm. fibularium** (see below); insertion tendon is located in **tendon groove of the cuboid** covered by **vagina plantaris tendinis m. fibularis longi**; often used synonym to „fibularis“ is „**peroneus**“ (fibularis longus = peroneus longus etc.)

FIBULARIS BREVIS MUSCLE



→ distal half of the lateral surface of the fibula

→ tuberosity of the 5th metatarsal

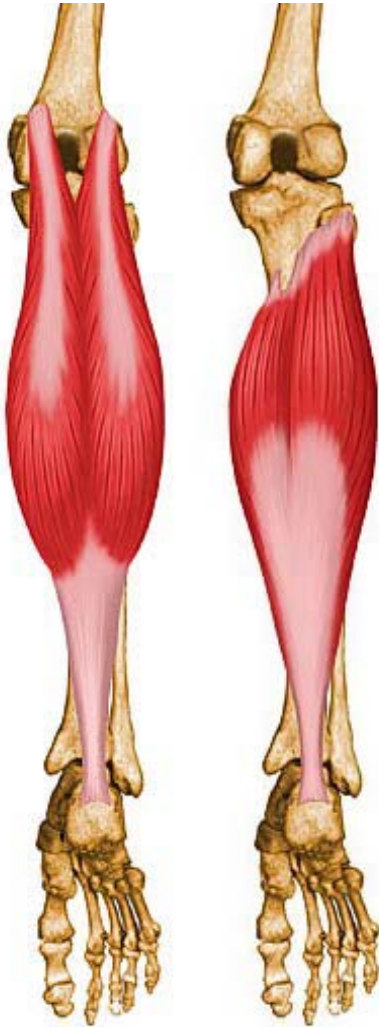
⇔ pronation, plantar flexion and abduction of the foot

⚠ superficial fibular nerve

✂ common tendon with **fibularis longus** - **vagina communis tendinum mm. fibularium** (see above)

2.3.3 Muscles of the leg –posterior group (superficial layer)

TRICEPS SURAE MUSCLE



- *medial head of gastrocnemius*
- *lateral head of gastrocnemius*
- *soleus*

↳ medial epicondyle of the femur / internal supracondylar tubercle (*medial head of gastrocnemius*); lateral epicondyle of the femur / external supracondylar tubercle (*lateral head of gastrocnemius*); head of the fibula + line of the soleus muscle on the tibia (*soleus*)

→| tuber calcanei as the calcanean tendon (Achilles tendon)

⇔ plantar flexion of the foot; flexion in the knee joint (only *gastrocnemius*)

⬇ tibial nerve

✂ origin of *soleus* is connected to the bone structures by **tendineous arch of soleus**, which is crossed by **tibial nerve** and **posterior tibial vessels**; **calcanean tendon** is not covered by tendon sheath – only by **peritenonium** (see below); *gastrocnemius* is dynamic and *soleus* static muscle; between **medial head of gastrocnemius** and insertion of **semimembranosus** lies **bursa gastrocnemio-semimembranosa**; in area of **calcanean tendon** two **bursae** are located – **bursa subcutanea calcanea** (between skin and calcanean tendon) and **bursa tendinis calcanei** (between tuber calcanei and calcanean tendon)

PLANTARIS MUSCLE



↳ popliteal surface of the femur (lateral supracondylar line)

→| insertion tendon merge together with calcanean tendon (Achilles tendon) and inserts to the tuber calcanei

⇔ weak plantar flexion of the foot; auxiliary flexion in the knee joint

⬇ tibial nerve

✂ rudimentary muscle corresponding to **palmaris longus** of upper extremity (is missing in 5% of cases); it is used for tendon reconstructions (after injury elsewhere in the body)

2.3.4 Muscles of the leg – posterior group (deep layer)

POPLITEUS MUSCLE



- ↳ lateral epicondyle of the femur (popliteal groove)
- posterior surface of the proximal tibia (above line of the soleus muscle)
- ⇔ auxiliary flexion of the knee joint; medial rotation in the knee joint in a flexed knee joint; influences the movement of the lateral meniscus
- ⬇ tibial nerve
- ✎ forms the floor of the popliteal fossa (see below)



TIBIALIS POSTERIOR MUSCLE

- ↳ interosseous membrane + adjacent surfaces of the tibia and fibula
- tuberosity of the navicular bone + plantar surface of the cuneiformis + cuboideum and basis of the 2nd to the 4th metatarsal
- ⇔ plantar flexion and supination of the foot; helps maintaining the longitudinal arch of the foot
- ⬇ tibial nerve
- ✎ insertion tendon runs in the synovial sheath (*vagina tendinis m. tibialis posterioris*) in the malleolar groove behind the medial malleolus

FLEXOR DIGITORUM LONGUS MUSCLE



- ↳ medial part of the posterior surface of the tibia
- plantar surface of the terminal phalanges of the 2nd to the 5th digits
- ⇔ plantar flexion of the digits and foot; helps maintaining the longitudinal arch of the foot
- ⬇ tibial nerve
- ✎ insertion tendon runs in the synovial sheath (*vagina tendinis m. flexoris digitorum longi*) in the malleolar groove behind the medial malleolus; insertion tendons on the digits have common insertion tendon with *flexor digitorum brevis* (*vaginae fibrosae et synoviales digitorum pedis*)

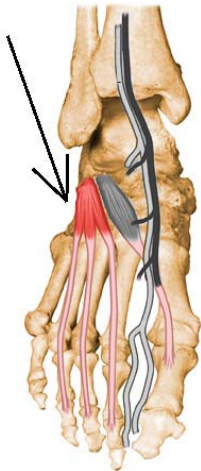


FLEXOR HALLUCIS LONGUS MUSCLE

- distal 2/3 of the posterior surface of the fibula + adjacent interosseous membrane
- plantar surface of the terminal phalanx of the 1st digit
- ⇌ flexion of the 1st digit; plantar flexion of the foot; helps maintaining the longitudinal arch of the foot
- ⬇ tibial nerve
- ✎ big toe is an important stabilizing point – this muscle is bigger than **flexor digitorum longus**; helps maintaining the longitudinal arch of the foot; insertion tendon is covered by **vagina tendinis m. flexoris hallucis longi**

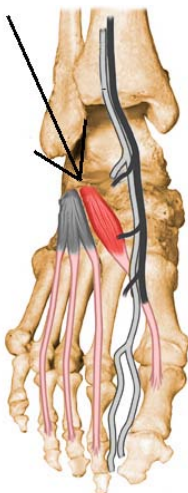
2.4 Muscles of the foot

2.4.1 Muscles of the foot – dorsal group



EXTENSOR DIGITORUM BREVIS MUSCLE

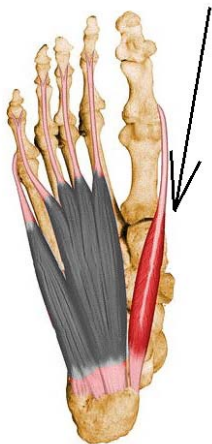
- dorsal surface of the calcaneus + adjacent tarsal ligaments
- dorsal aponeurosis of the 2nd to the 4th digit
- ⇌ extension of the 2nd to the 4th digit
- ⬇ deep fibular nerve



EXTENSOR HALLUCIS BREVIS MUSCLE

- dorsal surface of the calcaneus + adjacent tarsal ligaments
- dorsal aponeurosis of the 1st digit (together with the tendon of extensor hallucis longus)
- ⇌ extension of the 1st digit
- ⬇ deep fibular nerve

2.4.2 Muscles of the foot – muscles of the 1st digit



ABDUCTOR HALLUCIS MUSCLE

- ↳ medial process of tuber calcanei
- ↳ medial sesamoid bone + base of the proximal phalanx
- ⇔ abduction + auxiliary flexion of the 1st digit; helps maintaining the longitudinal arch of the foot
- ⌞ medial plantar nerve



FLEXOR HALLUCIS BREVIS MUSCLE

- *medial head*
- *lateral head*
- ↳ plantar surface of the cuneiform, navicular and cuboid bones (*head mediale et laterale*)
- ↳ medial sesamoid bone + adjacent part of the base of the proximal phalanx of the 1st digit (*medial head*); lateral sesamoid bone + adjacent part of the base of the proximal phalanx of the 1st digit (*lateral head*)
- ⇔ flexion of the 1st digit in metatarsophalangeal joint
- ⌞ medial plantar nerve



ADDUCTOR HALLUCIS MUSCLE

- *oblique head*
- *transverse head*
- ↳ plantar surface of the base of the 2nd to the 4th metatarsals + adjacent parts of the tarsal bones (*oblique head*); plantar surface of the 3rd to the 5th metatarsophalangeal joint (*transverse head*)
- ↳ lateral sesamoid bone + base of the proximal phalanx of the 1st digit
- ⇔ adduction of the 1st digit; auxiliary flexion in the 1st metatarsophalangeal joint
- ⌞ lateral plantar nerve

2.4.3 Muscles of the foot – muscles of the 5th digit



ABDUCTOR DIGITI MINIMI MUSCLE

- ↳ lateral process of tuber calcanei + outer margin of the plantar aponeurosis
- | tuberosity on the 5th metatarsal + base of proximal phalanx of the 5th digit
- ⇔ abduction + auxiliary flexion of the 5th digit
- ⬇ lateral plantar nerve

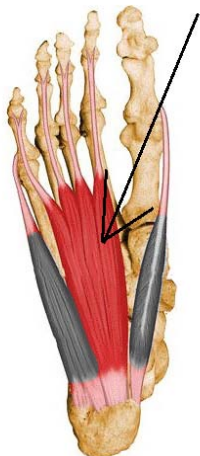


FLEXOR DIGITI MINIMI BREVIS MUSCLE

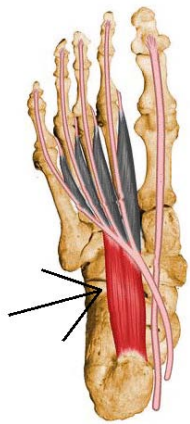
- ↳ base of the 5th metatarsal + long plantar ligament
- | basis of the proximal phalanx of the 5th digit
- ⇔ flexion in the metatarsophalangeal joint of the 5th digit
- ⬇ lateral plantar nerve
- ✂ similar course with insertion on the outer margin of the 5th metatarsal and metatarsophalangeal joint; has non-constant **opponens digiti minimi**, which adducts the 5th digit (both muscles often merge together); flexor digiti minimi longus does not exist

2.4.4 Muscles of the foot – middle group

FLEXOR DIGITORUM BREVIS MUSCLE

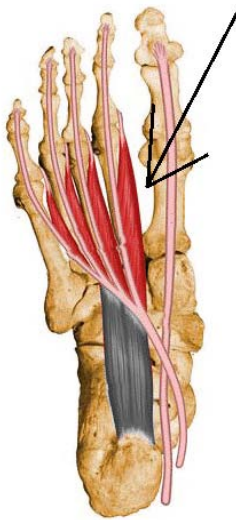


- ↳ medial process of tuber calcanei
- | by 4 tendons, each divided into two slips (**chiasma tendinum**), inserted onto the sides of bases of the medial phalanges of the 2nd to the 5th digits
- ⇔ flexion in the metatarsophalangeal joints; flexion in the proximal interphalangeal joints
- ⬇ medial plantar nerve
- ✂ division of the insertion tendons is crossed by the tendons of **flexor digitorum longus (chiasma tendinum)**; insertion tendons have common tendon sheath with **flexor digitorum brevis (vaginae fibrosae et synoviales digitorum pedis)**



QUADRATUS PLANTAE MUSCLE

- ➔ plantar surface of calcaneus
- ➔ from the lateral side to the tendon of flexor digitorum longus
- ⇌ by its pull it transfers oblique pull of flexor digitorum longus to more direct (aids the flexor function) – „flexor accesorius muscle“
- ⬇ lateral plantar nerve



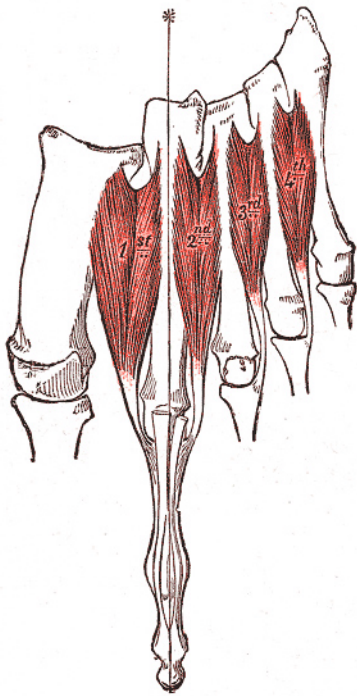
LUMBRICALE MUSCLES (I - IV)

- ➔ medial surfaces of individual tendons of flexor digitorum longus in the intermetatarsal spaces
- ➔ dorsal aponeurosis of the 2nd to the 5th digits
- ⇌ flexion in the metatarsophalangeal joints; extension in the proximal and distal interphalangeal joints; adduct digits to the 1st digit
- ⬇ medial plantar nerve (I + II); lateral plantar nerve (III + IV)



PLANTAR INTEROSSEI MUSCLES (I - III)

- ➔ medial side of the 3rd - 5th metatarsals
- ➔ dorsal aponeurosis of the 3rd to the 5th digits + proximal phalanges of the 3rd to the 5th digits
- ⇌ adduction of the 3rd to the 5th digits towards the 2nd digit; flexion in the proximal and terminal interphalangeal joints
- ⬇ lateral plantar nerve
- ✎ 2nd digit act as a longitudinal axis of the foot (in adduction of digits 2nd digit stays still)



DORSAL INTEROSSEI MUSCLES (I - IV)

→ 4 muscles, each by the two heads from the opposing surfaces of the metatarsals surrounding the intermetatarsal space

→ dorsal aponeurosis of the foot + basis of the proximal phalanges (I – tibial margin of the 2nd digit; II – fibular margin of the 2nd digit; III – fibular margin of the 3rd digit; IV – fibular margin of the 4th digit)

⇄ abduct fingers; flexion in the proximal interphalangeal joints; extension in the terminal interphalangeal joints

⬇ lateral plantar nerve

✂ 2nd digit act as a longitudinal axis of the foot (in abduction of digits 2nd digit stays still)

3. CLINICAL CORRELATIONS OF MUSCLES OF EXTREMITIES

3.1 Rotator cuff

All muscles inserting to the **lesser tubercle of the humerus (subscapularis)** and to the **greater tubercle of the humerus** (in craniocaudal order **supraspinatus, infraspinatus** and **teres minor**) forms a **rotator cuff**. By its “embrace” (see picture) it protects the shoulder joint from subluxation (like deltoid – see above). Symptoms of the rotator cuff injury (for example after fall on the shoulder) are shoulder pain, subluxation of the shoulder joint, restricted rotation movement, aggravated abduction due to the partial or total inability of supraspinatus function.

3.2 Arches of the foot

The feet skeleton is in its physiologic state arched in longitudinal and transverse way. These structures are called **arches of the foot**. They protect blood vessels and nerves of the planta from constriction and act as a shock absorber during walking. They develop relatively late after birth (by the end of the 1st year) – in newborn we speak about **physiologically flat foot**. The foot arch is supported by the pull of muscles and by the ligament structures around planta. The arches are categorized as **transverse** and **longitudinal** (see the picture).

Longitudinal arch is higher on the tibial side and in its forming have major role ligament structures of the plantar side of the foot, which are orientated in the longitudinal way - **long plantar ligament, plantar aponeurosis**, etc. They are not sufficient on their own and also pull of the muscles directing in longitudinal way is necessary – **tibialis anterior, flexor digitorum longus, flexor hallucis longus** and deeper **short muscles of planta**.

Transverse arch is most distinct around the cuneiform and cuboid bones. On its forming take part, like in the longitudinal arch, ligament structures of plantar side of the foot and **tendons of tibialis anterior and fibularis longus**, which insert to the same place (see above). It helps maintaining the longitudinal arch as well.

The most common defect of the arches of the foot is **flat foot (pes planus)**, in which the medial longitudinal arch is depressed or collapsed. Entire sole is in contact with the ground. The most common causes is muscle weakening or overstretching of the ligaments of the arch. That causes foot pain (due to constricted soft tissues of the planta) and depression of the medial malleolus. Less common is **clawfoot (pes cavus)**, when foot is highly arched.

3.3 Compartment syndrome

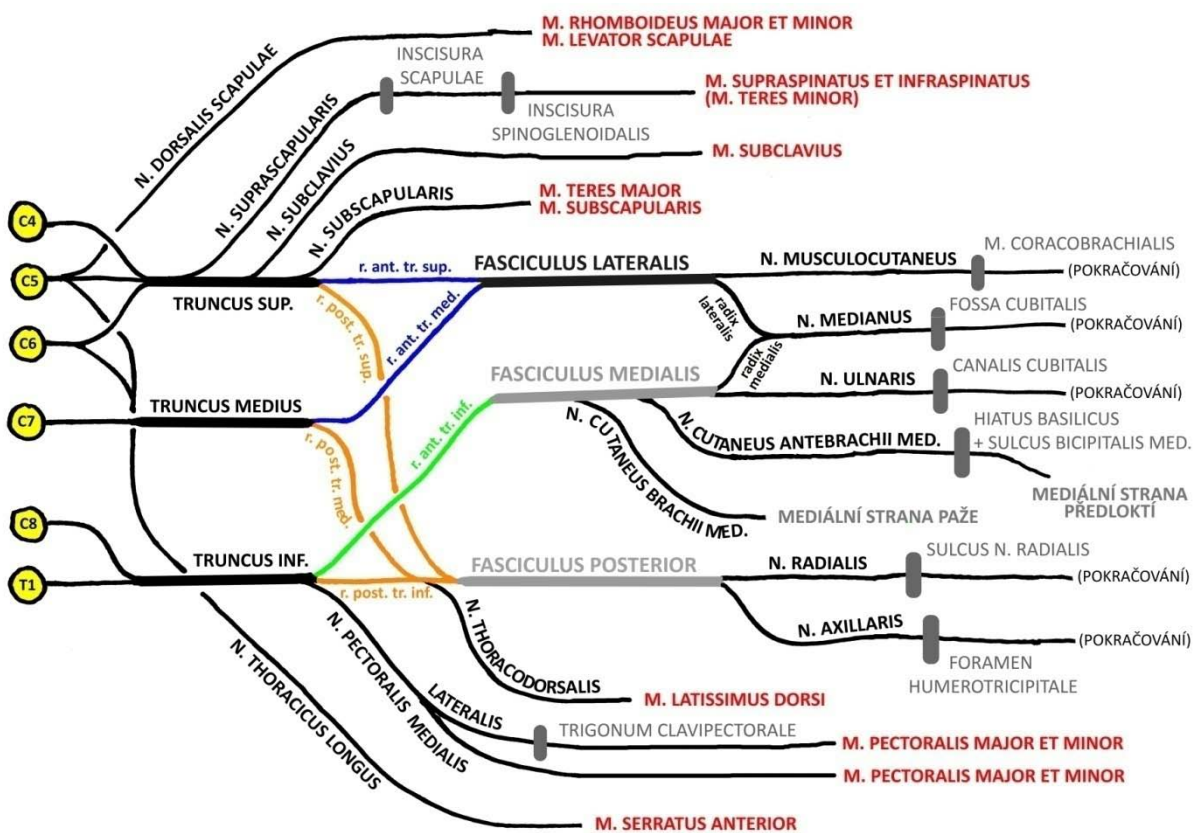
The compartment syndrome is a specific type of muscle injury. It occurs in the first hours after an injury of the muscle or after injuries of the long bones in the leg region, but also in forearm, femur or humerus. Essential is **increased pressure in the fascial space** – mostly caused by **intramuscular bleeding** or **oedema**. That leads to constriction of blood vessels and to **ischemia of muscle tissue with possible necrosis**. That is the biggest complication of the compartment syndrome, which may have implications for the muscle functions, prognosis of the whole extremity and to the overall state of the patient. Treatment of the compartment syndrome is usually surgical, known as **fasciotomy** (or also **dermatofasciotomy**) – cut through the fascia (and skin) in order to reduce the pressure in the fascial space. Non-invasive treatment is usually not sufficient and is used rarely.

4. NERVES OF UPPER EXTREMITY

4.1 Brachial plexus

Brachial plexus is a nervous plexus providing motor and sensitive innervations of the upper extremity. It is formed by union of anterior branches of spinal cord segments **C5 – C8**, they get connections from segments **C4** (cranially) and **T1** (caudally). The whole plexus (together with **subclavian artery**) passes **scalenic fissure**, continues below the **clavicle** in the **axillary fossa** and divides into two parts - **supraclavicular part** and **infraclavicular part** of the brachial plexus.

4.1.1 Supraclavicular part of brachial plexus



Supraclavicular part is the initial part of **brachial plexus**, in which three **trunks** are formed – **superior trunk**, **middle** and **inferior**. Nerves for shoulder girdle muscles originate from this part. That means that from **supraclavicular part of the brachial plexus** are innervated **spinohumeral muscles** (all except **trapezius**, which is innervated by **accessory nerve**), **thoracohumeral muscles** and **shoulder muscles**. Now, let's describe position of the structures on the specimen.

DORSAL SCAPULAR NERVE (C5 and C6) – over *levator scapulae* descends dorsally together with **dorsal scapular** vessels. However on individual specimens of extremities is usually missing or is "loose".

SUPRASCAPULAR NERVE (C4 - C6) – can be found easily in **scapular notch** (see topography), in which it lies under the **superior transverse scapular ligament**. Its passage through **spinoglenoid notch**, where it underlies the **inferior transverse scapular ligament**, usually it is covered by muscles and is not visible.

LONG THORACIC NERVE (C5 and C6) – descends on fleshy slips of **serratus anterior**. On dissected extremities usually loses it's connection with a muscle and remains "loose".

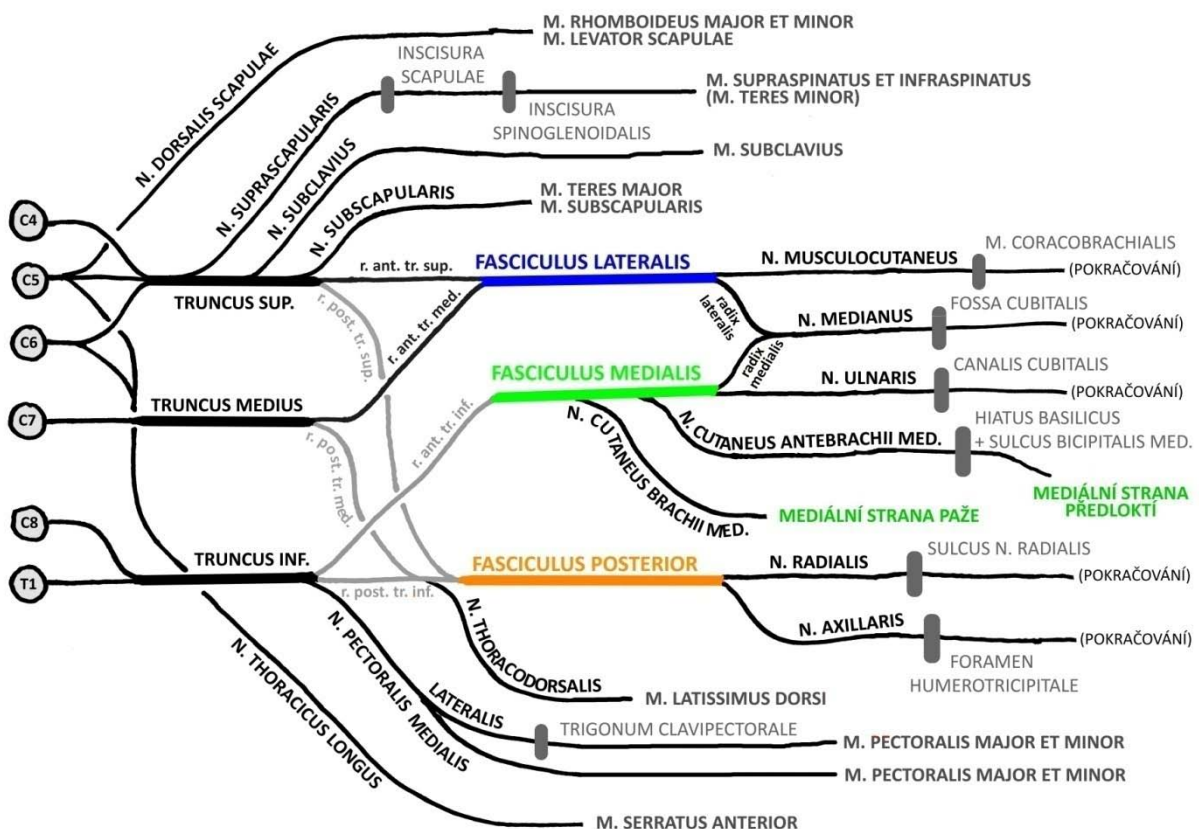
THORACODORSAL NERVE (C6 - C8) – is located at the inner (anterior) surface of **latissimus dorsi**. Like the previous nerve, the connection to the muscle does not remain and we are more likely to find only the part entering the muscle.

SUBSCAPULAR NERVES (C5 - C7) – can be found as thin branches going to **costal surface of the scapula** (right into ventral surface of **subscapularis**) – usually on dissected specimen only parts entering the muscle are preserved.

NERVE TO SUBCLAVIUS (C5 and C6) – usually is not preserved on the specimen

LATERAL AND MEDIAL PECTORAL NERVES (C5 - T1) – usually two nerves entering **pectoral muscles** and often are visible on their dorsal surface. Lateral pectoral nerves can be found also in the depth of **clavipectoral triangle**.

4.1.2 Infraclavicular part of brachial plexus



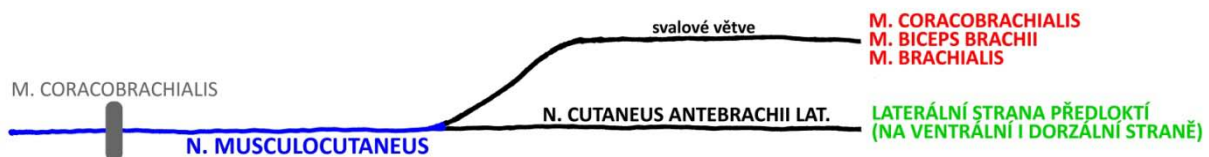
Infraclavicular part of the brachial plexus represents the part of the plexus, which is distal to the clavicle. In this area, from primary **trunks** three **CORDS (fascicles)** are formed – **lateral cord, medial cord and posterior cord**. These cords give branches to nerves for motor and sensitive innervations of the free part of the upper extremity (see below).

Names of these three **CORDS** are derived from their relation to **axillary artery**, which they enclose. Mistakes in their identifying are quite common, brief guide might be handy.

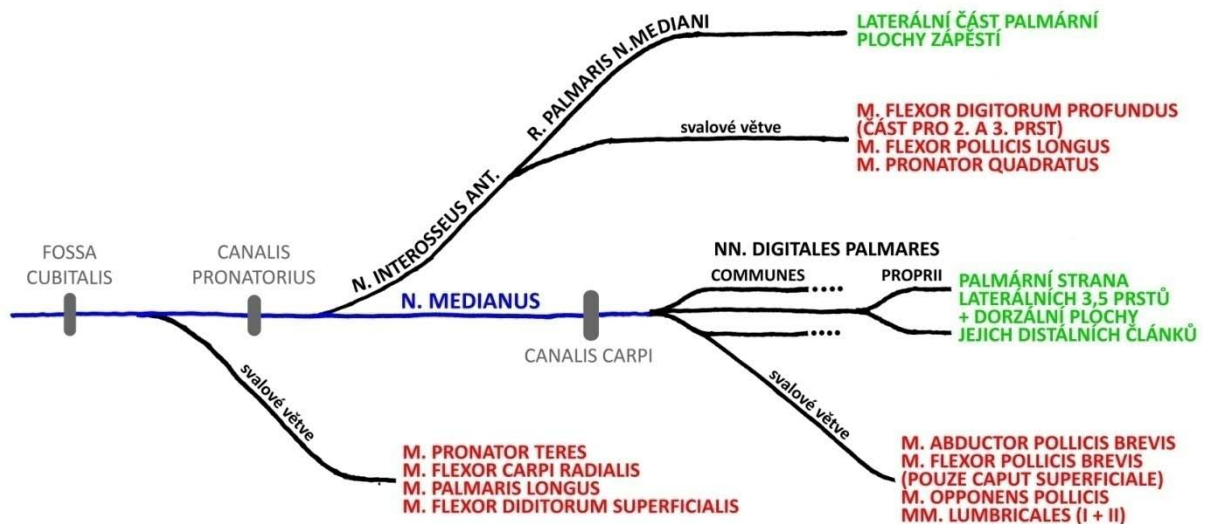
For their 100% identification we must find 4 nerves first – **musculocutaneous nerve, median nerve, ulnar nerve and radial nerve**. **Musculocutaneous nerve** is easily found after we look for **coracobrachialis** (see above), which this nerve penetrates. **Median nerve** is located in **cubital fossa** (see below), which the nerve enters together with **brachial vessels** and thanks to its strength the nerve is quite noticeable. **Ulnar nerve** can be found easily at entry to **cubital canal** behind **medial epicondyle of humerus** (see below) in **groove for the ulnar nerve** (“funny bone”). **Radial nerve** runs around the distal third of the humerus in laterodistal way (in **groove for radial nerve**) together with **deep brachial vessels** between **lateral and medial head of triceps**.

Then we use our knowledge of which nerve is a branch of which cord. We hold **ulnar nerve** and **median nerve** at the same time and continue in proximal way. On **median nerve** we come to bifurcation (connection of **medial root** and **lateral root of median nerve**). On **ulnar nerve** we come straight to **medial cord**, in a place where medial cord gives **medial root of median nerve**. In similar way we proceed with **lateral cord**. We take in hand (forceps) **median nerve** and **musculocutaneous nerve**. On our proximal way we get again to the bifurcation of **median nerve** and with **musculocutaneous nerve** straight to **lateral cord** at the place of branching of **lateral root of median nerve**. Then let’s move to the last cord, **posterior cord**. We will continue in proximal way on **radial nerve** behind **axillary artery**. Proximal from the branching of **axillary nerve** (only branch of **posterior cord**), which runs dorsally to **humerotricipital foramen** (see topography) together with **posterior circumflex vessels of the humerus**, lies the **axillary nerve**. We will find the individual nerves of **infraclavicular part of brachial plexus** in following way:

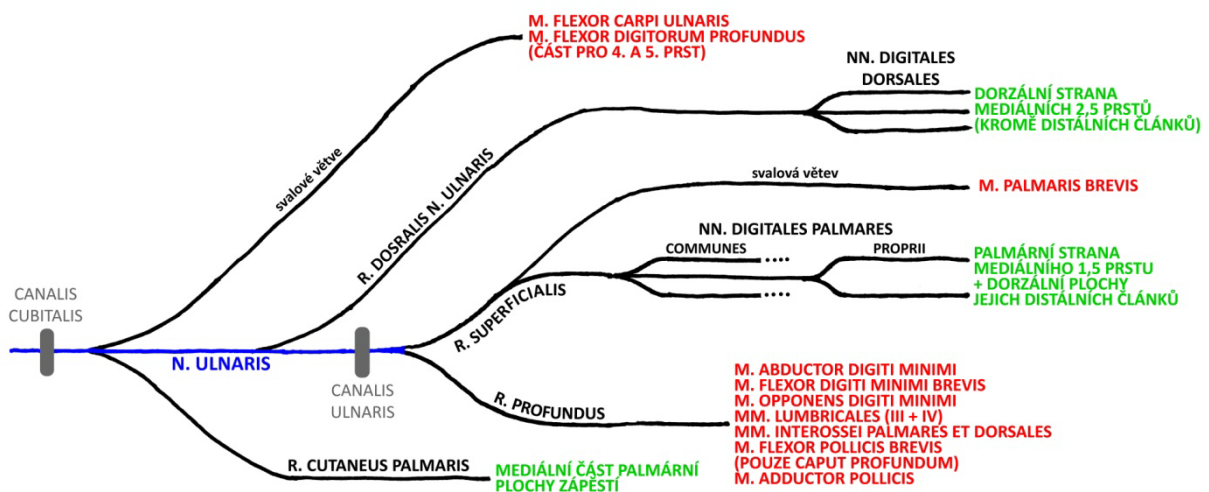
MUSCULOCUTANEOUS (NERVE C5 - C7) – easily to be found in the place of its perforation of **coracobrachialis** (see above).



MEDIAN NERVE (C6 - T1) – beside its course on the arm together with **brachial vessels** and in **cubital fossa** (and following in **pronator canal** – see topography) we can find median nerve easily in **carpal canal** (see topography) just under the **flexor retinaculum**, where it emerges on the surface from the depth of the forearm, where it runs **between 2nd and 3rd layer of anterior group of muscles of the forearm**.



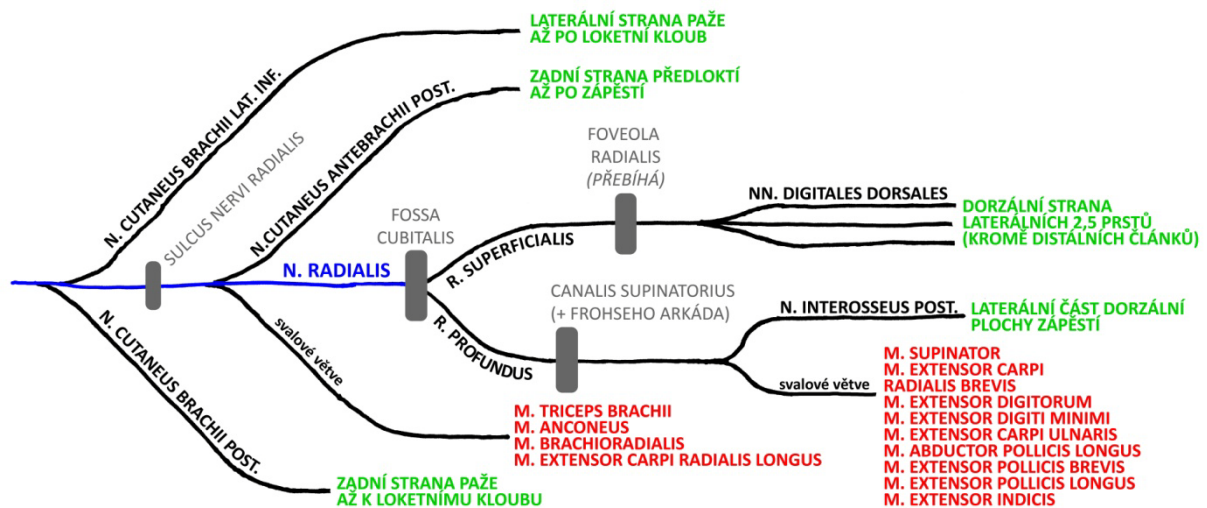
ULNAR NERVE (C7 – T1) – beside in the *groove for ulnar nerve* and in the *cubital canal*, we can easily identify the nerve in *ulnar canal* (see topography), in which it runs with *ulnar vessels*.



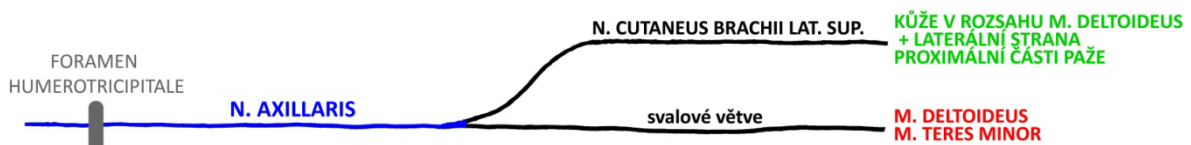
MEDIAL CUTANEOUS BRACHIAL NERVE – does not usually remain on the specimens.

MEDIAL CUTANEOUS ANTEBRACHIAL NERVE – if preserved, can be found in *medial bicipital groove* (see topography), where it accompanies *basilic vein*.

RADIAL NERVE (C5 – T1) – beside places mentioned above, can be found easily in the depth of *cubital fossa*, which the radial nerve enters between *brachialis* and *brachioradialis* (lies on *supinator*) from dorsal side of arm, shortly before it gives *superficial and deep branch of radial nerve*.



AXILLARY NERVE (C5 and C6) – can be found easily in *humerotricipital foramen* (see topography) together with *posterior circumflex vessels of the humerus*, shortly after it branches from *posterior cord* – easier is to look for the nerve from the dorsal side



4.2 Review of motor innervations of the upper extremity

ACCESSORY NERVE (accessory nerve is one of 12 cranial nerves and is not part of brachial plexus – see anatomy books for more detail): **trapezius**

4.2.1 From supraclavicular part of brachial plexus

DORSAL SCAPULAR NERVE: whole second layer of back muscles (**rhomboid major and minor; levator scapulae**)

SUPRASCAPULAR NERVE: **supraspinatus; infraspinatus**; variation **m. teres minor**

NERVE TO SUBCLAVIUS: **subclavius**

SUBSCAPULAR NERVE: **subscapularis; teres major**

THORACODORSAL NERVE: **latissimus dorsi**

MEDIAL PECTORAL NERVE: **pectoralis major and minor**

LATERAL PECTORAL NERVE: **pectoralis major**

LONG THORACIC NERVE: **serratus anterior**

4.2.2 From infraclavicular part of brachial plexus

MUSCULOCUTANEOUS NERVE: whole anterior group of muscles of the arm (**coracobrachialis; biceps brachii; brachialis**)

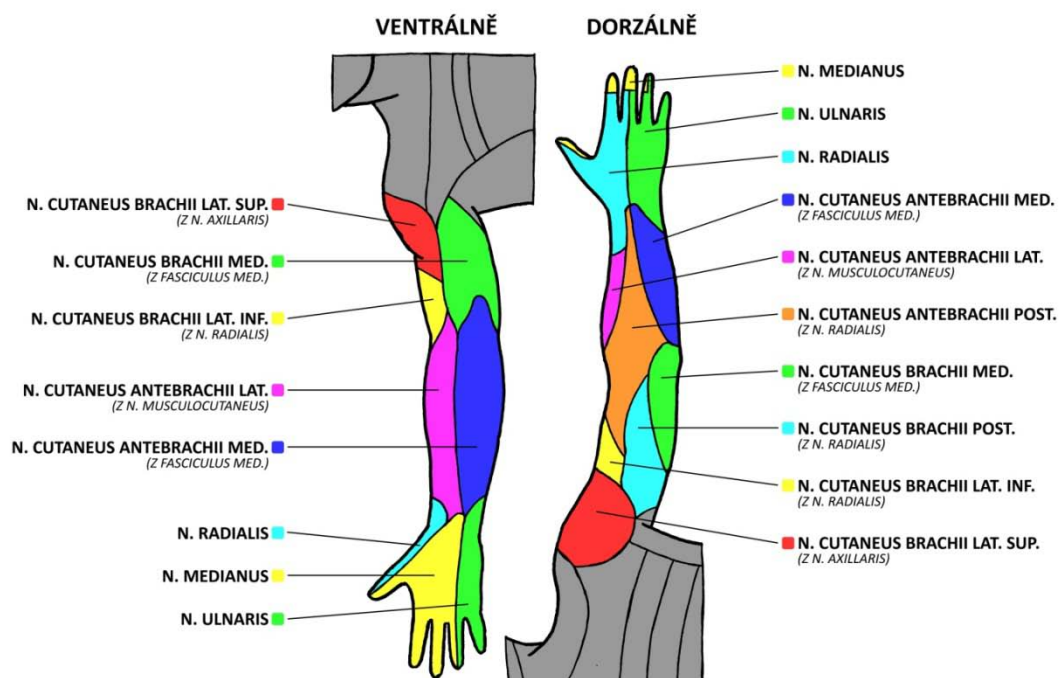
MEDIAN NERVE: whole anterior group of muscles of the forearm **WITH EXCEPTION OF FLEXOR CARPI ULNARIS AND PART OF FLEXOR DIGITORUM PROFUNDUS FOR 4th AND 5th DIGIT!!!** (**pronator teres; flexor carpi radialis; palmaris longus; flexor digitorum superficialis; part of flexor digitorum profundus for 2nd and 3rd digit; flexor pollicis longus; pronator quadratus**); muscles of the thenar **WITH EXEPTION OF ADDUCTOR POLLICIS AND DEEP HEAD OF FLEXOR POLLICIS BREVIS!!!** (**abductor pollicis brevis; superficial head of flexor pollicis brevis; opponens pollicis**); **lumbricales I and II**

ULNAR NERVE: from anterior group of muscles of the forearm **flexor carpi ulnaris** and **part of flexor digitorum profundus for 4th and 5th digit (INNERVATION EXCEPTIONS!!! – see above)**; from thenar muscle group **deep head of flexor pollicis brevis** and **adductor pollicis (INNERVATION EXCEPTIONS!!! – see above)**; all other muscles of the hand (**palmaris brevis; abductor digiti minimi; flexor digiti minimi brevis; opponens digiti minimi; lumbricales III and IV; palmar and dorsal interossei**)

RADIAL NERVE: whole posterior group of muscles of the arm (**triceps brachii; anconeus**); whole lateral group of muscles of the forearm (**brachioradialis; extensor carpi radialis longus and brevis; supinator**); whole posterior group of muscles of the forearm (**extensor digitorum; extensor digiti minimi; extensor carpi ulnaris; abductor pollicis longus; extensor pollicis longus and brevis; extensor indicis**) – innervates all extensors on the upper extremity

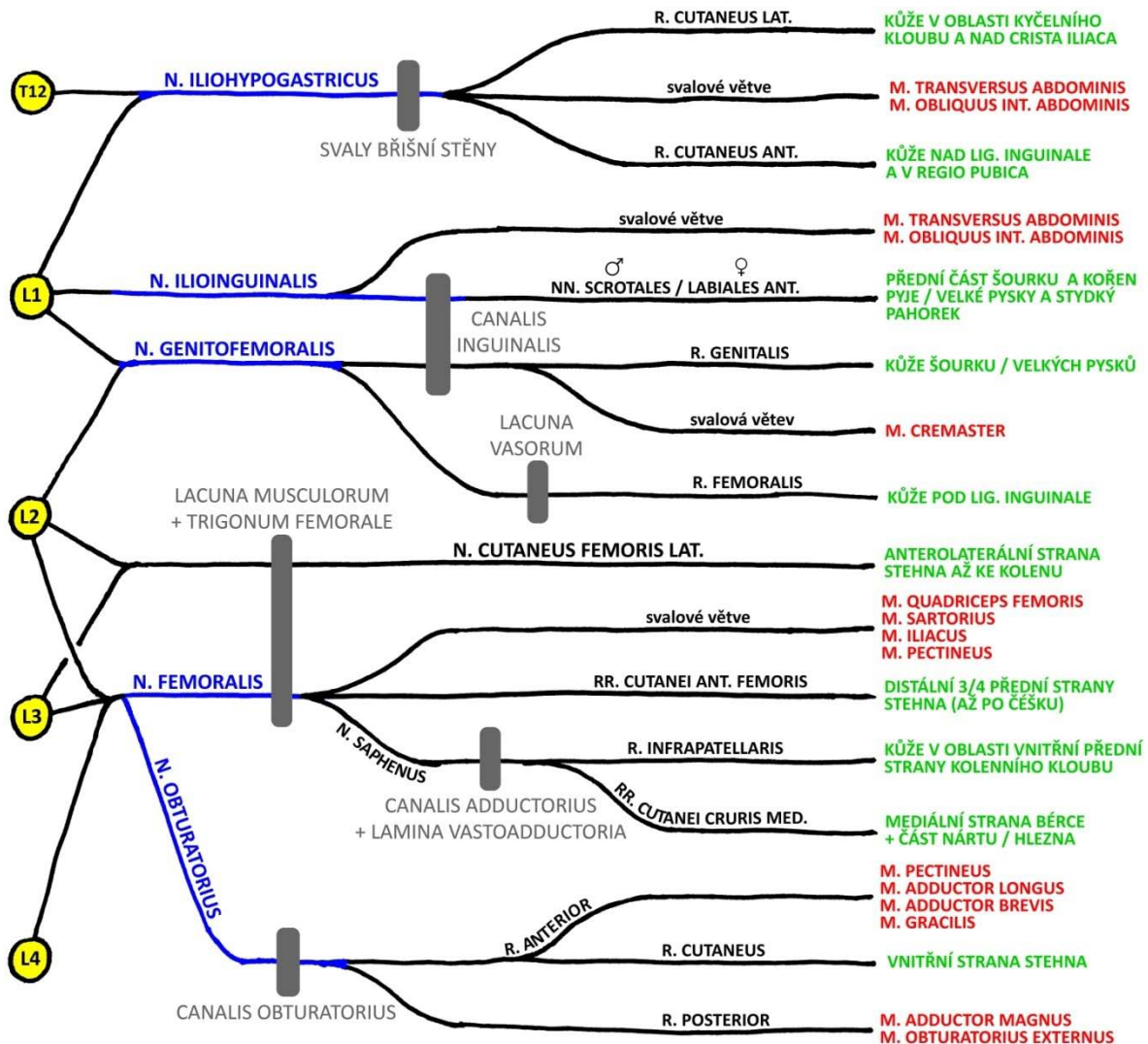
AXILLARY NERVE: **deltoideus; teres minor**

4.3 Review of sensitive innervation of the upper extremity



5. NERVES OF LOWER EXTREMITY

5.1 Lumbar plexus



Lumbar plexus is a nervous plexus which innervates parts the lower extremity (a second plexus – sacral plexus – innervates rest of the extremity). It is formed by the union of anterior branches of nerves from segments **L1 – L3** together with connections from segments **T12** (cranial) and **L4** (caudal). Identifying some of the nerves of **lumbar plexus** (iliohypogastric nerve, ilioinguinal nerve, genitofemoral nerve and lateral femoral cutaneous nerve) does not belong, because of their small diameter, amongst easy tasks. Again, as with cords of brachial plexus, little of „know how” might come useful.

ILIOHYPOGASTRIC NERVE (T12 and L1) – is the most cranial nerve of the plexus. It is a very thin nerve. It enters muscles of the abdomen above *iliac crest* and thus does not enter the pelvis.

ILIOINGUINAL NERVE (L1) – Can be found slightly caudal from previous nerve. This nerve enters the pelvis along **superior anterior iliac spine**, it enters muscles of the abdomen, through their layer the nerve enters the **inguinal canal**. Sometimes is found „loose”.

GENITOFEMORAL NERVE (L1 and L2) – two signs can help us identify this nerve from the rest of lumbar plexus. First sign is the place of its passing through **psaos major** (in which **lumbar plexus** is located). Whereas other nerves of **lumbar plexus** leaves this muscle along its sides, **genitofemoral nerve** penetrates the muscle ventrally and along the muscle surface descends towards **inguinal ligament**. Second characteristic sign is that the nerve sends two terminal branches after leaving **psaos major** before reaching **inguinal ligament**. First branch is **genital branch of genitofemoral nerve**, which goes laterally and like **ilioinguinal nerve** crosses **inguinal canal** and is sometimes on dissected specimen left „loose”. The second branch is medially located **femoral branch of genitofemoral nerve**, which we can locate in **vascular lacuna** – however, in some cases it loses its fixation on the specimen to surrounding tissue and is also „free”.

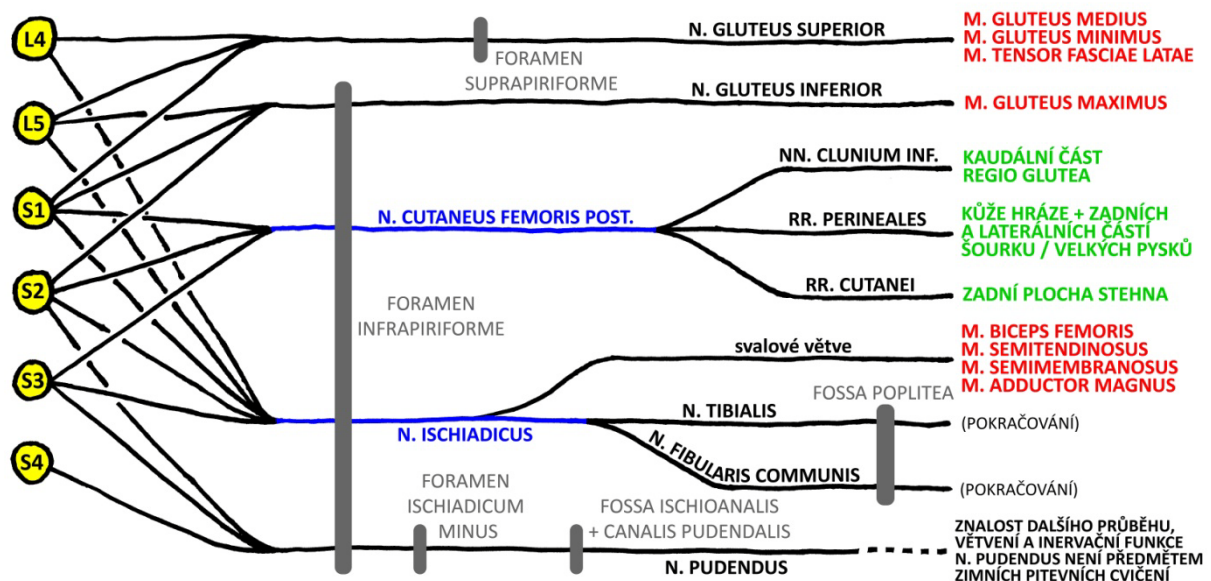
LATERAL FEMORAL CUTANEOUS NERVE (L2 and L3) – characteristic sign is its course through **muscular lacuna** in close proximity to **anterior superior iliac spine** (which can be easily palpated) laterally to **iliacus**. In praxis, we can find this place by **Sartorius**, which originates on **anterior superior iliac spine**.

FEMORAL NERVE (L2 – L4) – can be found easily due to its relatively big size in **muscular lacuna** medially to **iliopsoas**.

OBTURATOR NERVE (L2 – L4) – is the only nerve of the **lumbar plexus** emerging on medial margin of **psaos major** (in lesser pelvis, in which is found most easily in **obturator canal**).

5.2 Sacral plexus

5.2.1 Branches of sacral plexus for pelvis and thigh



Sacral plexus is the second nervous plexus for lower extremity. It is formed by the union of anterior branches of sacral segments **S1 – S5**, together with cranial connections from segments **L4** and **L5**. Individual nerves can be found in following way (it is easier to look for all these nerves from dorsal side):

SUPERIOR GLUTEAL NERVE (L4 – S1) – can be found easily in **suprapiriform foramen** (see topography), where is accompanied by **superior gluteal vessels** and eventually enters the muscles.

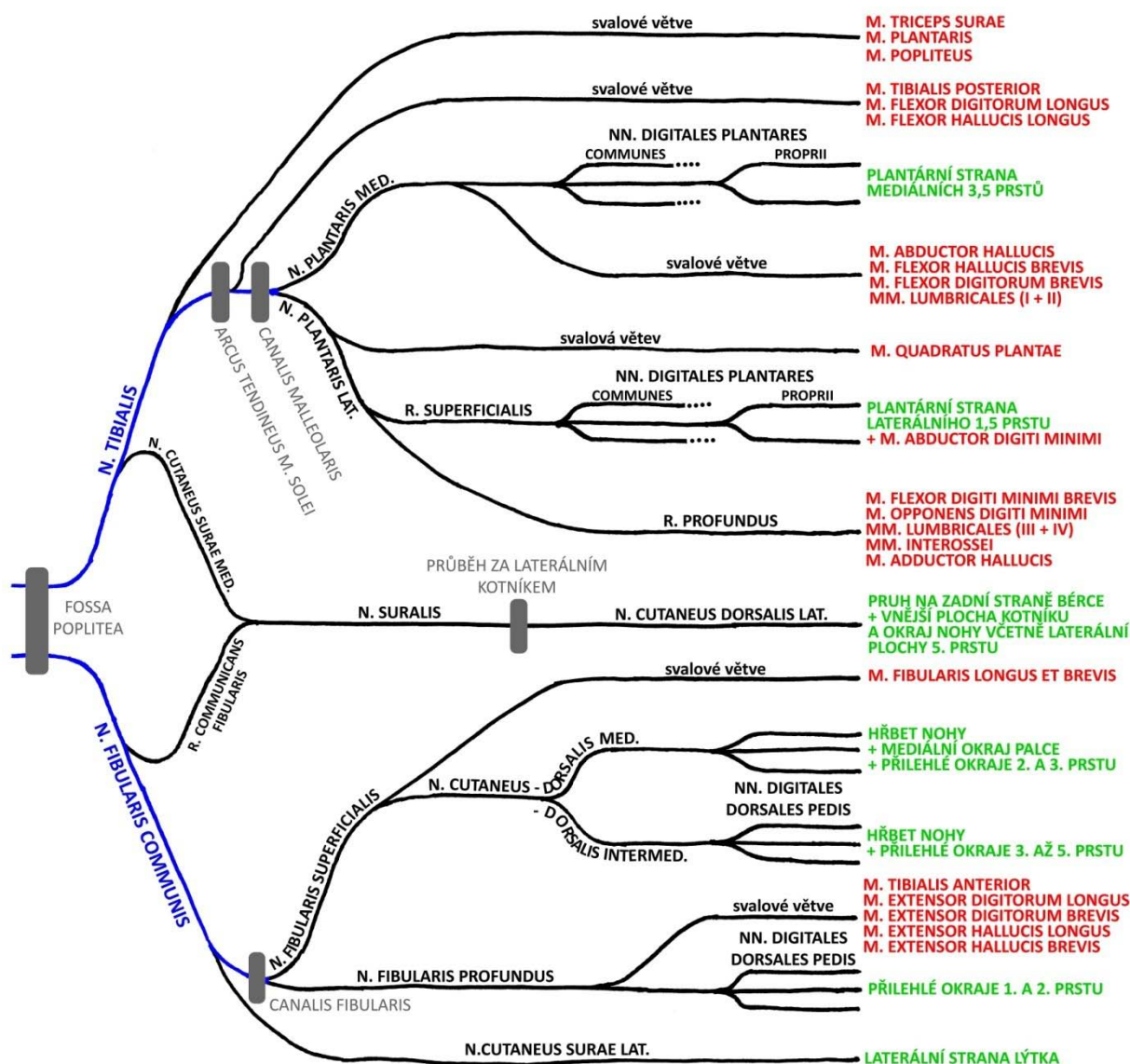
INFERIOR GLUTEAL NERVE (L5 – S2) – is one of 4 nerves crossing the **infrapiriform foramen** (see the scheme). It can be identified by the branching which enters **gluteus maximus** (together with **inferior gluteal vessels**), which it innervates.

POSTERIOR FEMORAL CUTANEOUS NERVE (S1 – S3) – crosses **infrapiriform foramen** and on dissected extremities is usually „free” (removal of skin and subcutaneous layer causes it’s loss of contact to innervated structures). On posterior surface of the thigh is accompanied by vein conjunction called **extensio cranialis v. saphenae parvae** (see below).

SCIATIC NERVE (L4 – S3) – can be easily recognised in the **infrapiriform foramen** by its noticeable thickness (biggest nerve in human body). However, we have to keep in mind, that the place of division of **sciatic nerve** is very variable. Usually, the nerve is divided to the **tibial nerve** and the **common fibular nerve** before entering **popliteal fossa**. In some cases this division can occur much higher, for example as high as in **infrapiriform foramen** the main of **sciatic nerve** does not have to be presented. So called “high splitting” has influence on motor innervations of muscles of the posterior side of the thigh and on **adductor magnus**. Usually whole posterior group of muscles of the thigh (**biceps femoris**, **semitendinosus** and **semimembranosus**) together with part of **adductor magnus** originating on **sciatic tuberosity** is innervated by **sciatic nerve**. However, if the nerve splits high enough, these muscles are innervated by **tibial nerve** and **common fibular nerve** in a following way: all muscles (or their parts) named above, originating on **sciatic tuberosity** (**long head of biceps femoris**, **semitendinosus**, **semimembranosus** and **part of adductor magnus**) are innervated by **tibial nerve** and only **short head of biceps femoris** by **common fibular nerve**.

PUDENDAL NERVE (S2 – S4) – can be found easily after leaving **infrapiriform foramen**, where the nerve rotates around **ischial spine** and enters **lesser sciatic foramen** (together with **internal pudendal vessels**) and immediately re-enters the pelvis through **Alcock’s canal**.

5.2.2 Tibial nerve and Common fibular nerve



Tibial nerve and **Common fibular nerve** are continuation of **sciatic nerve** (see above). Now let's describe how to find them and their most significant branches on dissected specimen:

TIBIAL NERVE (L4 – S3) – the easiest way to find the nerve is in the **popliteal fossa**, in which is located most lateral and most superficial relatively to **popliteal vessels** (see topography). Further on it can be found at its crossing of the **tendinous arch of soleus** and also as the only nerve crossing **malleolar canal** (see topography).

MEDIAL PLANTAR NERVE – is one of two terminal branches of **tibial nerve**. After branching from the **tibial nerve**, it runs together with **medial plantar vessels** between **bones** and **adductor hallucis** into the foot.

LATERAL PLANTAR NERVE – after branching from **tibial nerve** accompanies **lateral plantar vessels** and together run between **flexor digitorum brevis** and **quadratus plantae**.

SURAL NERVE – fastest way to find this nerve is where it originates by connection of **medial cutaneous sural nerve** and **communicating branch of fibular nerve** and further on dorsal side of the leg, where it accompanies (as far as the lateral malleolus) **small saphenous vein**.

COMMON FIBULAR NERVE (L4 – S2) – in **popliteal fossa** runs laterally from **tibial nerve** and can be identified by characteristic course behind the **head of the fibula**.

SUPERFICIAL FIBULAR NERVE – is one of two terminal branches of **common fibular nerve**. Fastest way to find it is after it's branching from **common fibular nerve** between **fibularis longus** and **fibula (fibular canal – see topography)**, where it emerges to the surface, in order to innervate skin of the dorsum of the foot.

DEEP FIBULAR NERVE – second terminal branch of **common fibular nerve** can be found easily in the depth between muscles of the anterior group of the leg, near **interosseous membrane**, by which it accompanies **anterior tibial vessels**.

5.3 Review of motor innervations of the lower extremity

5.3.1 From lumbar plexus

DIRECT BRANCHES FROM THE PLEXUS: **psoas major and minor**

FEMORAL NERVE: anterior group of muscles of the thigh (**sartorius; quadriceps femoris; iliopsoas; pectineus (DIPLONEURAL MUSCLE!)**)

OBTURATOR NERVE: whole adductor group of muscles of the thigh (**pectineus /DIPLONEURAL MUSCLE!; adductor longus; gracilis; adductor brevis; adductor magnus /DIPLONEURAL MUSCLE!; obturator externus**)

5.3.2 From sacral plexus

DIRECT BRANCHES FROM THE PLEXUS: all muscles of the deep layer of posterior group of muscles of the hip joint - so called **pelvitrochanteric muscles:** **piriformis** – independent branch from the plexus; **gemellus superior + obturator internus** – common branch from the plexus; **gemellus inferior + quadratus femoris** – common branch from the plexus

SUPERIOR GLUTEAL NERVE: **gluteus medius; gluteus minimus; tensor fasciae latae**

INFERIOR GLUTEAL NERVE: **gluteus maximus**

SCIATIC NERVE: whole posterior group of muscles of the thigh (**biceps femoris; semitendinosus; semimembranosus; adductor magnus (DIPLONEURAL MUSCLE!)** – in case of “high splitting” are these muscles innervated by tibial nerve and common fibular nerve (see above)

TIBIAL NERVE: whole posterior group of muscles of the leg (**triceps surae; plantaris; popliteus; tibialis posterior; flexor digitorum longus; flexor hallucis longus**)

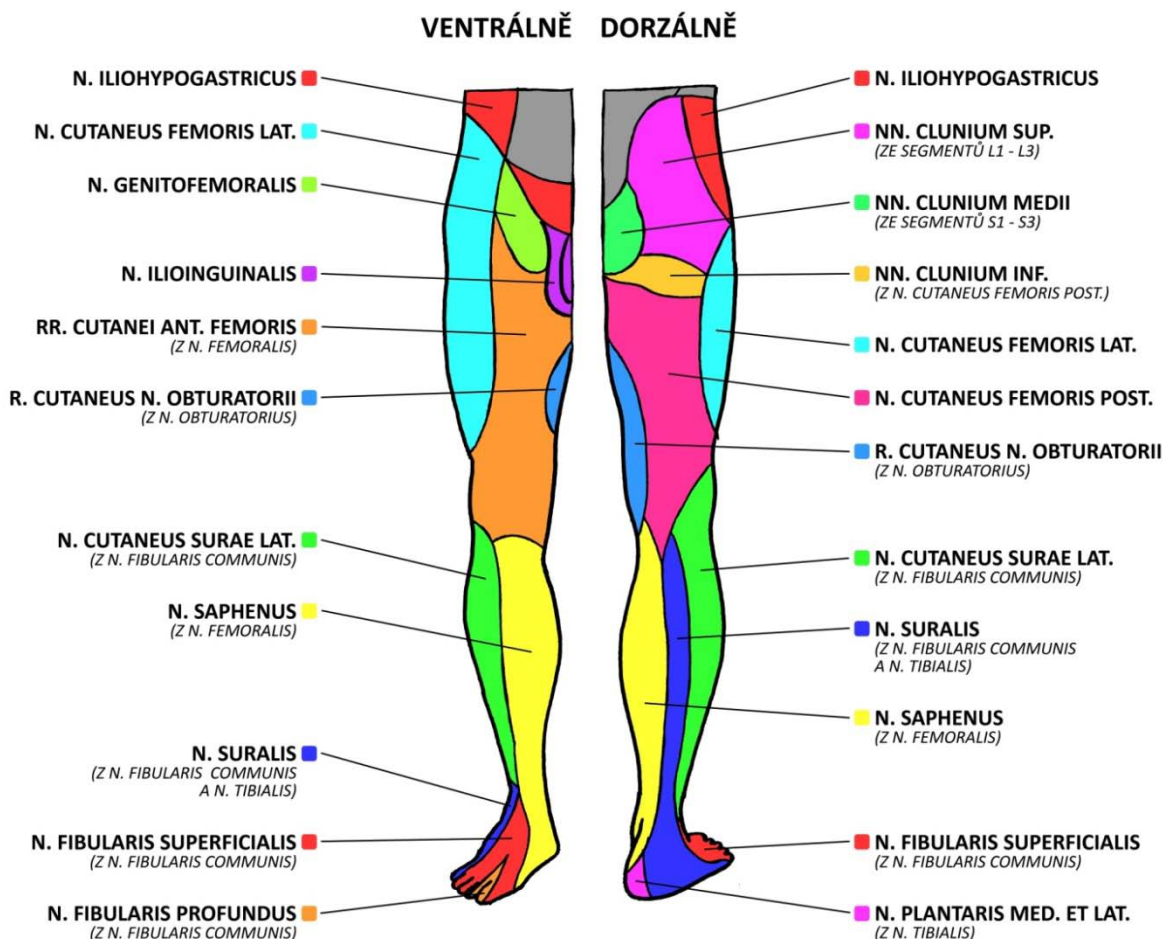
MEDIAL PLANTAR NERVE: foot muscles **abductor hallucis; flexor hallucis brevis; flexor digitorum brevis; lumbricales I and II**

LATERAL PLANTAR NERVE: rest of muscles of the foot (**abductor digiti minimi; flexor digiti minimi brevis; pponens digiti minimi; lumbricales III and IV; plantar and dorsal interossei; quadratus plantae; adductor hallucis**)

SUPERFICIAL FIBULAR NERVE: both muscles of lateral group of muscles of the leg (**fibularis longus; fibularis brevis**)

DEEP FIBULAR NERVE: whole anterior group of muscles of the leg (**tibialis anterior; extensor digitorum longus; extensor hallucis longus**); dorsal muscles of the foot (**extensor digitorum brevis; extensor hallucis brevis**)

5.4 Review of sensitive innervation of the lower extremity



6. CLINICAL CORRELATIONS OF NERVES OF EXTREMITIES

Clinical symptoms of functional defects of peripheral nerves of extremities are of two types. Primarily, there are **motor symptoms**, which have origin in loss of innervations of individual muscles or whole muscle groups. Beside reduced locomotive functions of innervated muscles, there is reduced or total absence of sensitive innervations (loss of skin sensitivity for various stimuli) in area innervated by damaged nerve (so called **area nervina**).

Causes of nerve damage are most commonly mechanical – **traumas**. Those can be divided to **open** and **closed**. Open traumas result in partial or total discontinuation of the nerve. These traumas are usually caused by laceration or incision. Closed traumas can be divided to **stretch injuries**, in which part of axon loses its continuity by overstretching, and to **contusions**. There compression of the nerve damages myelin sheath in particular (axons consequently). Contusions can be **inner** and **outer**. In outer contusions compression of the nerve against hard surface occurs (for example compression of ulnar nerve in groove for ulnar nerve on the humerus – „funny bone“). In comparison in inner contusions nerve is compressed by its surroundings in anatomically narrowed spaces – for example median nerve in carpal tunnel. In these cases we describe **tunnel syndromes** (for example carpal tunnel syndrome).

In following review we describe and explain main motor symptoms of injuries of individual nerves of the extremities. Beside mentioned reduction of locomotive functions, loss of sensitive innervations in corresponding area nervina also occurs. (see above their areas for sensitive innervations of upper and lower extremity).

6.1 Nerves of upper extremity

6.1.1 Accessory nerve

Accessory nerve (XI. cranial nerve) descends over triangular shaped origin of **scapular spine**, where is vulnerable (for example by falling on the back). In injury of the nerve at this place **ascending part of trapezius** is disabled, trapezius is not able to rotate **inferior angle of scapula** laterally. Abduction of arm above horizontal is not possible – **serratus anterior** as synergist is not able to perform this movement on its own due to too great weight of the extremity.

6.1.2 Long thoracic nerve

Injury of **long thoracic nerve** causes functional defects of **serratus anterior**. Scapula is not fixated to thorax enough. That causes **winged scapula** („**scapula alata**“) – see picture. Also movement of the arm is limited – particularly abduction of the arm above horizontal (see above).

6.1.3 Axillary nerve

Injury of **axillary nerve** (for example in fracture of **neck of the humerus**) has the biggest clinical impact reduced movement of **deltoid**. Abduction of the arm is affected especially above horizontal, abduction up to 90° is provided mostly by **supraspinatus**. Also subluxation in shoulder joint occurs due to worsened fixation of the **head of humerus** in **glenoid cavity**.

6.1.4 Musculocutaneous nerve

Isolated damage of this nerve is rare. Most commonly is affected in larger lesion of **brachial plexus**. Motor symptom is weakened flexion in the **elbow joint** (because of paresis of **biceps brachii** and **brachialis**) and supination of forearm (due to paresis of **biceps brachii**).

6.1.5 Radial nerve

Radial nerve injury is fairly common. Place where it is damaged most often in fractures is **radial groove** on mid-shaft of humerus (Holstein – Lewis fracture). In similar way, fractures of the forearm can cause injury of **radial nerve**. Clinical signs include absence of **triceps reflex**, weakening of extension in **elbow joint** (reduced ability of **triceps brachii**). Another noticeable sign is **wristdrop** (see picture), which occurs due to unopposed **flexion of the wrist** (extensors are not innervated), dominance of pronators (paresis of **supinator**) and **adduction of thumb** (paresis of abductors).

6.1.6 Median nerve

Injury of **median nerve** usually occurs in anatomically narrowed spaces, which median nerve crosses (**carpal tunnel** – „carpal tunnel syndrome”, **pronator canal**, between heads of **flexor digitorum superficialis**, etc.), in **axilla** by dislocations in **shoulder joint** or is caused by stab or shoot wounds and by fractures of the wrist (for example **Colles' fracture**) or by incisions („suicide wrist“).

Motor changes in **median nerve** palsy include **inability of pronation** (**pronators** are paralyzed), **inability of opposition and thumb flexion** (paralysis of **opponens pollicis** and **thumb flexors** – beside **deep head of flexor pollicis brevis**; which is the biggest difficulty for the patient - „**apelike hand**“) and inability of flexion of 2nd and 3rd finger (**flexor** paralysis). Flexion of 4th and 5th finger remains, thanks to innervations exception of anterior muscle group of the forearm – ulnar half of **flexor digitorum profundus**, which is innervated by **ulnar nerve**. The causes together form „**preachers' hand**“ – see the picture.

6.1.7 Ulnar nerve

Ulnar nerve is injured most likely in anatomically narrowed space, which the nerve crosses (**cubital canal** and **ulnar canal/Guyoni/**) and in fractures of the forearm and elbow joint area (often together with **median nerve**).

Typical motor sign of **ulnar nerve** palsy is „**claw hand**“ – see the picture. In normal conditions is tonus of the muscles of the forearm in balance with tonus of muscles of the hand. This balance is disturbed in **ulnar nerve** palsy. **Flexors** (innervated by **median nerve**) and **extensors** (innervated by **radial nerve**) of fingers dominate. This imbalance causes **extension in metacarpophalangeal joints** (increased influence of extensors) and **flexion in proximal and terminal interphalangeal joints** (increased influence of flexors). Most noticeable position is at 4th and 5th finger (**lumbricales** of 2nd and 3rd finger are innervated by **median nerve**). At the same time **thumb is in abduction** (**adductor pollicis** is paralysed) and whole hand is in **radial abduction** (paralysis of **flexor carpi ulnaris** and **lumbricales III and IV**). Also, because of denervation of **interossei**, **it is not possible to adduct and abduct fingers**. These muscles are affected by **denervation atrophy**, which is manifested by dilatated intermetacarpal spaces.

Another sign of **ulnar nerve palsy** is **Froment's sign**. Patient is not able to hold a sheet of paper between thumb and index finger without flexion in **thumb's interphalangeal joint**. That is caused by **compensation of not functioning adductor pollicis** by **flexor pollicis longus** (innervated by **median nerve**).

6.2 Nerves of lower extremity

6.2.1 Femoral nerve

Trauma damage of **femoral nerve** can be caused by fractures of pelvis, luxation in **hip joint** or during surgeries. Even **incorrect application of intramuscular injection** can injure the nerve (injections have to be put into lateral part of thigh!). From non-traumatic causes is the most common pressure of enlarged inguinal lymph nodes (tumor) and aneurysm of femoral artery.

Main motor signs of **femoral nerve** palsy are due to paralysis of **quadriceps femoris** – **walking without support is not possible, climbing up the stairs is difficult, patient is unable to raise thigh from lying down position** (**rectus femoris** paralysis); standing is unstable, it is not possible to stamp or to stay in crouch. In some cases **genu recurvatum** – hyperextension in the knee joint, is present (see the picture).

6.2.2 Obturator nerve

Isolated peripheral palsy of **obturator nerve** is very rare. Motor defects represent weakened function of **adductor group of muscles of the thigh** – **decreased ability of adduction and lateral rotation in hip joint**. Also crossing of lower extremities is not possible. The nerve can be irritated by **enlarged uterus in pregnancy**.

6.2.3 Superior and inferior gluteal nerve

Palsy of **inferior gluteal nerve** causes loss of function of **gluteus maximus – extension in hip joint is limited** (difficulty climbing up the stairs). Damages to **superior gluteal nerve** causes **limited functions of gluteus medius, gluteus minimus and tensor fasciae latae**. First two muscles provide abduction in hip joint. Also, their pull have great significance for walking and standing on one leg, where prevents elevation of pelvis on the side where we stand. **Trendelenburg's sign** (see the picture) shows defect of this muscle function, **elevation of pelvis on the side of the nerve lesion**, which is compensated by **lateral flexion to the opposite side**. Similar sign is shown during walking - „goose gait“.

6.2.4 Sciatic nerve

Traumatic damage of this nerve occurs in **pelvis fractures** or **posterior luxations in hip joint**. Non-traumatic compression of nerve is most commonly caused by hematoma or tumour in gluteal region. **Sciatic nerve** can also be damaged by **incorrect application of intramuscular injection** (it has to be put always to upper outer quadrant of gluteal region!). Because of **sciatic nerve** splitting to **common fibular nerve** and **tibial nerve**, it's lesion manifests in similar way as lesion of it's branches (see below). In **less serious forms of palsy there are only limited functions of muscles of posterior group of the thigh** (extensors in hip joints and flexors in knee joint. Motor sign is foot **drop**. Limited function of this muscle group often remains spotless, because extension in hip joint is compensated by **gluteal muscles** and flexion in knee joint by **gastrocnemius**. **More serious nerve damages makes walking impossible**.

6.2.5 Tibial nerve

Injuries of **tibial nerve** are often caused by **serious traumas in hip joint** (dislocating fractures and luxations). More often is lesion of **tibial nerve** in his passage in **malleolar canal** – scission wounds, ankle fractures or compression by tumour or incorrectly put plaster on fractured ankle.

Motor sign is **inability of plantar flexion** of foot due to **triceps surae** paralysis (it is not possible to lift the heel and stand on the tiptoes). Also **Achilles tendon reflex** is reduced. Dorsal flexion of foot is present (due to **tibialis anterior**) and the patient falls on the heel during walking - „pes calcaneus“.

6.2.6 Common fibular nerve

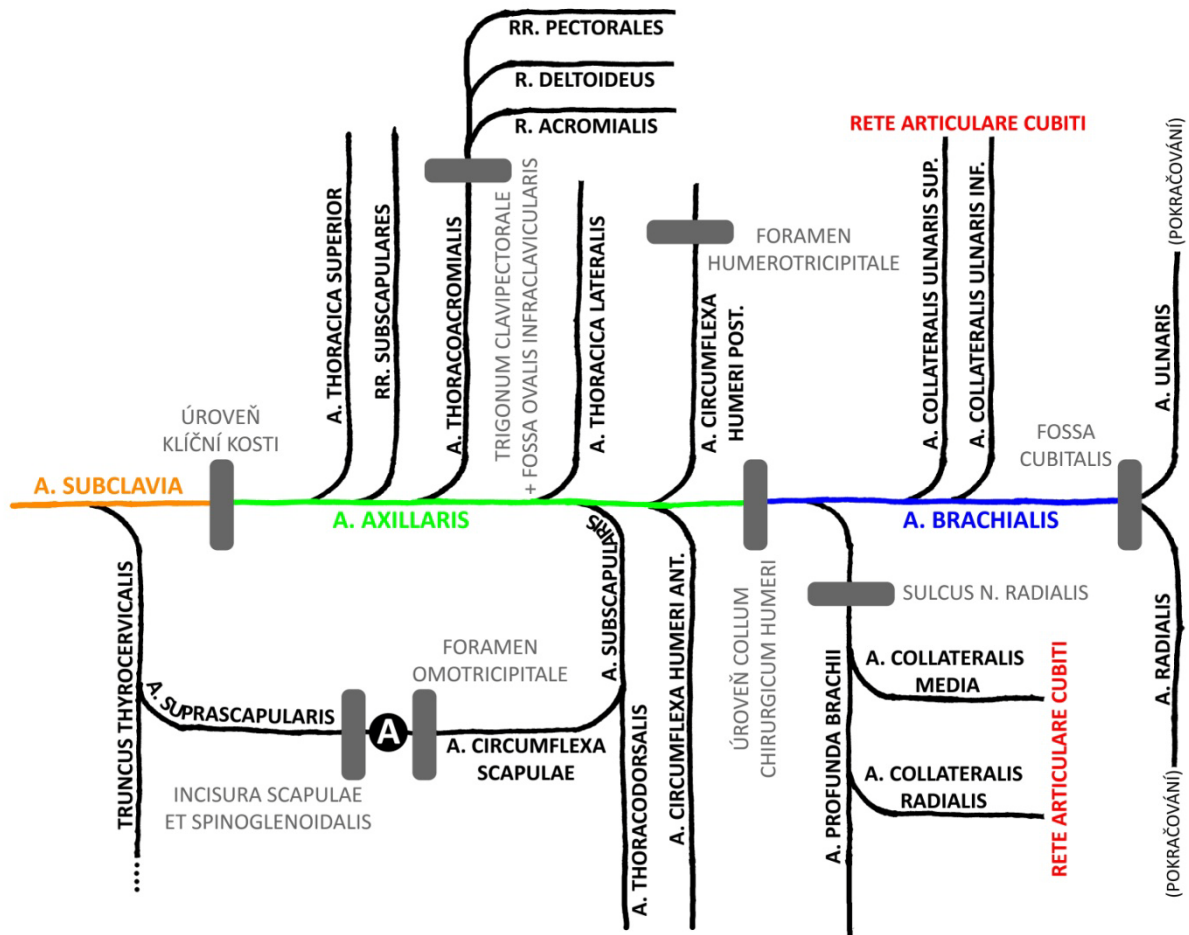
Compression of **common fibular nerve** is most likely behind **head of fibula**, where it covered only by skin layer (for example caused by **incorrectly put plaster**). Contusion of **common fibular nerve** can also occur in a place of it's course between **fibularis longus** and **fibula** (fibular canal). Common are also stretch injuries of the nerve in luxations or distortions of knee joint.

Motor symptoms show weakened functions of innervated muscles. Due to loss of function of muscles of anterior group of the leg plantar **foot drop** occurs, which causes "flopping" during walking. Patient tries to compensate this by raising the legs high „rooster gait“. **Also standing on heels is not possible. Foot arch is depressed**, because **tibialis anterior** and **fibularis longus** are paralysed.

7. VESSELS OF UPPER EXTREMITY

7.1 Arteries of upper extremity

7.1.1 Subclavian artery; axillary artery; brachial artery



Subclavian artery has also other branches. Their knowledge is not the topic of the winter dissection course and therefore they are not included into the scheme.

Main vessels of the shoulder girdle and arm can be found in following way.

SUPRASCAPULAR ARTERY – can be found easily in the **scapular notch** (see below) above the **superior transverse scapular ligament**.

AXILLARY ARTERY – is easily to be found in the **axillary fossa** (see topography).

SUPERIOR THORACIC ARTERY – heads towards first two intercostals spaces and upper slips of **serratus anterior**. It is rarely preserved in dissected extremities.

SUBSCAPULAR BRANCHES – thin branches of the **axillary artery**, which can be sometimes found on the anterior surface of the **subscapularis** together with the **subscapular nerve**.

THORACOACROMIAL ARTERY – the easiest way to locate this artery is in the **clavipectoral triangle** (see below) together with its branches (**clavipectoral fascia** and **infraclavicular oval fossa** are usually not preserved). Sometimes its **pectoral branches** supplying the **pectoral muscles** can be found.

LATERAL THORACIC ARTERY – is preserved fairly often. Can be identified by the accompanying **long thoracic nerve**, they both branch on the outer surface of **serratus anterior**.

SUBSCAPULAR ARTERY – when searching for this artery it is convenient to start from its branch - **CIRCUMFLEX SCAPULAR ARTERY**. That can be found easily in the **omotricipital foramen** (see topography), which crosses and later on anastomoses with the **suprascapular artery** on the dorsal surface of scapula. If we follow the artery towards the **axillary artery**, we find the second branch - **THORACODORSAL ARTERY**, which leads to the **latissimus dorsi** and **teres major** together with the **thoracodorsal nerve**. More proximally the strong stem of the **subscapular artery** is then easily identified.

ANTERIOR AND POSTERIOR CIRCUMFLEX HUMERAL ARTERIES – the last two branches of the **axillary artery** arise at the level of the **surgical neck of humerus**, where the **axillary artery** gets in front of **humerus**. We easily find the **POSTERIOR CIRCUMFLEX HUMERAL ARTERY**, which runs dorsally with the **axillary nerve** through the **humerotricipital foramen** (see topography). **ANTERIOR CIRCUMFLEX HUMERAL ARTERY** is smaller, heading ventrally around **surgical neck of humerus** towards the shoulder joint and surrounding tendons.

BRACHIAL ARTERY – continuation of the **axillary artery** (from the level of the **surgical neck of humerus** distally) runs between the anterior and posterior arm muscle groups medially.

DEEP BRACHIAL ARTERY – can be identified by the accompanying **radial nerve**; together they descend into the **groove for radial nerve** on the dorsal surface of the **humerus** between the **medial and lateral heads of triceps brachii**.

Rete articulare cubiti is an arterial network around the **elbow joint**. It interconnects several branches from surrounding arteries. Similar networks are formed around all joints of the body. Numerous branches provide sufficient collateral blood supply for distal parts of the joint regardless of its current position.

7.1.2 RADIAL ARTERY; ULNAR ARTERY

Forearm and hand are supplied by terminal branches of the **brachial artery** – **radial artery** and **ulnar artery**. Let us describe how to identify them and their most significant branches on the specimen:

RADIAL ARTERY – can be found easily in the distal part of the forearm between tendons of the **brachioradialis** and **flexor carpi radialis** (artery can be palpated there) or in the **radial foveola** (see topography).

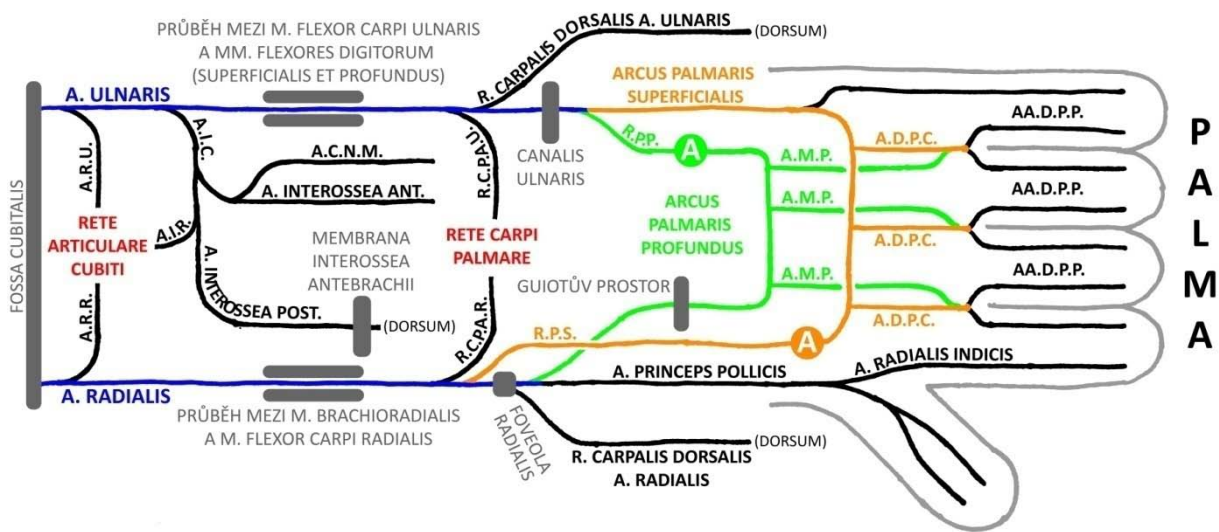
PRINCEPS POLLICIS ARTERY – arises from the **radial artery** (right before it enters into the palm inside muscles) and heads to thumb.

ULNAR ARTERY – can be located easily between the tendons of the **flexor digitorum superficialis** and **profundus** and the tendon of the **flexor carpi ulnaris**. The artery is accompanied by the **ulnar nerve**.

COMMON INTEROSSEOUS ARTERY – arises from the **ulnar artery** just after its branching from the **brachial artery** and runs deeper towards the **antebrachial interosseous membrane**, where it bifurcates into the **anterior** and **posterior interosseous arteries** (see the scheme).

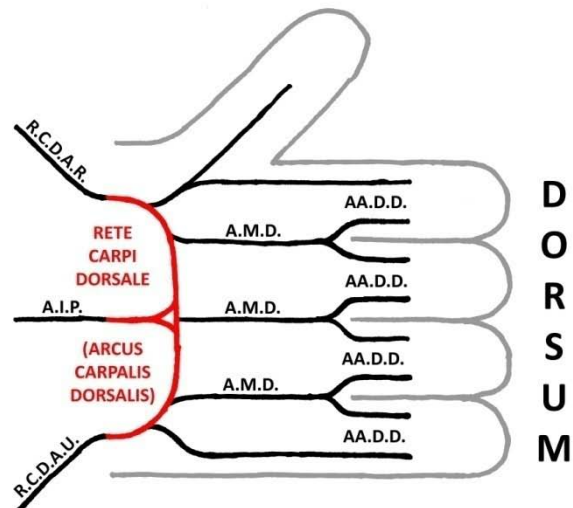
SUPERFICIAL AND DEEP PALMAR ARCHES – see below

Superficial and deep palmar arches are important anastomoses between the **radial** and **ulnar artery**. They provide blood supply to the hand. **Superficial palmar arch** is a terminal branch of the **ulnar artery**, the arch is completed by the **superficial palmar branch of radial artery** from the radial side. It is located more distally than the **deep palmar arch** and lies superficially between the **palmar aponeurosis** and **insertion tendons of flexors**. **Deep palmar arch** is a terminal branch of the **radial artery**, which enters the **Guiot's space** (see topography) and later forms the deep arch together with the **deep palmar branch of ulnar artery**. Deep palmar arch is located in the depth between the **insertion tendons of flexors** and **palmar interossei**.

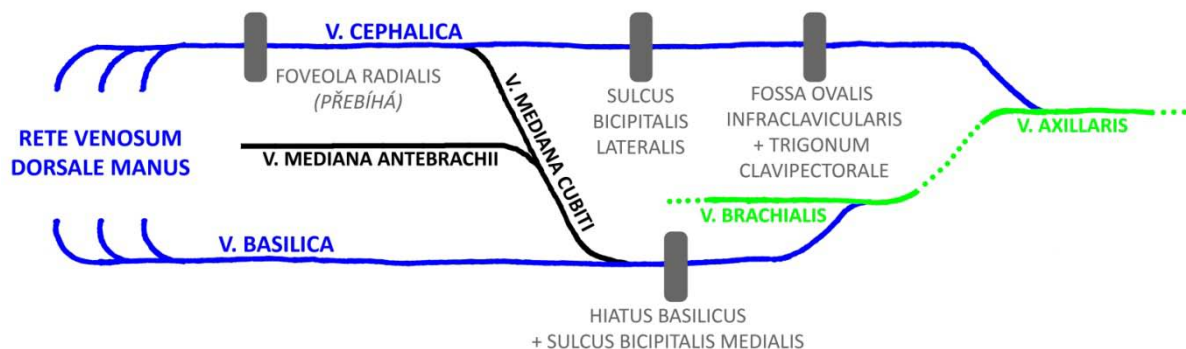


- A.R.R. / A.R.U. = A. RECURRENS RADIALIS ET ULNARIS
- A.I.C = A. INTEROSSEA COMMUNIS
- A.I.R. = A. INTEROSSEA RECCURENS
- A.C.N.M. = A. COMITANS NERVI MEDIANI
- R.C.P.A.R. / R.C.P.A.U. = R. CARPALS PALMARIS A. RADIALIS ET ULNARIS
- R.P.P. = R. PALMARIS PROFUNDUS (A. ULNARIS)
- R.P.S. = R. PALMARIS SUPERFICIALIS (A. RADIALIS)
- A.M.P. = A. METACARPALIS PALMARIS
- A.D.P.C. = A. DIGITALIS PALMARIS COMMUNIS
- AA.D.P.P. = AA. DIGITALES PALMARES PROPRIAE

- R.C.D.A.R. / R.C.D.A.U. = R. CARPALS DORSALIS A. RADIALIS ET ULNARIS
- A.I.P. = A. INTEROSSEA POSTERIOR
- A.M.D. = A. METACARPALIS DORSALIS
- AA.D.D. = AA. DIGITALES DORSALES



7.2 Veins of upper extremity



7.2.1 Deep venous system of upper extremity

In general, in the extremities, there are **two venous systems** – **superficial** and **deep**. In addition, the veins of the extremities contain **venous valves**, which regulate direction of the blood flow. **Deep venous system accompanies arteries**, terms of arteries and veins are identical (e.g. the **suprascapular vein** runs together with the **suprascapular artery**). From periphery as far as to the **axillary vein** the veins are doubled – the arteries are accompanied by two veins of the same name (e.g. the **brachial artery** runs together with two **brachial veins**). Due to this arrangement it is convenient to use the term „**vessels**“ (**vasa** in Latin), which stands for artery and its accompanying vein(s) as a pair. For example, if we would like to say that the **omotricipital foramen** contains only the **circumflex scapular artery**, the description would not be complete – we would have omit the **circumflex scapular vein**. Therefore, it is better to say that the **circumflex scapular vessels** run through this foramen.

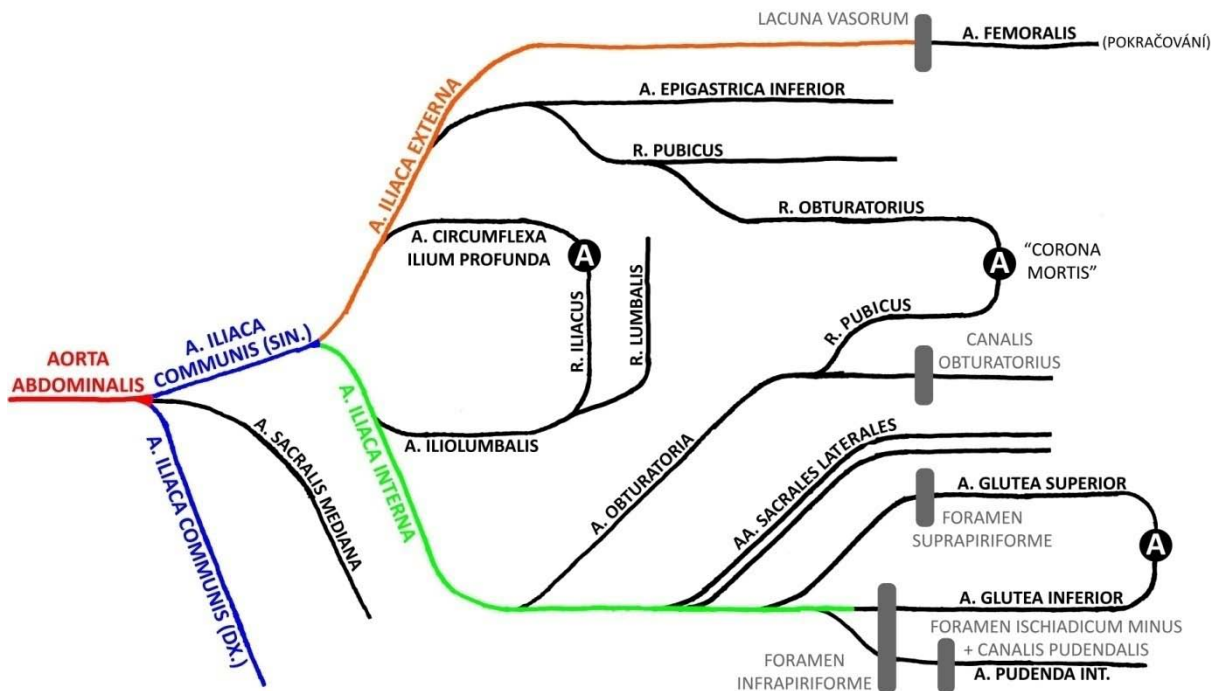
7.2.2 Superficial venous system of upper extremity

Superficial venous system of the upper extremity originates from the **dorsal venous network of the hand**. Veins on this side of the hand are subjected to far lesser pressure. On the palmar side only the **superficial venous palmar arch** is formed, which is connected with the dorsal network by the **intercapitular veins** (located close to the heads of metacarpals within the intermetacarpal spaces). From the **dorsal venous network of the hand** two main superficial veins of the upper extremities are formed – **cephalic vein** and **basilic vein**. For remembering their location there is a shortcut **CRBU** – **C**ephalic vein originates along the **R**adial edge of the hand and **B**asilic vein along the **U**lnar edge. In the **cubital fossa** (see below) are both veins interconnected by the **median cubital vein**. Later on, both superficial veins drain blood into the deep venous system – **cephalic vein** reaches the shoulder and enters the **axillary vein** (within the **axillary fossa**), **basilic vein** enters one of the **brachial veins** usually at some point around distal part of humerus.

8. VESSELS OF LOWER EXTREMITY

8.1 Arteries of lower extremity

8.1.1 External and internal iliac arteries



Abdominal aorta splits at **aortic bifurcation** into two **common iliac arteries**. This place is at level of **L4**. Remain of descending aorta is **median sacral artery**, which continue along pelvic surface of sacrum in the midline. Division of **common iliac artery** into **internal iliac artery** and **external iliac artery** is in the level of **sacroiliac joint**.

Beside arteries covered in the scheme, **internal iliac artery** has several visceral arteries, which supply organs of the lesser pelvis. Their knowledge is subject of following semesters and therefore is not required in winter dissections (as well as branches of **internal pudendal artery**). Principal arteries in this region can be found in following way:

ABDOMINAL AORTA– on the specimen of lower extremities we usually find only few centimetres of its terminal segment at **aortic bifurcation** (often with no connection to surrounding structures).

COMMON ILIAC ARTERY– arteries of both sides are formed by splitting of **abdominal aorta** (see above) and can be found as strong arteries facing laterodistally from **aortic bifurcation**. **Common iliac arteries** don't have any branches along their course.

MEDIAN SACRAL ARTERY– can be found as thin branch, firmly attached to midline of **pelvic surface** of sacrum (in some cases is not preserved on the specimen).

EXTERNAL ILIAC ARTERY– after splitting from **common iliac artery** descends along medial edge of **psoas major** into **vascular lacuna** (see topography) and continues further as **femoral artery** to the thigh.

INFERIOR EPIGASTRIC ARTERY– arises from **external iliac artery** dorsally from **inguinal ligament** and ascends along dorsal surface of **rectus abdominis**. However, this muscle is on some specimens of extremities incomplete and the artery often remains „loose“.

DEEP ILIAC CIRCUMFLEX ARTERY – leaves **external iliac artery** at the same level as previous artery, heading laterally along **inguinal ligament** and **iliac crest**

INTERNAL ILIAC ARTERY– after splitting from **common iliac artery** headings towards lesser pelvis in front of **sacroiliac artery** and sends its branches in front of **sacral plexus**.

ILIOLUMBAL ARTERY– after arising from the **internal iliac artery** gets to the medial side under **psoas major**. In some cases is not preserved on the specimen.

OBTURATOR ARTERY– the fastest way is to search at entrance to **obturator canal** (see topography), in which it accompanies **obturator nerve**.

LATERAL SACRAL ARTERIES – usually as 2 thin branches of **internal iliac artery** descend on **pelvic surface of sacrum** and enter **anterior sacral foramina**. They are often not preserved on the specimen.

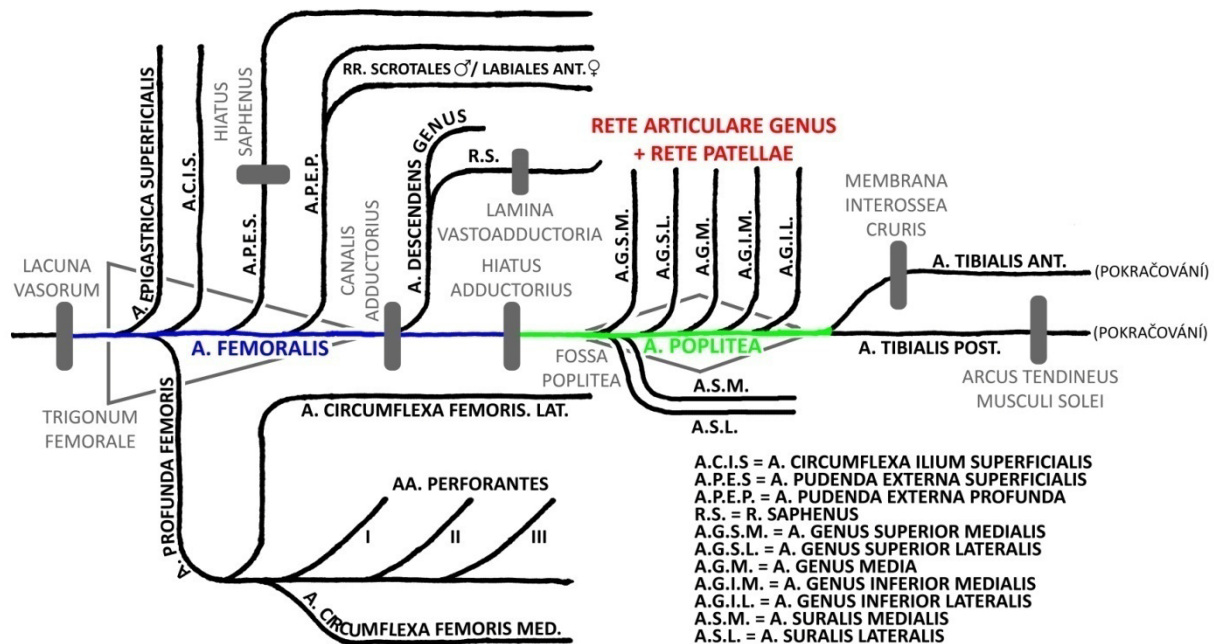
SUPERIOR GLUTEAL ARTERY– is easy to be found in the **suprapiriform foramen** (see topography) together with **the superior gluteal nerve** and **superior gluteal vein**.

INFERIOR GLUTEAL ARTERY– in similar way, can be found in **infrapiriform foramen** (see topography), in which accompanies **inferior gluteal nerve** and **inferior gluteal artery**, and then on the dorsal side sends branches to **gluteus maximus**.

INTERNAL PUDENDAL ARTERY– also crosses **infrapiriform foramen** and immediately turns around **iliac spine** and heads backwards through **lesser sciatic foramen** (see topography) and re-enter pelvis (into **ischioanal fossa** under **levator ani**, which is rarely preserved on the specimen). The course of **internal pudendal artery** is similar to **pudendal nerve**, which the artery accompanies.

For some vessels of lower extremity we can use the **rule of „5“**. In case of **internal iliac artery** it means, that the artery has **5** parietal branches (**iliolumbal artery**, **lateral sacral arteries** – count as one, **superior gluteal artery**, **inferior gluteal artery** and **obturator artery**).

8.1.2 Femoral artery, popliteal artery



Femoral artery sends all its branches (beside **descending genicular artery**) in **femoral triangle** (see topography). **Genicular arteries** along with **sural arteries** leaves **popliteal artery** is **popliteal fossa**. **Perforating arteries** (together with **medial femoral circumflex artery**) pass on the dorsal side of the thigh between insertions of **adductor muscles**, which are supplied by these arteries, as well as muscles of the dorsal group of the thigh. They replace **sciatic artery**, which is main artery of hind legs in lower vertebrates. In humans sometimes a branch from **superior gluteal artery** can be preserved – **accompanying artery of sciatic nerve**.

FEMORAL ARTERY – is continuation of **external iliac artery** after crossing the **vascular lacuna** (see above). This artery can be easily located in **femoral triangle**, in which all branches (except **descending genicular artery**) of femoral artery arise.

DEEP FEMORAL ARTERY – is a large vessel, a branch of **femoral artery** for muscles of the thigh. Heads laterodorsally into the depth **between medial and anterior muscle groups of the thigh**.

LATERAL AND MEDIAL FEMORAL CIRCUMFLEX ARTERY – both arteries arise from proximal segment of **deep femoral artery**. **Lateral femoral circumflex artery** leads under **rectus femoris** (and split into 3 branches for anterior group of muscles of the thigh and **knee joint**) and **medial femoral circumflex artery** passes to dorsal side of the thigh between insertions of **adductor muscles** (see above) and supplies **knee joint**.

PERFORATING ARTERIES (I – III) – the easiest way is to look for them from the dorsal side between insertions of **adductor muscles**.

SUPERFICIAL EPIGASTRIC ARTERY – a thin vessel ascending to subcutaneous layer of abdomen. On dissected specimens is usually not preserved or remains „loose“.

SUPERFICIAL ILIAC CIRCUMFLEX ARTERY – a thin branch of **femoral artery** heading along **inguinal ligament** to **anterior superior iliac spine** to reach subcutaneous layer. On dissected specimens is usually not preserved or has lost connection to surrounding structures.

SUPERFICIAL AND DEEP EXTERNAL PUDENDAL ARTERY– both thin and short, send their terminal branches in the area of **external genitals**, **superficial external pudendal artery** crosses **saphenous ring** (see topography). However, these arteries are not often preserved on the specimens.

DESCENDING GENICULAR ARTERY– arises from **femoral artery** in **adductor canal** (see topography), in which can be found together with **saphenous nerve** (arterial **saphenous branch** together with **saphenous nerve** then penetrate **vastoadductor lamina**).

GENICULAR AND SURAL ARTERIES – all are arteries emerging from **popliteal artery** in **popliteal fossa** (see topography), where they can be found as relatively thin branches. **Genicular arteries** enter **rete articulare genus** and **rete patellae**, **sural arteries** into **medial** and **lateral heads of gastrocnemius**.

Rule of „5“ in this case says that **femoral artery** has **5 branches** (**deep femoral artery**, **superficial epigastric artery**, **superficial iliac circumflex artery**, **external pudendal arteries** – count as one branch; and **descending genicular artery**). This rule can be applied also to **deep femoral artery**, which also has **5 branches** (**lateral and medial femoral circumflex arteries**, **I – III perforating arteries**). **Popliteal artery** sends **5 genicular arteries** (see the picture).

8.1.3 Anterior and posterior tibial arteries

Anterior and **posterior tibial arteries** are terminal branches of **popliteal artery**, while **posterior tibial artery** is a direct continuation of **popliteal artery**. Principal arteries of the leg can be found in following way:

POSTERIOR TIBIAL ARTERY– can be located quickly under **tendineous arch of soleus**, under which accompanies **tibial nerve** and further on behind **medial malleolus** (in **malleolar canal**) in which sends it's branches (see below).

FIBULAR ARTERY– arises from **posterior tibial artery** distally from the **tendineous arch of soleus** and enters between **fibula** and **flexor hallucis longus** (**musculofibular canal** – see topography)

MEDIAL AND LATERAL PLANTAR ARTERY – terminal branches of **posterior tibial artery**. Accompany nerves of the same names (see above).

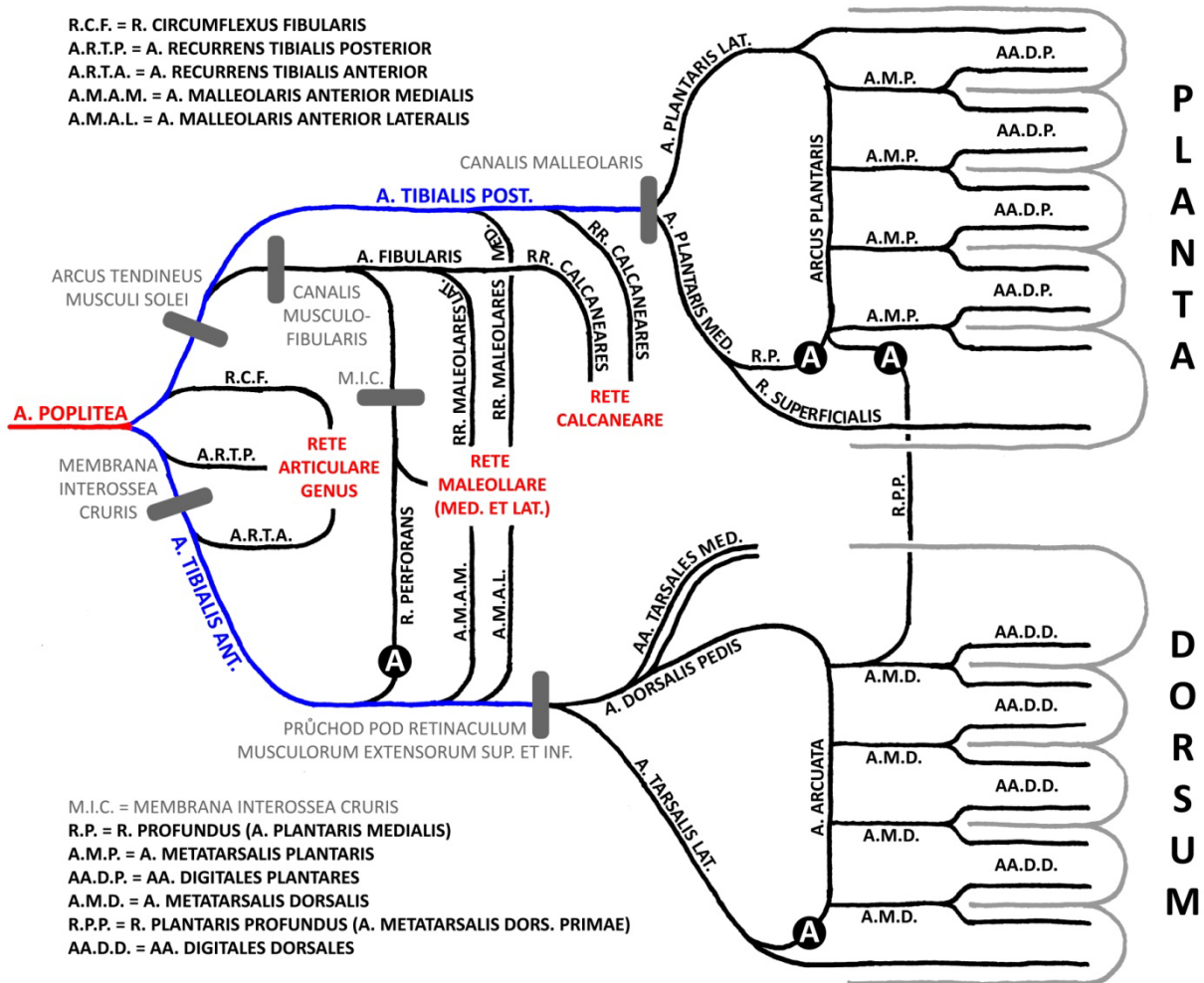
PLANTAR ARCH– see below

ANTERIOR TIBIAL ARTERY– after branching from **popliteal artery** heads in the front between **tibia** and **fibula**, penetrates **interosseous membrane** at its proximal end emerges on anterior surface of leg. After crossing under **extensor retinaculum** changes to **dorsalis pedis artery**

DORSALIS PEDIS ARTERY – fastest way is to look **above 1st intermetatarsal space**, where the artery is heading between first two digits (place of palpation of **dorsalis pedis**).

LATERAL TARSAL ARTERY – sometimes can be found as branch of **dorsalis pedis** at the level of **talus**, leading to **lateral surface of tarsal bone**.

ARCUATE ARTERY – see below



In similar way as blood supply in the hand, foot supply is carried by **arterial arches**, from which arise arterial branches for individual digits. First two can be found on dorsal surface of the foot between short extensors and bones with ligaments of the foot. This arterial arch is formed by **dorsalis pedis artery** (continuation of **tibialis anterior artery** after crossing under **superior and inferior extensor retinaculum**), which as **arcuate artery** runs laterally in area of **Lisfranc joint**. **Arcuate artery** forms anastomosis with **lateral tarsal artery** (branch of **dorsalis pedis artery**) which completes the arch. However, this arrangement is valid only in around 10% and thus serves more of a didactic role.

On plantar surface of the foot is formed **plantar arch** in similar way. **Lateral plantar artery** – the terminal branch of **tibialis posterior artery** – in the foot heads medially under **flexor digitorum brevis** and **quadratus plantae**. Then it forms plantar arch in a space between **plantar interossei** and **oblique head of adductor hallucis**. **Deep branch of medial plantar artery** then connect to complete the arch. Both arterial arches are connected by

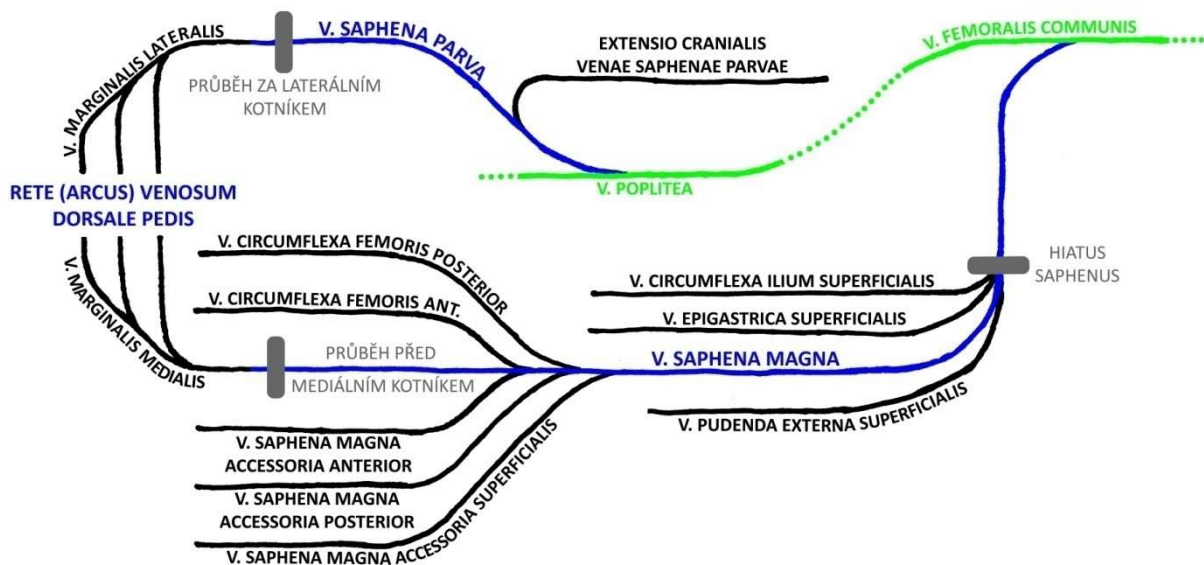
perforating branches. The biggest of them is **deep plantar branch** (branch of **arcuate artery** or **first dorsal metatarsal artery**) which forms connection in first intermetatarsal space.

8.2 Veins of lower extremity

8.2.1 Deep venous system of lower extremity

On the lower extremity (same as on the upper) are **two venous systems** – **superficial** and **deep**. **Deep venous system accompanies arteries**, whereas names of arteries and veins are identical (for example together with **femoral artery** goes **femoral vein**). From periphery as far as to **popliteal vein** the veins are doubled – arteries are accompanied by two veins of the same name (for example **fibular artery** is accompanied by **fibular veins**). Due to this arrangement it is convenient to use the term **vessels**, which stands for arteries as well as for veins. For example if we would like to say that the **popliteal fossa** contains **popliteal artery**, the description would not be complete – we would have left out the **popliteal vein**. That is why we use the term **popliteal vessels**.

8.2.2 Superficial venous system of lower extremity



Superficial venous system of lower extremity originates from venous network – **dorsal venous arch of the foot**. Veins on this side of the foot are subjected to far lesser pressure, that is why this venous network is formed here. Two marginal veins originate from this place – **lateral marginal vein** and **medial marginal vein**. From their continuation two principal superficial veins of lower extremity are formed – the **great saphenous vein** (from **medial marginal vein**) and the **small saphenous vein** (from **lateral marginal vein**). **Small saphenous vein** runs behind **lateral malleolus** together with **sural nerve**, ascends along posterior side of the leg and enters the deep venous system in **popliteal fossa**, where it ends into **popliteal vein**. Just before entering **popliteal vein**, the **femoropopliteal vein** is joined. **Great saphenous vein** runs in front of **medial malleolus** together with **saphenous nerve** and ascends along medial side of leg and thigh up to **saphenous ring** where several local superficial veins – as shown on the picture- enter **femoral vein**.

8.2.3 Connection of superficial and deep veins of lower extremity **(perforating veins)**

Beside superficial veins running in subcutaneous layer, outside of the muscle fascias, and deep veins accompanying arteries of the same name, there are also connections which cross fascias and **connect both venous systems**. They are called **perforating veins**. Valves in these veins are orientated in a way which allows the blood flow from superficial to deep system. In normal conditions the venous blood drainage from lower extremity is performed **at 80% by deep venous system and at 20% by superficial venous system**. Disruptions of this blood flow regulation have clinical implications in forming **varices (varicose veins)**, following by inflammations and thrombosis, which can cause even pulmonary embolism. Altogether there are around 100 – 150 perforating veins, from which around 40 are present constantly. They are divided into six groups by location (**perforating veins of foot, tarsus, crura, knee, femoral and gluteal**). Most clinically significant are **posterior tibial perforating veins of crura (3 „Cockett’s perforators“)** connecting **posterior accessory great saphenous vein** and **posterior tibial veins**. Some others also have eponym names, but their using is not recommended and additional information is above topic of this study material.

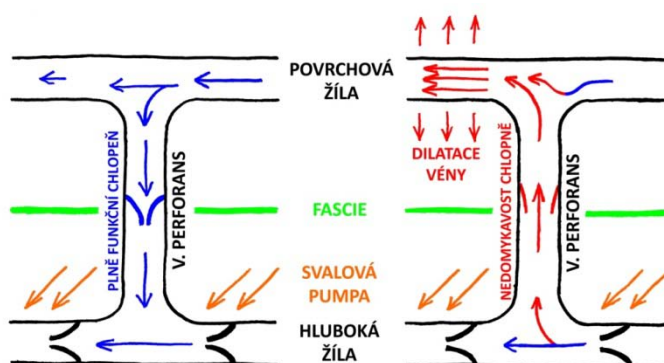
9. CLINICAL CORRELATION OF VESSELS OF LOWER EXTREMITY

9.1 „Corona mortis“ (Hesselbachi)

„Corona mortis“ („crown of death“) is non-constant anastomosis between **pubic branch of inferior epigastric artery** (more precisely it's **obturator branch**) and **pubic branch of obturator artery**. This anastomosis passes over **superior ramus of pubis** (4 – 8 cm from **pubic symphysis** around **pubic pecten**). It is present in **8 – 20% of cases**. Much more common is **venous anastomosis (50 – 90% of cases)**. Both can be even replaced by **obturator vessels**.

Clinical significance of „corona mortis“ lies in its **high vulnerability** around passage over superior ramus of pubis. Injury of this vessel may lead to bleeding to lesser pelvic space and **can be life threatening**. This connection can be damaged during surgeries in this location (for example operation of hernia, especially femoral hernia) and by fractures of pubis or acetabulum (this anastomosis should be remembered even during repositioning of fracture). Also child births can be life threatening because of this anastomosis.

9.2 Significance of perforating veins in forming varices



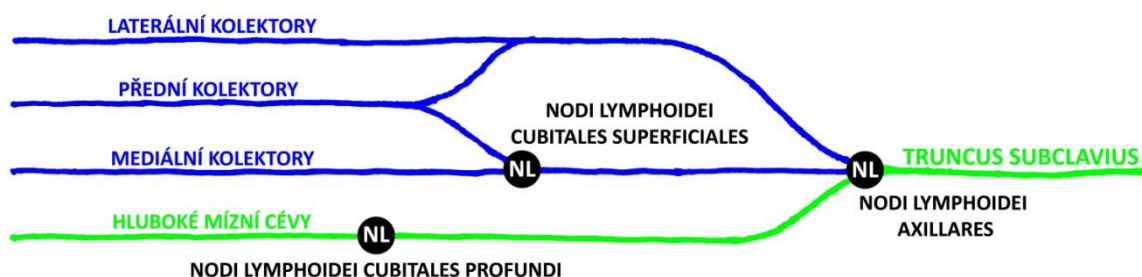
Valves in **trans fascial connections of superficial and deep venous system** of lower extremity in normal conditions (left) regulate blood flow to deep veins, from which this blood outflows (with the help of the **muscle pump** and other mechanisms). Venous blood drainage by superficial system is only 20 – 40% of total amount of venous return from lower extremity.

If **valves in perforating veins are incompetent** (for example after thrombophlebitis, defected collagen or smooth muscle development in the vein wall), **these connections do not sufficiently regulate the blood flow into the deep system** (right). In addition, muscle pump increases pressure in deep venous system and draws even more blood to the superficial system. **After some time** (depending on structure of the vein wall) **superficial veins can no longer sustain increased venous blood pressure and they dilate**. These dilated veins are noticeable in subcutaneous layer as **varicose veins**.

Treatment is **conservative** or **surgical**. Conservative treatment is only supportive – wearing compressive stockings and by usage of anti-inflammatory medicaments. Surgical therapy can be done by sclerotization, laser treatment or extirpation of insufficient veins. More detailed description is beyond the scope of this study material.

10. LYMPHATIC DRAINAGE OF EXTREMITIES

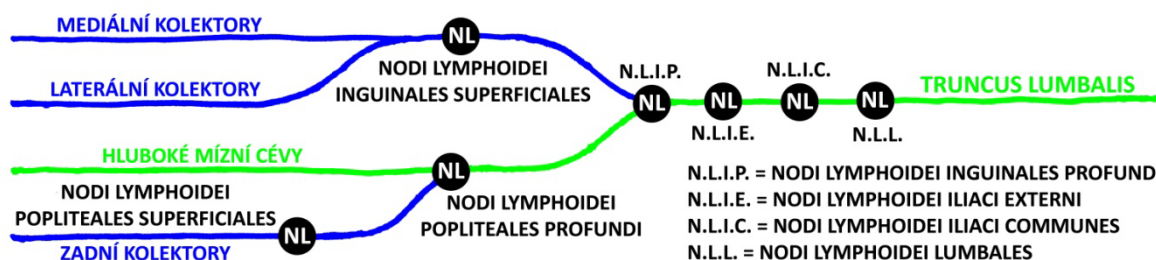
10.1 Lymphatic drainage of upper extremity



Lymphatic drainage of extremities is similar to the venous one – here as well are two systems as well – **superficial lymphatic system**, which accompanies principal blood vessels. Along their course **lymph nodes** can be found – the most important lymph nodes are shown in the scheme and some of them can be found in certain topographical sites (see below). Before the lymph enters the venous system in the confluens of the subclavian and internal jugular vein (venous angle), it has to be „filtered“ by at least one lymph node.

Superficial lymph vessels of the upper extremity are represented by **three groups of collectors** – **lateral** (accompanying the **cephalic vein**), **medial** (accompanying the **basilic vein**) and **anterior** (accompanying the **median antebrachial vein**). Those enter the **deep lymph vessels** in corresponding topographical sites and finally enter the **axillary lymph nodes**. From there the deep lymph vessels continue as the **subclavian trunk**. Further and closer description of the lymphatic system is not the topic of the winter dissection course.

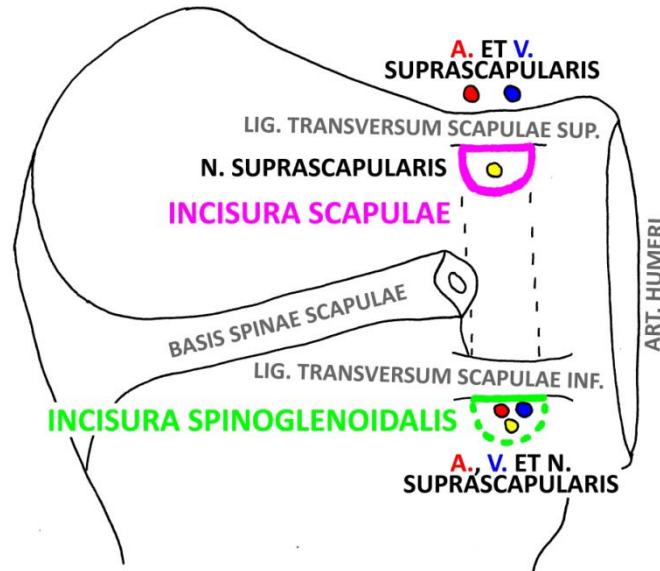
10.2 Lymphatic drainage of lower extremity



Drainage of lymph from the lower extremity is similar to that of the upper one. **Superficial system** is represented by **three groups of collectors** – **lateral**, **medial** (accompanying the **great saphenous vein**) and **posterior** (accompanying the **small saphenous vein**). Lymph from the **medial** and **lateral collectors** enters the **deep lymph vessels** through the **superficial and deep inguinal lymph nodes**. **Posterior collectors** join the **deep lymph vessels** through the **superficial and deep popliteal lymph nodes**. Lymph from the superficial and deep system then enters the **lumbar trunk** after passing through several iliac and lumbar lymph nodes (see the scheme).

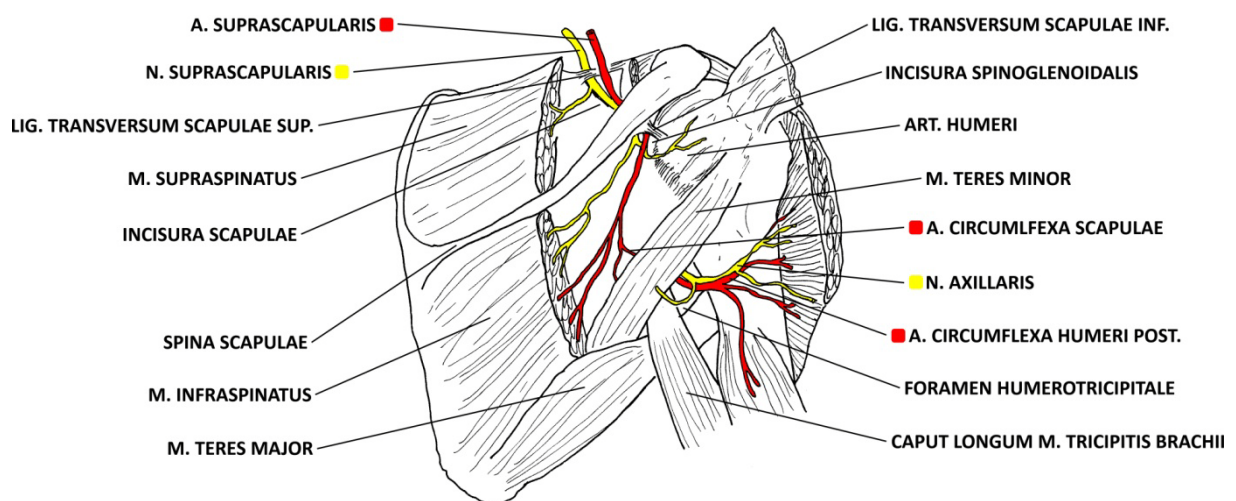
11. TOPOGRAPHY OF UPPER EXTREMITY

11.1 Scapular and spinoglenoid notch



SCAPULAR NOTCH

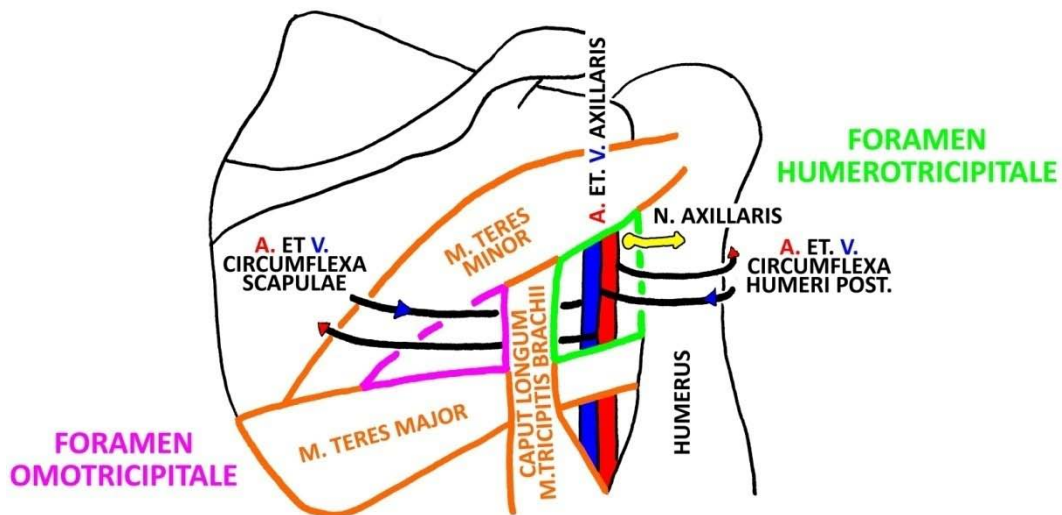
Scapular notch is topographical location between bone edges - *scapular notch (caudally)* and *superior transverse ligament (cranially)*. Content is only the **suprascapular nerve**. Suprascapular vessels run above the ligament. The ligament is occasionally ossified, which can cause compression of the **suprascapular nerve**.



SPINOGLENOID NOTCH

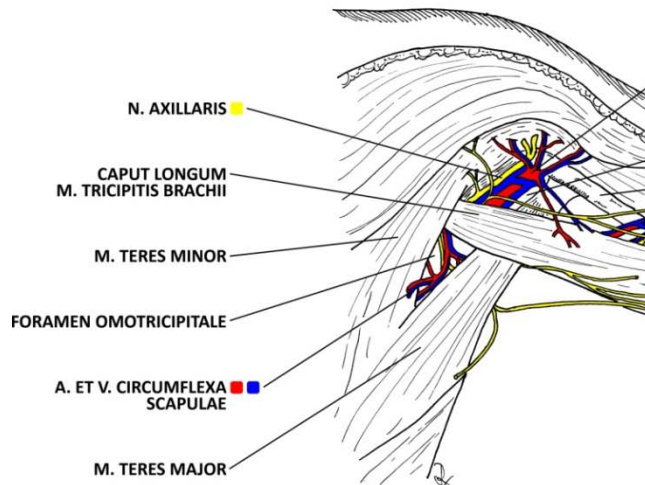
It is a passage between the *spine of the scapula (medially), shoulder joint (laterally)* and *the inferior transverse ligament (dorsally)*. Suprascapular nerve runs here together with **suprascapular vessels** (watch out for difference between position of **suprascapular vessels** compared to **scapular notch!**).

11.2 Omotricipital and humerotricipital foramen

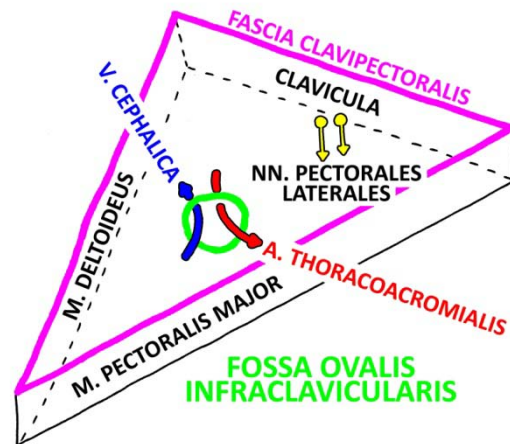


OMOTRICIPITAL FORAMEN (TRIANGULAR SPACE)

Omotricipital foramen is triangular space between three muscles – **teres minor (proximally), teres major (distally)** and **long head of triceps brachii (laterally)**. **Circumflex scapular vessels** pass here **from axillary fossa** and continue dorsally on scapula.



TRIGONUM CLAVIPECTORALE DX.



HUMEROTRICIPITAL FORAMEN (QUADRANGULAR SPACE)

It is a similar foramen lateral to **omotricipital foramen** margined from **lateral side by humerus** and by the same muscles as omotricipital foramen – **teres minor (proximally), teres major (distally) and long head of triceps brachii (medially)**. **Axillary nerve and posterior circumflex humeral vessels** pass here from **axillary fossa** and continue dorsally behind humerus.

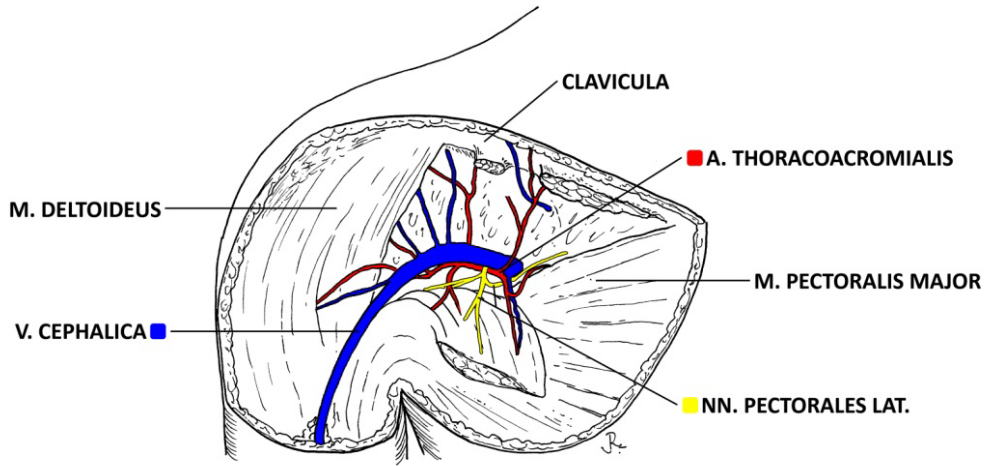
11.3 Clavipectoral triangle; infraclavicular oval fossa

CLAVIPECTORAL TRIANGLE (*DELTOPECTORAL*)

It is a space between **deltoid (lateral), pectoralis major (medial)** and the **clavicle (cranial)**, from which these muscles partially origin. Whole space is covered by **clavipectoral fascia**. **Thoracoacromial artery** crosses this space to emerge on the surface, where it gives its branches. **Cephalic vein** gets from subcutaneous layer into depth, in which enters **axillary vein** in **axillary fossa**. **Lateral pectoral nerves** are also located in **clavipectoral triangle**.

INFRACLAVICULAR OVAL FOSSA (*MOHRENHEIM*)

It is a passage in the **clavipectoral fascia** (see above), through which **thoracoacromial artery** gets to the surface and **cephalic vein** gets to the depth. **Lateral pectoral nerves** don't cross this space, they remain subfascially and innervate **pectoralis major and minor**. This fossa is sometimes referred as „**fossa of lovers**“, because on this place the girl lays her head on the shoulder of the boy.



11.4 Axillary fossa

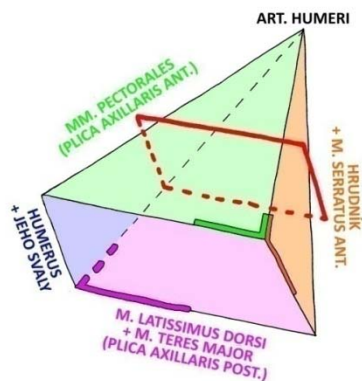
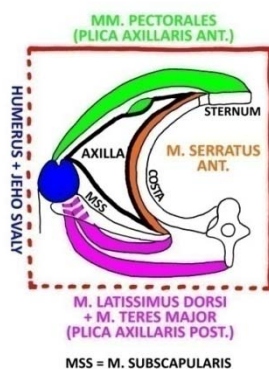
Axillary fossa is a pyramidal shaped space, which **apex** is located at lower edge of the **shoulder joint**. From **anterior side** it is limited by **anterior axillary fold**, which is formed by **pectoral muscles**. Dorsal margin of axilla is made by **posterior axillary fold**, which is formed by **latissimus dorsi** and **teres major**. **Medial margin** of axillary fossa is **thorax** with **serratus anterior**, **lateral margin** is **humerus** and its muscles.



FP = FASCICULL
 NCBM = N. CUT
 NCAM = N. CUT

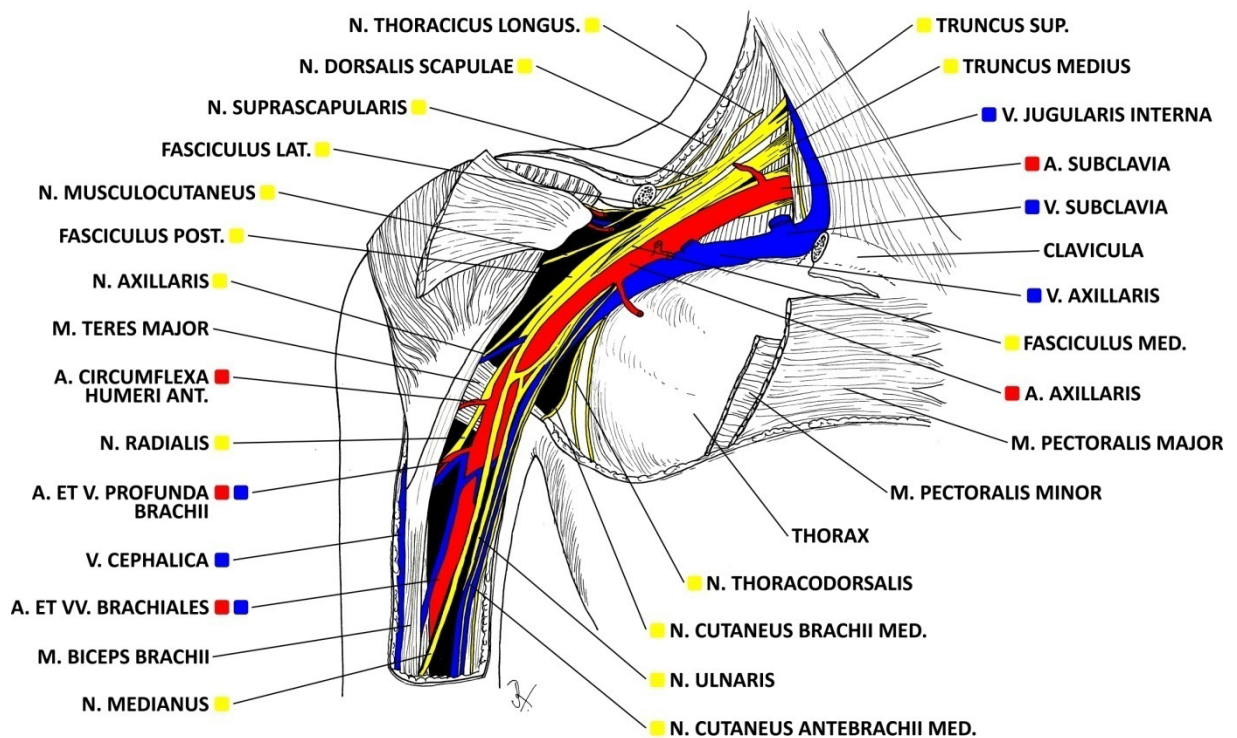
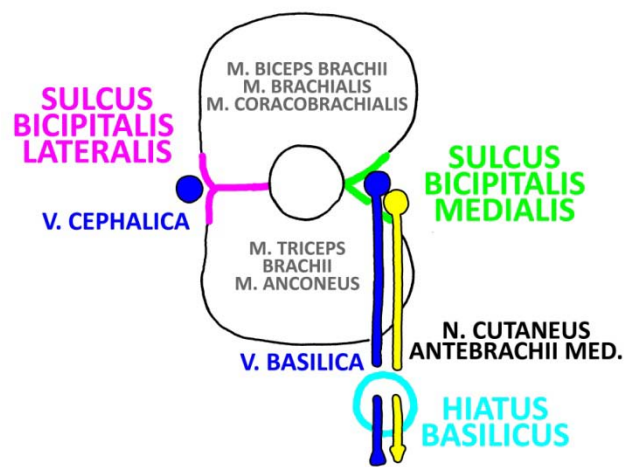
Content is the **axillary branches**

axillary



of the axillary fossa **artery** and **its** (see the picture). Ventromedially from **artery** is the **axillary**

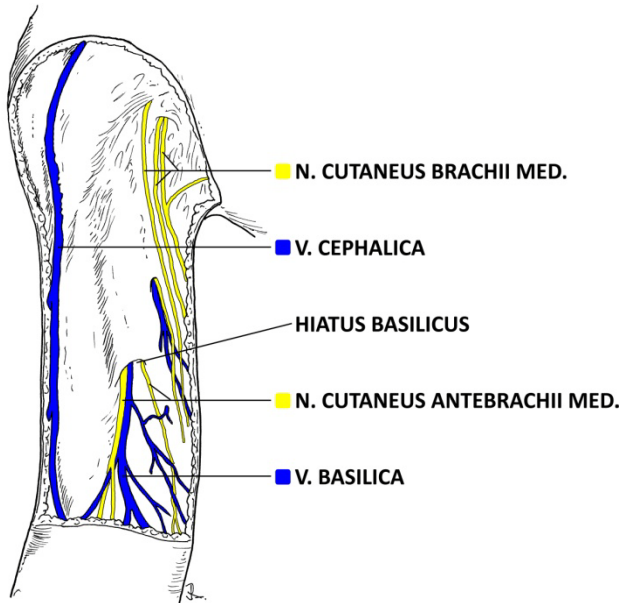
vein and its tributaries. **Cephalic vein** enters the **axillary vein** here as well (coming from the surface through **clavipectoral triangle** – see above). **Axillary artery** is surrounded by **infraclavicular part of brachial plexus with its cords and branches** (see the picture). From **supraclavicular part of brachial plexus** we can find **thoracodorsal nerve** and **long thoracic nerve**. However, both nerves are on the dissected specimen usually „free“, or are missing – their exact location is better shown in summer dissection course. Beside blood vessels and nerves **lymph nodes** are also located in the **axillary fossa**. They are distributed in several groups – knowledge of their exact locations is not required for winter dissection course.



11.5 Medial and lateral bicipital groove; hiatus basilicus

MEDIAL BICIPITAL GROOVE + HIATUS BASILICUS

It is a superficial **groove between ventral and dorsal group of muscles on the medial side of arm**, in which run sensitive branch from **medial cord** supplying medial side on the forearm – **medial antebrachial cutaneous nerve** – together with superficial **basilic vein**. Both structures can be found also in **hiatus basilicus** (aperture in brachial fascia 3-4 fingers



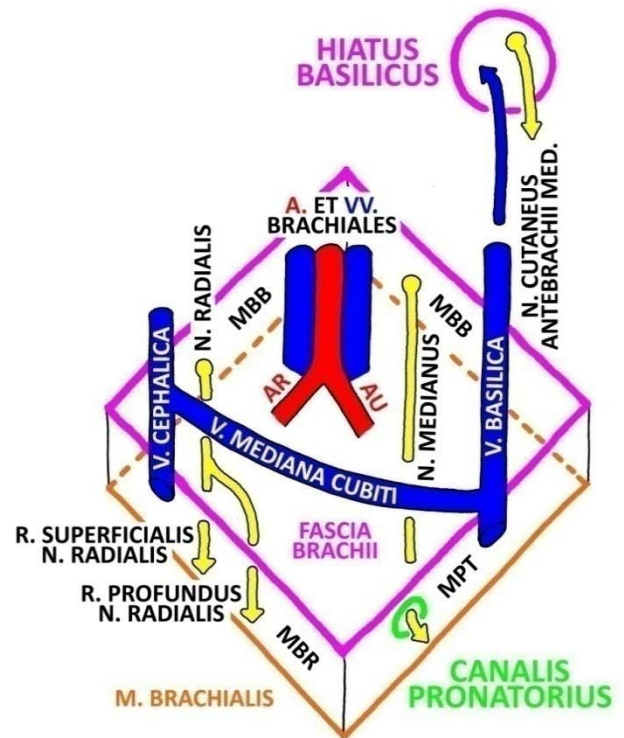
arm. Through this groove passes cephalic vein.

proximally from elbow joint), through which basilic vein gets from subcutaneous layer deeper and medial antebrachial cutaneous nerve ascends from the depth into the subcutaneous layer.

Deeper in medial intermuscular septum (outside superficial medial bicipital groove) runs median nerve together with brachial vessels.

LATERAL BICIPITAL GROOVE

It is a similar groove between ventral and dorsal muscle group, which is on the lateral side of the



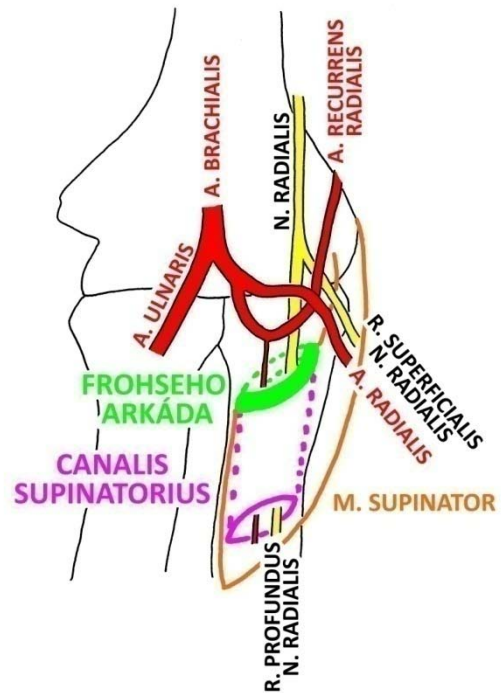
MBB = M. BICEPS BRACHII
 MBR = M. BRACHIORADIALIS
 MPT = M. PRONATOR TERES
 AR = A. RADIALIS
 AU = A. ULNARIS

11.6 Cubital fossa; pronator canal

CUBITAL FOSSA (ANTERIOR CUBITAL REGION)

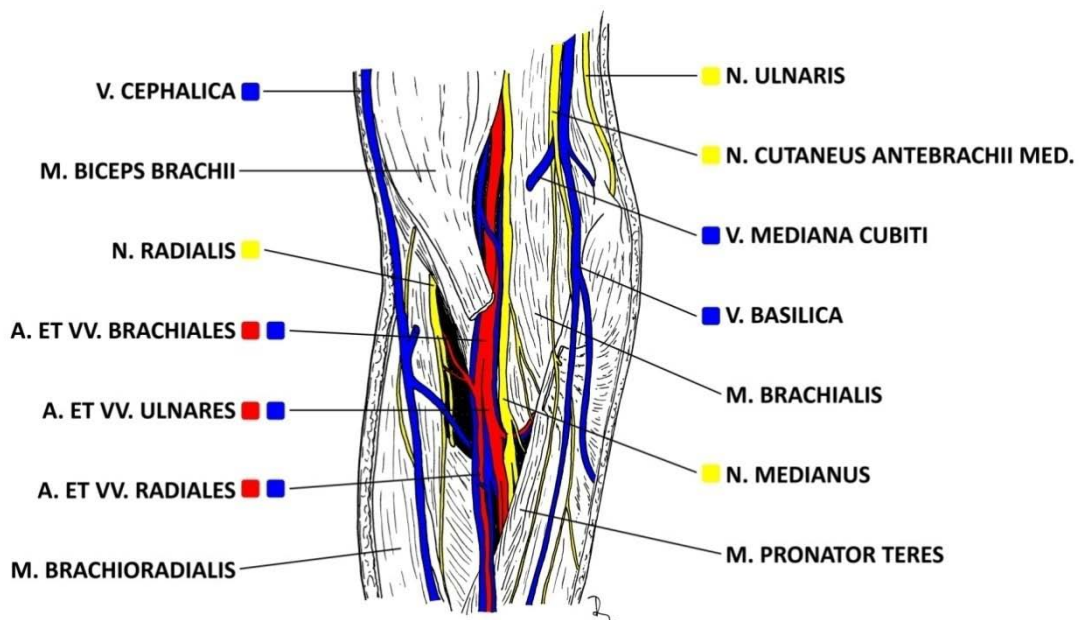
Cubital fossa is bordered by 4 muscles – proximal end of insertion tendon of biceps brachii (proximal), brachioradialis (lateral), pronator teres (medial) and brachialis (forms the floor of cubital fossa). Content is the brachial artery, which divides here to the ulnar

artery and to the **radial artery**. All arteries are accompanied by doubled veins. On the surface (on the **brachial fascia**) run two most significant superficial veins of the upper extremity (**cephalic and basilic veins**) which are connected by **median cubital vein**. **Cubital fossa** also contains **median nerve** (medial from brachial vessels) and **radial nerve** (lateral, hidden between the muscles), which divides here to **superficial** and **deep branch**.



PRONATOR CANAL

It is a canal between **humeral head** and **ulnar head of pronator teres**, which **continues between humeroulnar head and radial head of flexor digitorum superficialis**. **Median nerve** runs here from **cubital fossa** further to the forearm. Rarely can be compressed here, and tunnel syndrome occurs.



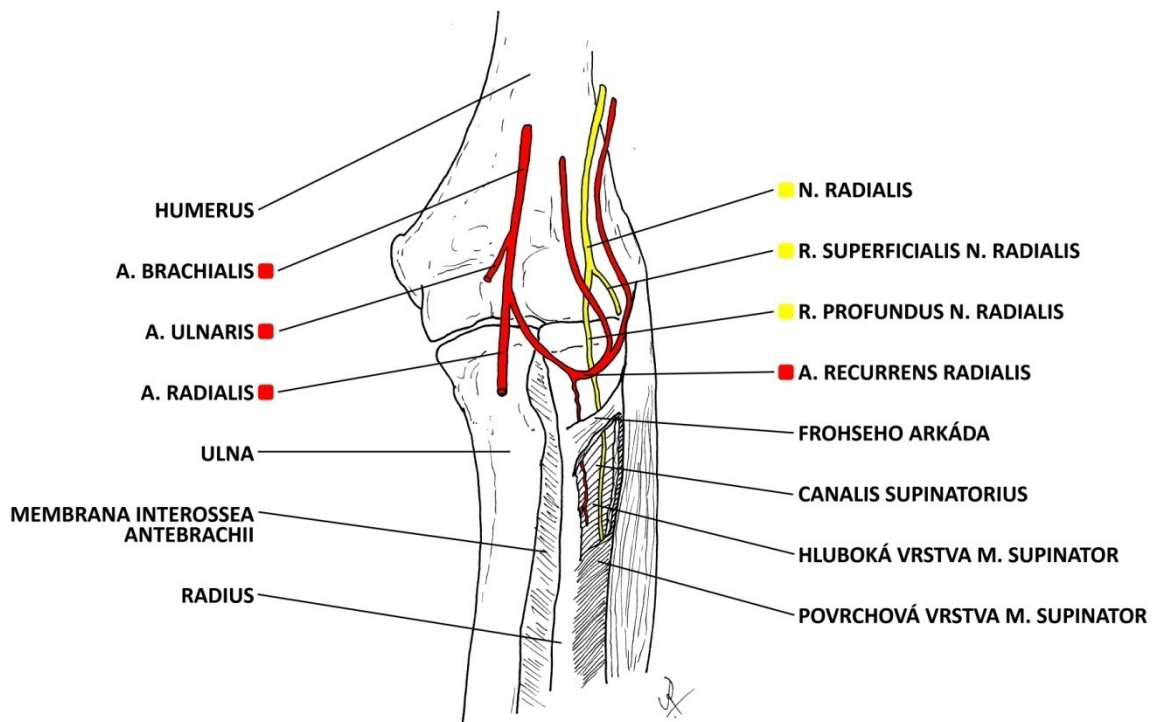
11.7 Supinator canal + arcade of Frohse; cubital canal

SUPINATOR CANAL + ARCADE OF FROHSE

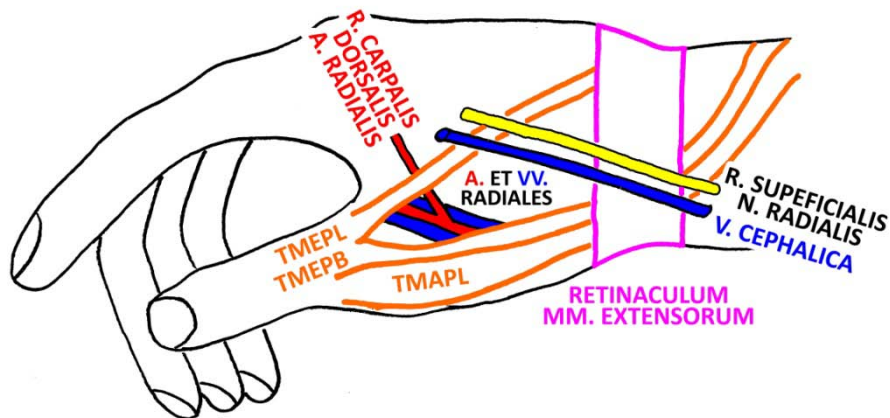
Supinator canal is a passage between superficial and deep layer of supinator. Arcade of Frohse is fibrous arch on the beginning of the canal. Deep branch of radial nerve runs in the canal together with branch from recurrent radial artery. The arcade of Frohse is the most frequent site of deep branch of radial nerve entrapment.

CUBITAL CANAL

Cubital canal (not shown on the picture) is similar to pronator canal. It is a passage between humeral head and ulnar head of flexor carpi ulnaris. Content of the canal is ulnar nerve, which can get entrapped here.

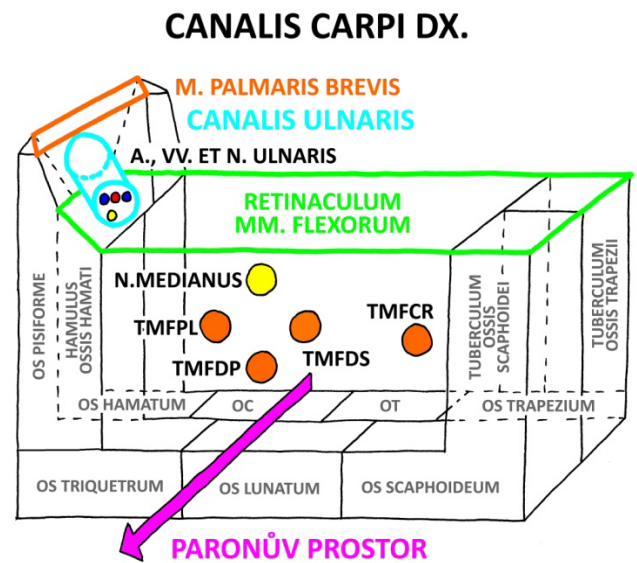
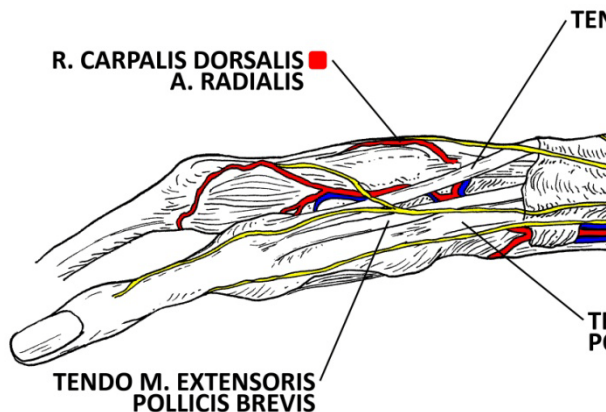


11.8 Radial foveola („fossa la tabatière“, „anatomical snuff-box“)



TMEPL = TENDO M. EXTENSORIS POLLICIS LONGI
 TMEPB = TENDO M. EXTENSORIS POLLICIS BREVIS
 TMAPL = TENDO M. ABDUCTORIS POLLICIS LONGI

Radial foveola is topographical place on the radial side of hand between *extensor retinaculum (proximal)*, *insertion tendons of extensor pollicis brevis and abductor pollicis longus in common tendon sheath (palmar)* and *insertion tendon of extensor pollicis longus (dorsal)*.



TMFDS = TENDO M. FLEXORIS DIGITORUM SUPERFICIALIS
 TMFPL = TENDO M. FLEXORIS POLLICIS LONGI
 TMFDP = TENDO M. FLEXORIS DIGITORUM PROFUNDI
 TMFCR = TENDO M. FLEXORIS CARPI RADIALIS
 OC = OS CAPITATUM
 OT = OS TRAPEZOIDEUM

On the surface of the foveola (above structures making the borders) runs **cephalic vein** together with **superficial branch of radial nerve**. In the depth (under structures forming the borders) run **radial vessels** – **radial artery** here gives a branch **dorsal carpal branch of radial artery** for **dorsal carpal arch**. The name „la tabatière“ or „snuffbox“ comes from placing tobacco (snuff) into this foveola.

Carpal canal; ulnar canal; Paron’s space

CARPAL CANAL

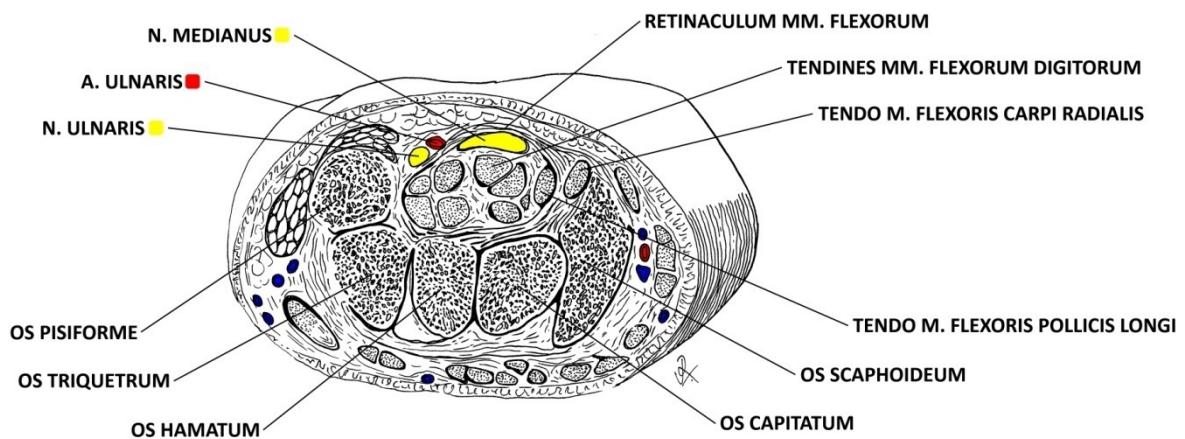
The carpal canal (carpal tunnel) is a **passage between carpal bones (radial, dorsal, ulnar) and flexor retinaculum (palmar)**, which is divided into ulnar and radial part. In the ulnar part run the **median nerve** and insertion tendons of **flexor pollicis longus, flexor digitorum superficialis** and **flexor digitorum profundus** in their tendon sheaths. In the radial part there is an insertion tendon of **flexor carpi radialis** in its tendon sheath. Median nerve runs in superficial, palmar and ulnar direction. It can be easily compressed by insertion tendons, which causes the most common tunnel syndrome – carpal tunnel syndrome.

PARON'S SPACE

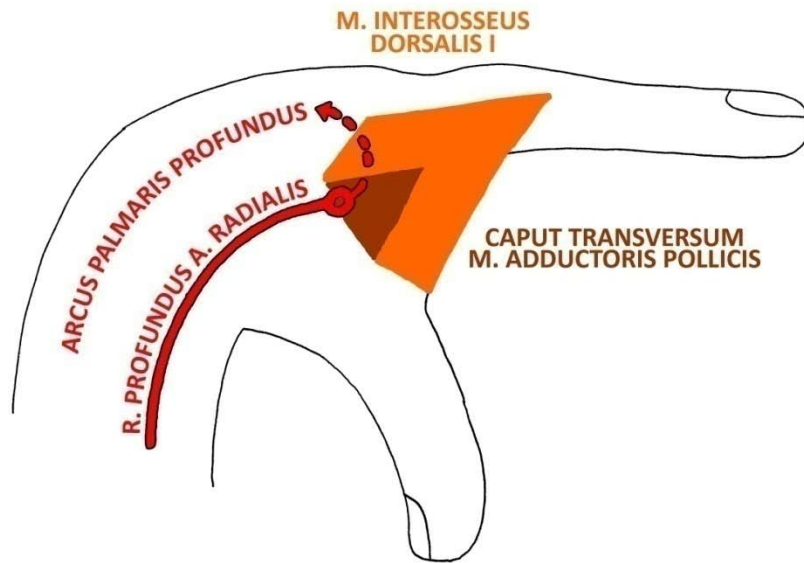
It is a **continuation of carpal canal proximally between pronator quadratus (dorsal) and insertion tendons of flexor digitorum profundus together with flexor pollicis longus (palmar)**. The space is filled only with **loose connective tissue**, which enables **inflammation** to spread easily, for example from palm or surrounding bursae.

ULNAR CANAL (GUYON'S BOX)

Ulnar canal is located **between pisiforme and hamulus of hamate**. From **palmar side** is this passage margined by **palmaris brevis** and **dorsally by flexor retinaculum**, which divides this canal from deeper **carpal canal**. Through Guyon's canal run **ulnar vessels** together with **ulnar nerve**, which can get entrapped here.



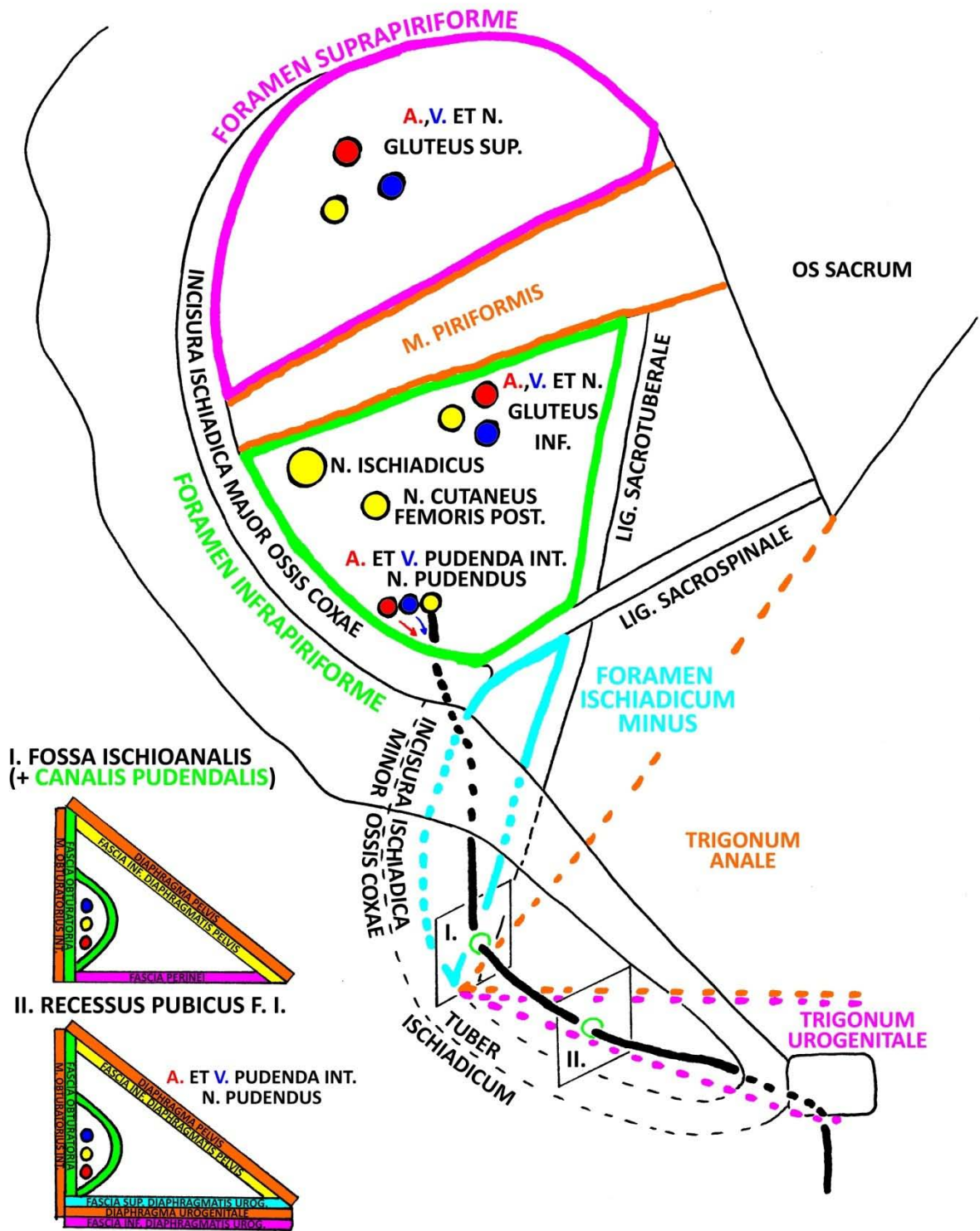
11.9 Guiot 's space



Guiot's space is between **first dorsal interosseus (dorsal)** and **transverse head of adductor pollicis (palmar)**. **Deep branch of radial artery** gets between muscles of the hand through this space and then forms **superficial palmar arch**.

12. TOPOGRAPHY OF LOWER EXTREMITY

12.1 Greater sciatic foramen (suprapiriform foramen and infrapiriform foramen); lesser sciatic foramen; pudendal canal



GREATER SCIATIC FORAMEN

It is a large foramen margined by **major sciatic notch (ventral / lateral)**, **sacrotuberous ligament (dorsal / medial)** and **sacrospinous ligament (caudal)**. Through this foramen

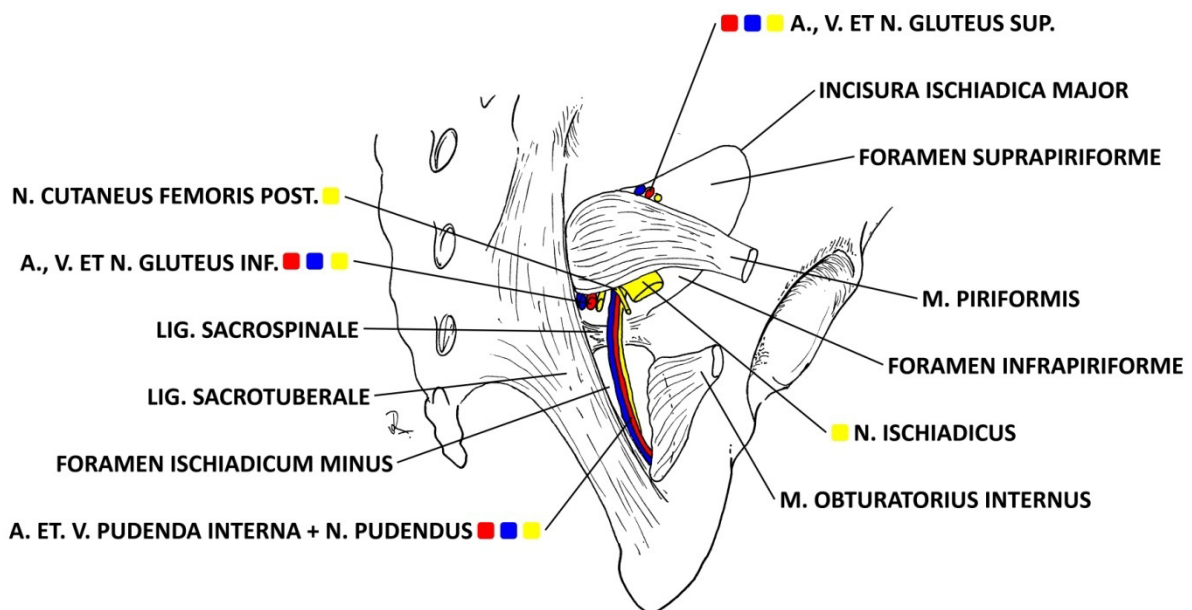
piriformis runs from **pelvic surface of sacrum** to **greater trochanter**. **Piriformis** divides this foramen into two separate topographical locations – **suprapiriform foramen** and **infrapiriform foramen**.

SUPRAPIRIFORM FORAMEN

Suprapiriform foramen is cranial part of **greater sciatic foramen** – **above piriformis (which forms caudal margin of this foramen)**. Other borders are **greater sciatic notch (ventral /caudal)** and **sacrotuberal ligament (dorsal / medial)**. **Superior gluteal vessels and superior gluteal nerve** pass through this foramen. Rarely herniae may pass here.

INFRAPIRIFORM FORAMEN

It is topographical passage in **greater sciatic foramen below level of piriformis (which forms cranial margin of this foramen)**. Other margins are **greater sciatic notch (ventral / lateral)**, **sacrotuberal ligament (dorsal / medial)** and **sacrospinal ligament (caudal)**. In this foramen four nerves can be found. **Sciatic nerve** (the largest nerve in human body) runs through this foramen most laterally. Medially is the **puddental nerve, inferior gluteal nerve** and the **posterior femoral cutaneous nerve**. From blood vessels **inferior gluteal vessels and internal pudendal vessels** (both medially from **sciatic nerve**) are found here. Rarely herniae may pass here.



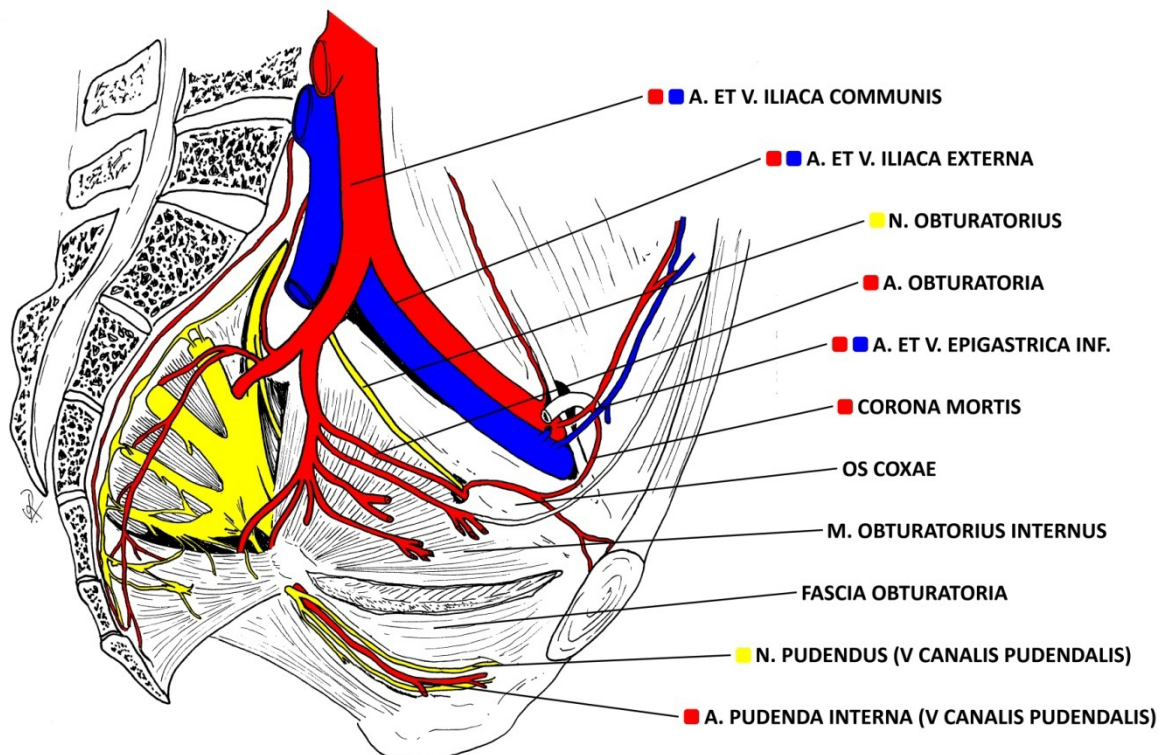
LESSER SCIATIC FORAMEN

Lesser sciatic foramen is a passage margined by **lesser sciatic notch (ventral / lateral)**, **sacrotuberal ligament (dorsal / medial)** and **sacrospinal ligament (cranial)**. **Pudendal nerve** together with **internal pudendal vessels** continue here from **infrapiriform foramen**, after these structures pass around **ischial spine**. Then they continue back into pelvis, caudally

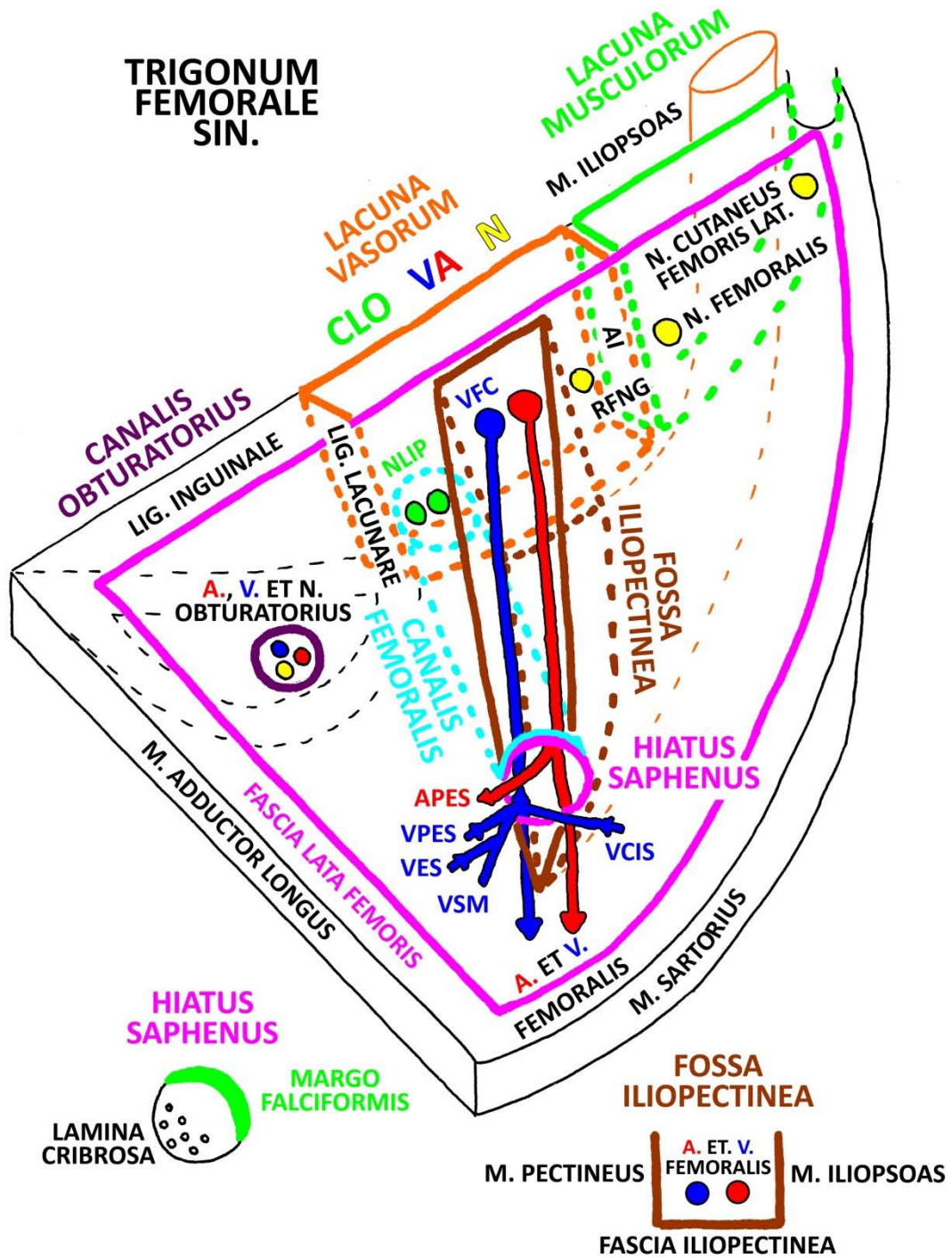
from pelvic floor (levator ani) into **ischioanal fossa**. **Obturator internus** heads to its insertion from lesser pelvis into **trochanteric fossa** (not shown on the scheme).

PUDENDAL CANAL (ALCOCK'S)

Alcock's canal is passage in *doubled layer of fascia of mediocaudal edge of obturatorius internus*. It is located in **ischioanal fossa** (see the picture). **Pudendal nerve** and **internal pudendal artery** pass here from **lesser sciatic foramen**, heading to **pubic symphysis**.



12.2 Muscular lacuna; vascular lacuna; femoral canal; saphenous hiatus; obturator canal; femoral triangle; iliopectineal fossa



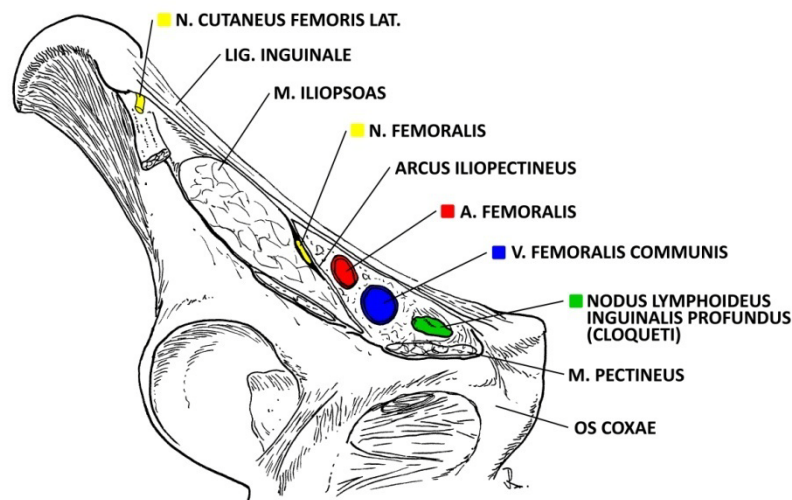
- NLIP = NODI LYMPHOIDEI INGUINALES PROFUNDI
- VFC = V. FEMORALIS COMMUNIS
- AI = ARCUS ILIOPECTINEUS
- RFNG = R. FEMORALIS N. GENITOFEMORALIS
- APES = A. PUDENDA EXTERNA SUPERFICIALIS
- VPES = V. PUDENDA EXTERNA SUPERFICIALIS
- VES = V. EPIGASTRICA SUPERFICIALIS
- VSM = V. SAPHENA MAGNA
- VCIS = V. CIRCUMFLEXA ILIUM SUPERFICIALIS

MUSCULAR LACUNA

Muscular lacuna is *lateral part of the space between inguinal ligament (ventral) and hip bone (dorsal). Medial margin is iliopectineal arch (thickened medial fascia of iliopsoas).* Contents of **muscular lacuna** are **iliopsoas** (hence its name) and two nerves – laterally is passing **lateral femoral cutaneous nerve** (which might get constricted here and contusion syndrome appears) and medially located is **femoral nerve**.

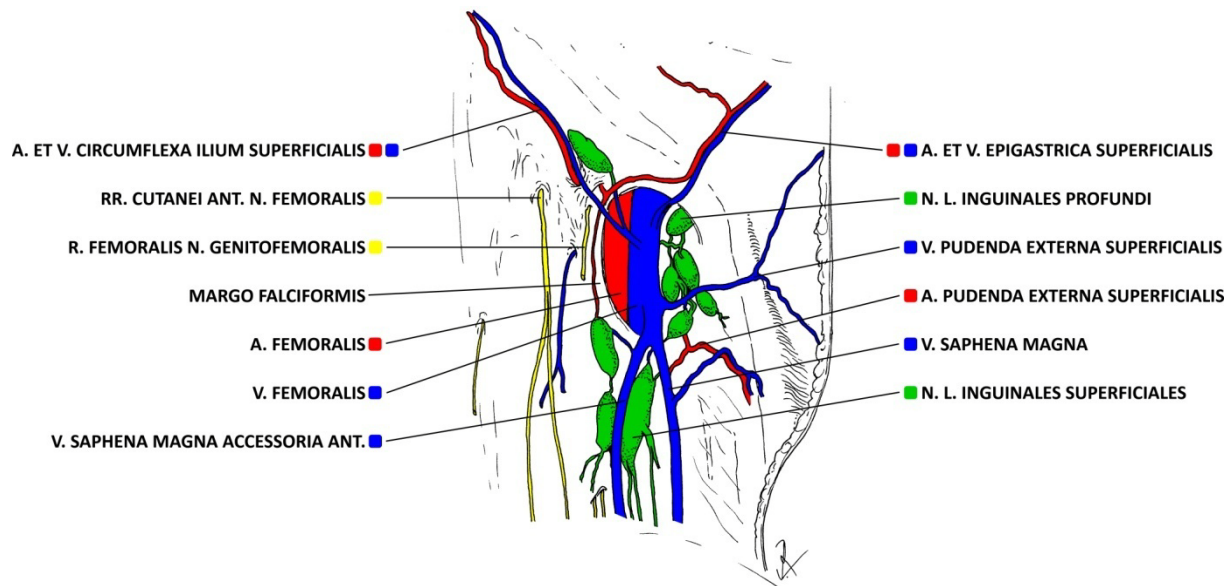
VASCULAR LACUNA

Lies between **inguinal ligament (ventral), hip bone (dorsal),** which is covered by **pectineal ligament**. From lateral side is margined by **iliopectineal arch** and from medial side by **lacunar ligament**. For easier remembering of content and relations there is mnemonics **CLOVAN** – mediolaterally: **proximal deep inguinal lymph node / CLOqueti/; common femoral Vein; femoral Artery** and **femoral branch of genitofemoral Nerve**.



SAPHENOUS RING

Saphenous ring is a *passage through fascia cribrosa* (part of fascia lata) *into iliopectineal fossa* (see below), *which is margined from lateral side by thickened ligament – margo falciformis*. Superficial **great saphenous vein** passes into depth, joined by its tributaries – **superficial epigastric vein, superficial external pudendal vein and superficial circumflex iliac vein**. This region of the vein is called **confluens venosus subinguinalis**. From depth to the surface through **saphenous ring** pass **superficial external pudendal artery**.

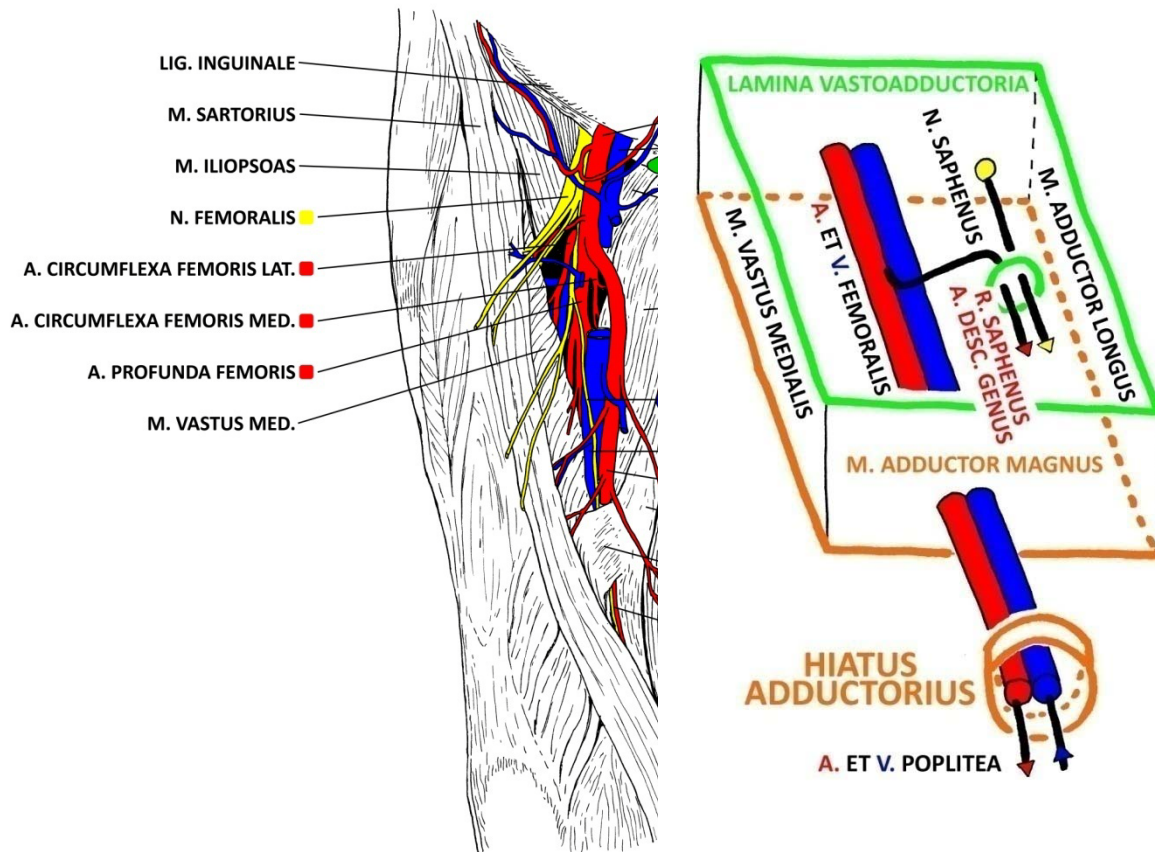


OBTURATOR CANAL

*It is a passage in obturator membrane in place of bone obturator groove. Obturator nerve and obturator vessels pass from the lesser pelvis on medial side of the thigh through this canal. Some branches of above named structures then pass between **pectineus** and **adductor longus** into **femoral triangle** (see below).*

FEMORAL TRIANGLE (*FOSSA SCARPAE MAJOR*)

Femoral triangle is relatively large topographical space margined by **sartorius (lateral)**, **adductor longus (medial)** and **inguinal ligament (proximal)**. Here can be found all of the contents of **muscular and vascular lacuna** (by the mnemonics **CLOVAN**; **proximal deep inguinal lymph node / CLOqueti/** (most cranially located); **femoral Vein** and its tributaries and further on **common femoral vein**, which is formed by joining **femoral vein** and **deep femoral vein** (in femoral triangle is joined by **great saphenous vein**); **femoral Artery** with its branches and **femoral branch of genitofemoral Nerve**; also **femoral nerve** (+ its branches) and **lateral femoral cutaneous nerve**. In the depth (between **pectineus** and **adductor longus**) the **femoral triangle** is joined by branches of **obturator nerve** and of **obturator vessels**.



ILIOPECTINEAL FOSSA (FOSSA SCARPAE MINOR)

Iliopectineal fossa lies in the depth of femoral triangle and is margined by iliopsoas (lateral), pectineus (medial) and by iliopectineal fascia (forms bottom of iliopectineal fossa – is stretched between iliopsoas and pectineus). From vascular lacuna further continue femoral artery and common femoral vein.

12.3 Adductor canalis + adductorius hiatus

ADDUCTOR CANAL (HUNTER'S)

Hunter's canal lies distally from femoral triangle. It is a passage between vastus medialis (lateral), adductor longus (medial), adductor magnus (dorsal) and aponeurotic lamina vastoadductoria (ventral). Across the whole canal runs sartorius. Femoral vessels come here from femoral triangle. Sensitive saphenous nerve, which is also located in the canal, perforates lamina vastoadductoria together with saphenous branch of descending genicular artery, which branch from femoral artery in adductor canal. (picture of adductor canal – see femoral triangle)

ADDUCTOR HIATUS

Ends **adductor canal (Hunter's)** from distal side. It is a *passage between two insertion parts of adductor magnus (see above) and adjacent part of femur*. Femoral vessels here leave **femoral canal** onto dorsal side of knee to **popliteal fossa**. Also names of artery and vein here change to **popliteal artery and vein**.

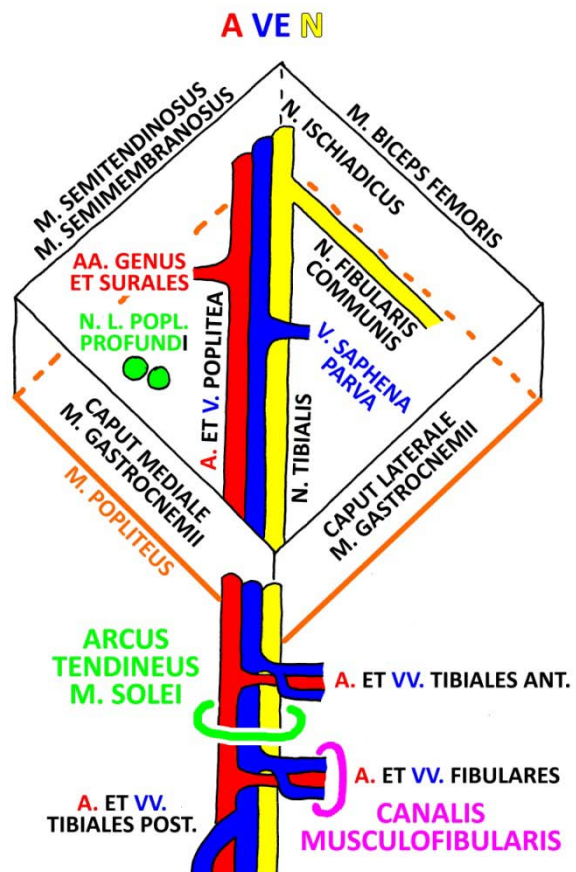
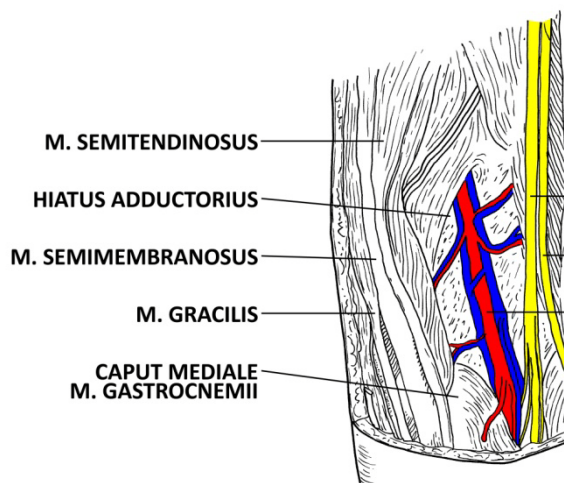
12.4 Popliteal fossa; fibular canal; tendineous arch of soleus; musculofibular canal

POPLITEAL FOSSA

Popliteal fossa is topographical place margined by five muscles: *semitendinosus and semimembranosus (medial / proximal), biceps femoris (lateral / proximal), medial and lateral head of gastrocnemius (distal) and popliteus (forms bottom of popliteal fossa)*. For remembering the content and its relations can be useful mnemonic **AVEN**- mediolaterally from the depth to the surface: **popliteal Artery, popliteal Vein and its tributaries** – especially superficial **small saphenous vein** and in the depth **genicular venous plexus and gastrocnemial veins**. **Sciatic Nerve** is usually already split into **tibial nerve** and **common fibular nerve** (see above). **Deep popliteal lymphatic nodes** are also located here. Be aware of the reverse order of artery and vein than in **vascular lacuna** – in **popliteal fossa** is the artery deeper than the vein.

FIBULAR CANAL

Is a little space between *fibularis longus (lateral) and fibula (medial)*. **Common fibular nerve** passes here. This nerve can get constricted in **fibular canal** and contusion syndrome appears (see above).

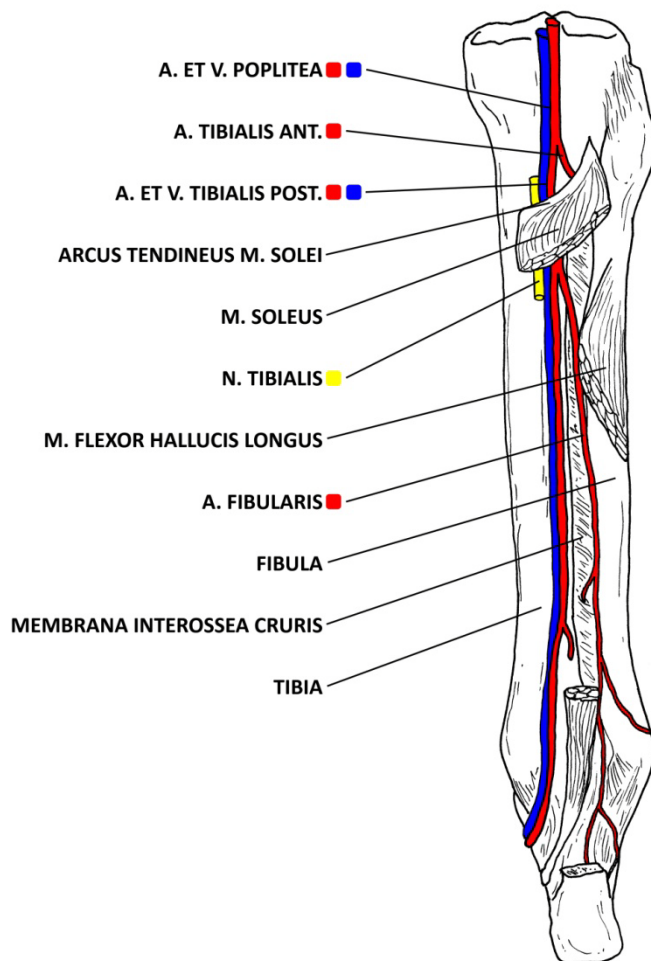


TENDINEOUS ARCH OF SOLEUS

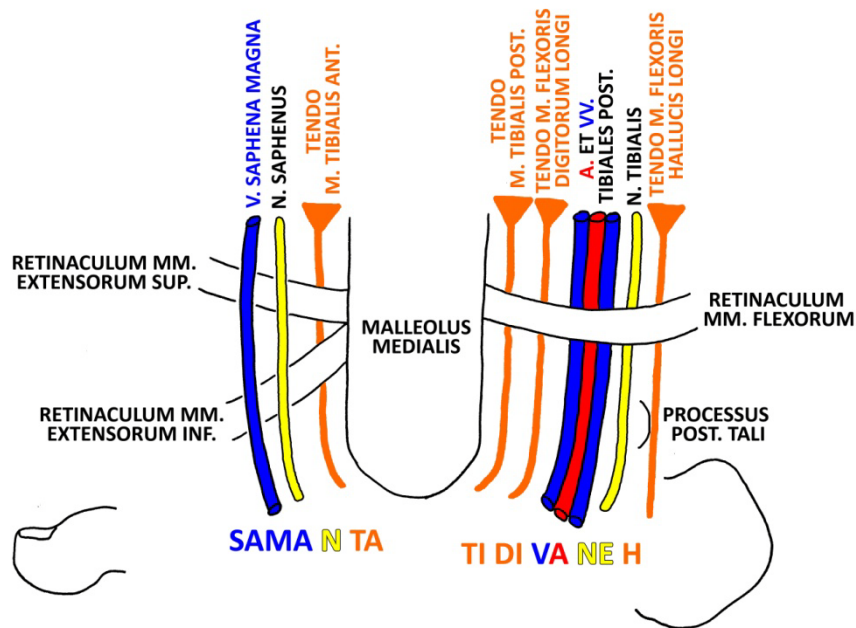
Tendineous arch, by which soleus originates from soleal line of tibia. Beneath the arch runs **tibial nerve** together with **posterior tibial vessels**. This anatomic arrangement has great significance, because during standing or walking prevents contusion of mentioned structures while **soleus** is contracted.

MUSCULOFIBULAR CANAL (HYRTL'S)

Hyrtl's canal is a *passage between fibula (lateral) and one of the muscles of the leg – flexor hallucis longus (medial)*. Fibular vessels pass through here.

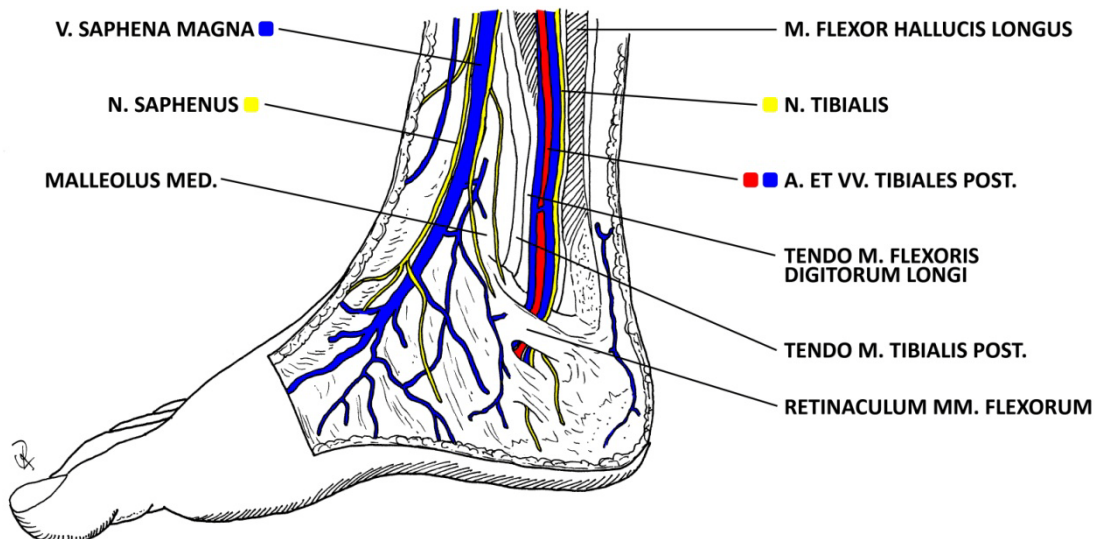


12.5 Structures in front of and behind medial malleolus



STRUCTURES IN FRONT OF MEDIAL MALLEOLUS

Passage in front of *medial malleolus* is margined by *superior and inferior extensor retinaculum (ventral)*. The content is easier remembered by mnemonics **SAMANTA** – **ve**n**a** **S**aphena **M**agna , **s**aphenous **N**erve and **t**endo**n** of **T**ibialis **A**nterior in its tendons sheath. Veins and nerve run superficially (over superior and inferior extensor retinaculum) tendons run in the depth (below retinaculi).

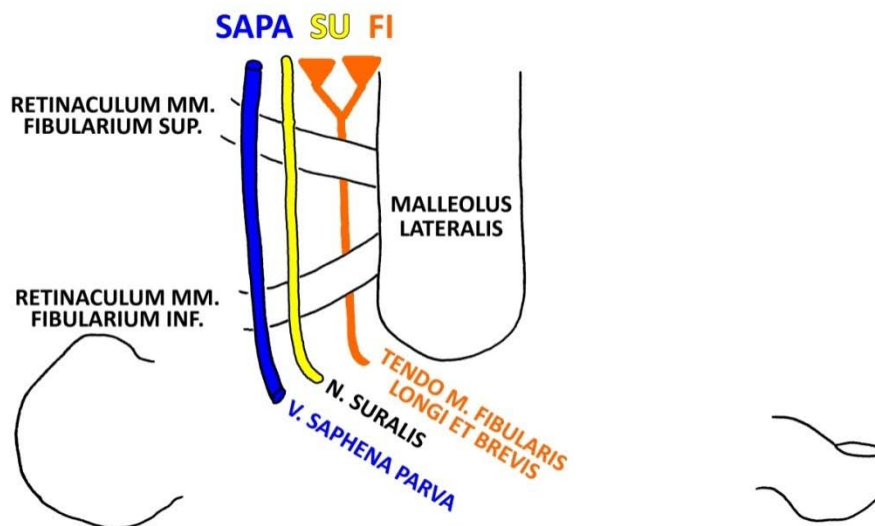


STRUCTURES BEHIND MEDIAL MALLEOLUS = CANALIS MALLEOLARIS

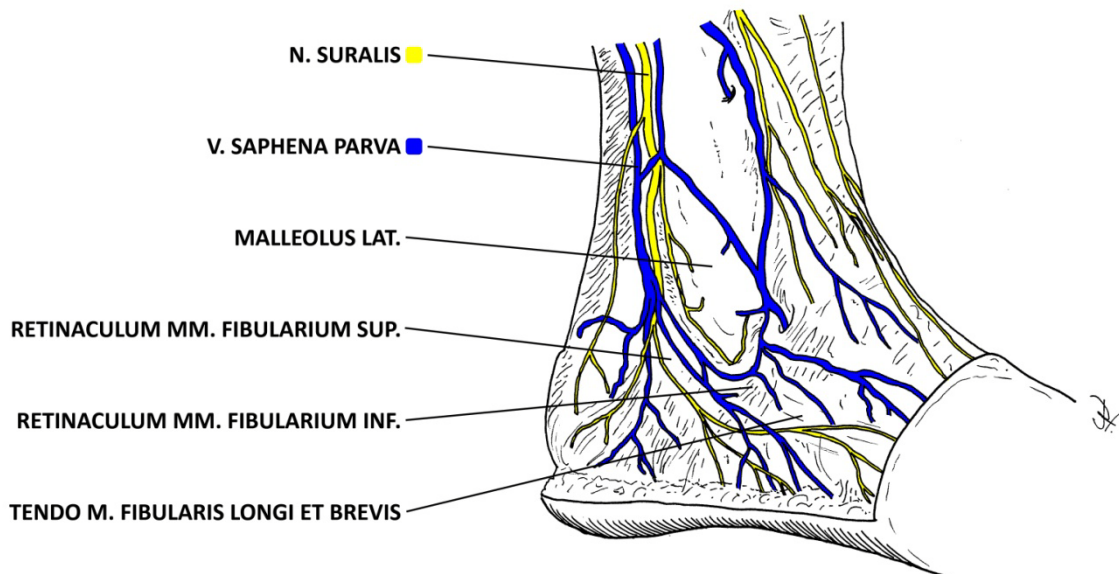
Passage behind medial malleolus is also known as **canalis malleolaris (tarsal canal)**. It is margined by **medial malleolus (ventral)**, **flexor retinaculum (medial)** and **tuber of the calcaneus (dorsal)**.

Mnemonics **TIDIVANEH** shows content and position of the canal – in **ventrodorsal order**: **tendon of Tibialis posterior** in its tendon sheath, tendon of **flexor Digitorum longus** in its tendon sheath, **V**asa tibialia posteriora, **tibial N**erve and **tendon of flexor Hallucis longus** in its tendon sheath. All the structures are covered by **flexor retinaculum** and lean on **medial malleolus**. Only exception is **tendon of flexor hallucis longus**, which is from all structures most dorsal and runs in groove in **posterior process of talus** (groove for tendon of flexor hallucis longus on the talus).

12.6 Structures behind lateral malleolus



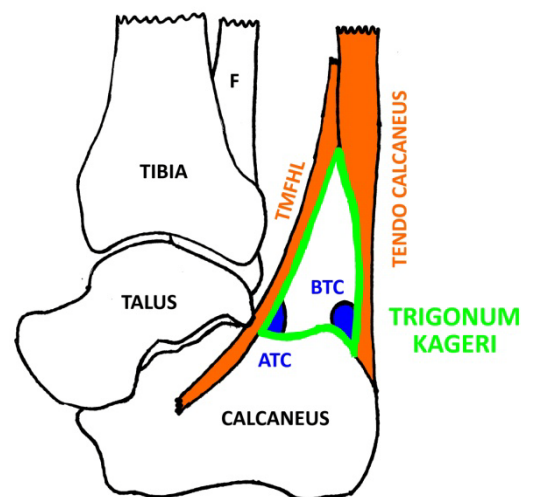
Passage behind **lateral malleolus (ventral)** is margined by **superior and inferior fibular retinaculum (lateral)** and **tuber of the calcaneus (dorsal)**.



Structures which run in this topographical location can be remembered by mnemonics **SAPASUFI** vena **S**Aphena **PAR**va, **SU**ral nerve and tendons of **F**ibularis longus and brevis in their common tendon sheath. Similar as in structures in front of medial malleolus, also here vein together with nerve run superficially (over retinaculum), and insertion tendons of muscles run in the depth (under retinaculum).

12.7 Kager's triangle

Is a space, which is filled by **Kager's adipose tissue**. It is margined by insertion tendons of flexor hallucis longus (ventral), tendo calcaneus (dorsal) and calcaneus (dorsal). With this adipose tissue interfere capsule of talocrural joint and bursa tendinis calcanei (see the picture), **Kager's adipose tissue** is significant especially for radiology diagnostics. Multiple pathologic signs in proximity of **Kager's adipose tissue** (for example rupture of tendo calcanei etc.) is manifested by change in density in **Kager's triangle** on lateral X-ray image.



F - FIBULA
 TMFHL - TENDO M. FLEXORIS HALLUCIS LONGI
 BTC - BURSA TENDINIS CALCANEI
 ATC - POUZDRO ART. TALOCRURALIS

13. ACCESSORY MUSCLE APPARATUS AND OSTEOFASCIAL SPACES OF EXTREMITIES

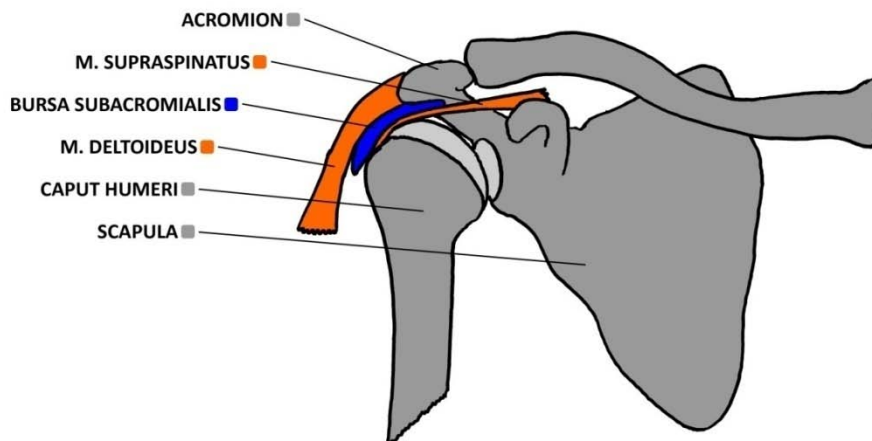
13.1 Bursae

Bursae are spaces located in the loose connective tissue near muscles and joints. They are, like joint capsules, lined by **synovial membrane**, which produces to the space of bursa small amount of **synovial fluid**. Here it provides the same function as in joints – reduces the friction and enables smooth movement of contact surfaces of layers of the bursa. Bursae have many shapes – oval, ovoid, lobular, etc.

Bursae can be found in places, which deal with pressure and friction at the same time – between muscles (or their tendons), between muscle (or its tendon) and joint or bone, between skin and bone, etc. Physiologic role of bursae lies in reducing the negative effect of pressure and friction on structures, between which it is located. It can be compared to ball bearing in machines. Bursae are clinically significant especially if they are inflamed (bursitis), in which they are swollen and painful. As well as in joint capsules, also in bursae hematoma can occur.

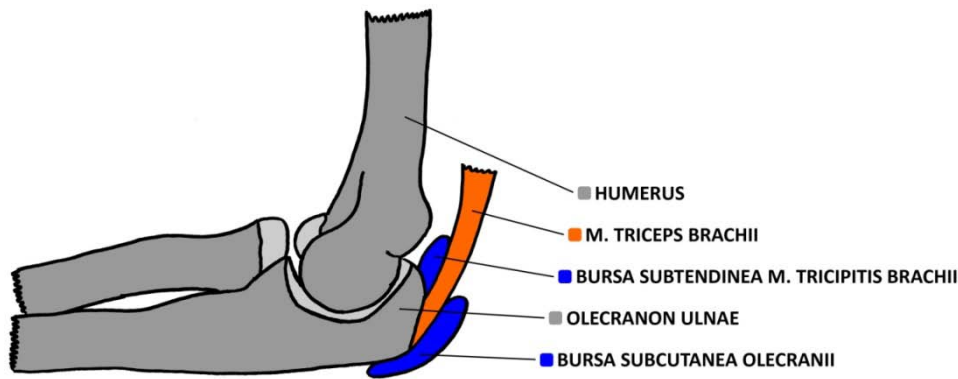
13.1.1 Principal bursae of upper extremity

SUBACROMIAL BURSA – is inserted between *deltoideus* and *shoulder joint*, lies as far as under *acromion* and under the insertion of *supraspinatus*.



SUBCUTANEOUS OLECRANON BURSA – inserted between skin and *olecranon of the ulna*.

TRICIPITAL BURSA – inserted between insertion of *triceps brachii* and *olecranon of the ulna*.

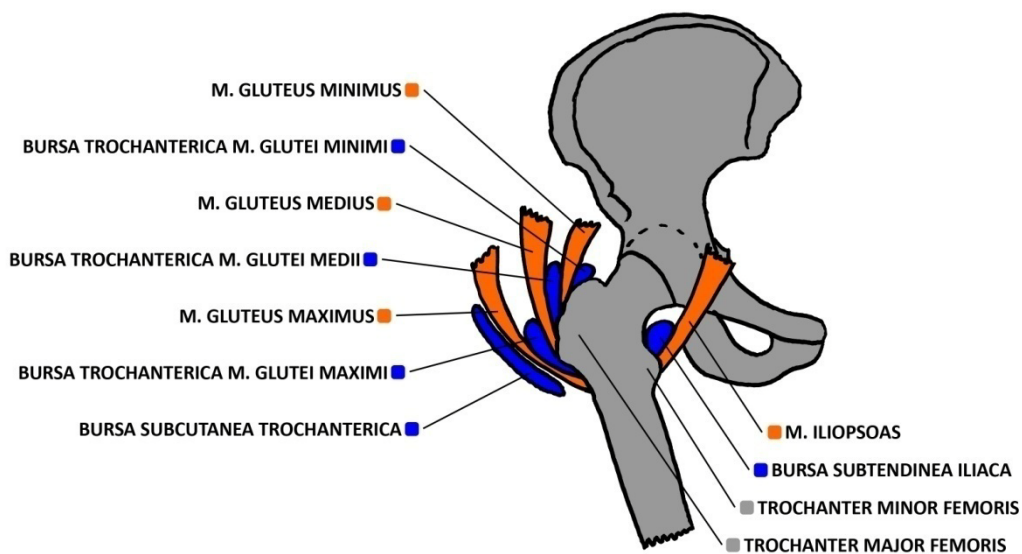


13.1.2 Principal bursae of lower extremity

BURSA SUBCUTANEA TROCHANTERICA – inserted between *skin* and *greater trochanter*.

BURSAE TROCHANTERICAE MM. GLUTEORUM – inserted between *greater trochanter* and insertions of *gluteus maximus, medius and minimus*.

BURSA SUBTENDINEA ILIACA - inserted between *bone* and insertion of *iliopsoas*.



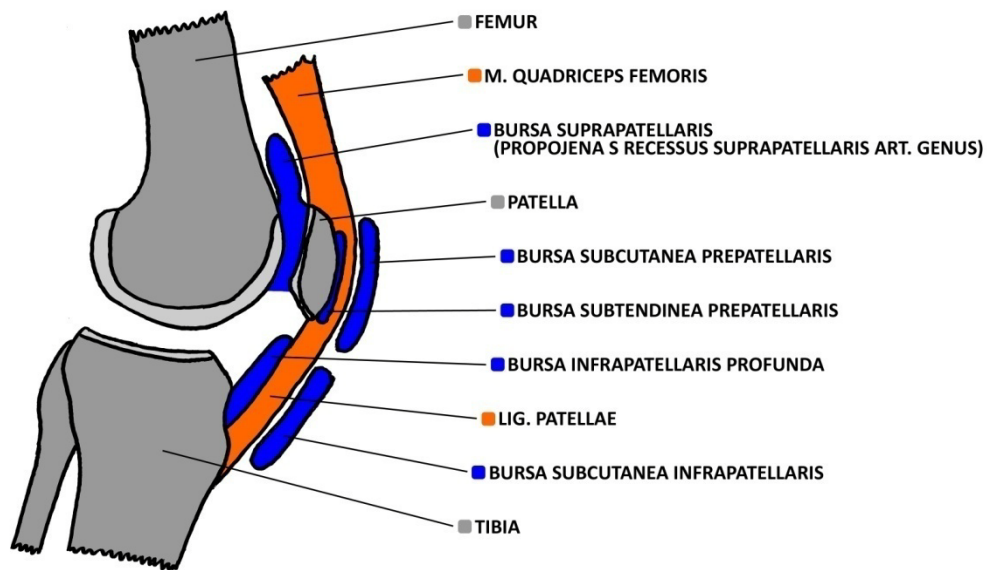
BURSA SUPRAPATELLARIS – inserted between tendon of *quadriceps femoris* and *patellar surface of femur*; often connected with *suprapatellar recess of knee joints*.

BURSA SUBCUTANEA PREPATELLARIS – inserted between *skin* and *superficial fascia*.

BURSA SUBTENDINEA PREPATELLARIS – inserted between *patellar ligament* and *patella*.

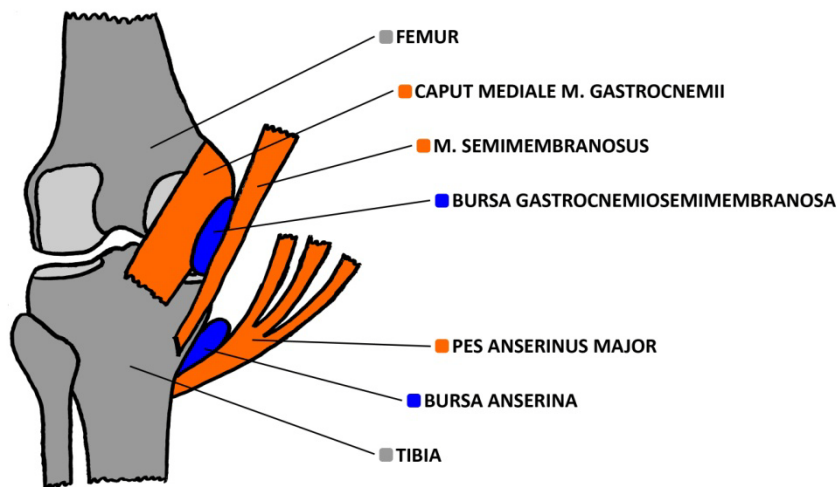
BURSA SUBCUTANEA INFRAPATELLARIS – inserted between *skin* and *patellar ligament* below the *patella*.

BURSA INFRAPATELLARIS PROFUNDA – inserted between *patellar ligament* and *tibia*.



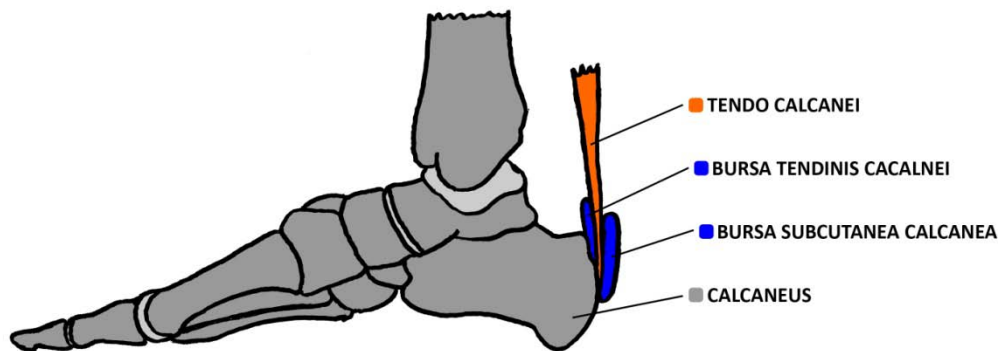
BURSA ANSERINA – inserted between *pes anserinus (major)* and *medial condyle of tibia*.

BURSA GASTROCNEMIOSEMIMEMBRANOSA – inserted between tendon of *medial head of gastrocnemius* and insertion tendon of *semimembranosus*; pathologically enlarged is called *Baker's cyst*.



BURSA SUBCUTANEA CALCANEA – inserted between *skin* and *calcaneous tendon*.

BURSA TENDINIS CALCANEI – inserted between *calcaneous tendon* and *tuber calcanei*.



13.2 Tendon sheaths

Tendon sheaths are narrow spaces along insertion tendons of muscles. They are formed especially in places, where long tendon run through narrow osteofibrous canal (passage between fibrous connective tissue and bone) – on dorsum of the foot (and hand), along ankles, in carpal tunnel, etc. Whole space of tendon sheath is lined with **synovial membrane**, which produces small amount of **synovial fluid**. This fluid, as well as in bursae, enables smooth movement. Synovial sheath has three parts: **epitenonium** (inner synovial layer), **peritenonium** (outer synovial layer) and **mesotenonium** (longitudinal double layer, in which two previous layers merge together). Mesotenonium is filled with loose connective tissue, through which comes blood supply of corresponding tendon. Synovial sheath is then covered by **fibrous layer** – surface of osteofibrous canal. Fibrous sheaths are well developed for example on palmar side of fingers, where they hold insertion tendons of flexor digitorum superficialis and profundus to the bones.

Physiological role of tendon sheaths is similar to the bursae – reduces the negative effects of pressure and friction during tendon movement (muscle contraction) to the surrounding structures and on the tendon itself. Clinical significance is inflammation, which spreads in characteristic way along these tendon spaces (tenosynovitis).

13.2.1 Tendon sheaths of upper extremity

VAGINA TENDINIS INTERTUBERCULARIS – covers tendinous origin of **long head of biceps brachii** in intertubercular groove of humerus; continues as exvagination of shoulder joint capsule.

VAGINA TENDINIS M. FLEXORIS POLLICIS LONGI – covers tendon of **flexor pollicis longus**.

VAGINA TENDINIS M. FLEXORIS CARPI RADIALIS – covers tendon of **flexor carpi radialis**.

VAGINA COMMUNIS TENDINUM MM. FLEXORUM – covers tendons of **flexor digitorum superficialis** and **profundus**.

VAGINA TENDINUM MM. EXTENSORUM CARPI RADIALIUM – covers tendons of **extensor carpi radialis longus** and **brevis**.

VAGINA TENDINUM M. ABDUCTORIS POLLICIS LONGI ET EXTENSORIS POLLICIS BREVIS – covers tendons of *abductor pollicis longus* and *extensor pollicis brevis*.

VAGINA TENDINIS M. EXTENSORIS POLLICIS LONGI – covers tendon of *extensor pollicis longus*.

VAGINA TENDINUM M. EXTENSORIS DIGITORUM ET EXTENSORIS INDICIS – covers tendons of *extensor digitorum* and *extensor indicis*.

VAGINA TENDINIS M. EXTENSORIS DIGITI MINIMI – covers tendon of *extensor digiti minimi*.

VAGINA TENDINIS M. EXTENSORIS CARPI ULNARIS – covers tendon of *extensor carpi ulnaris*.

VAGINAE FIBROSAE ET SYNOVIALES DIGITORUM MANUS – covers tendons of *flexor digitorum superficialis* and *profundus* on fingers of the hand.

13.2.2 Tendon sheaths of upper extremity

VAGINA TENDINIS M. TIBIALIS ANTERIORIS – covers tendon of *tibialis anterior*.

VAGINA TENDINIS M. EXTENSORIS HALLUCIS LONGI – covers tendon of *extensor hallucis longus*.

VAGINA TENDINIS M. EXTENSORIS DIGITORUM LONGI – covers tendon of *extensor digitorum longus*.

VAGINA TENDINIS M. FLEXORIS DIGITORUM LONGI – covers tendon of *flexor digitorum longus*.

VAGINA TENDINIS M. TIBIALIS POSTERIORIS – covers tendon of *tibialis posterior*.

VAGINA TENDINIS M. FLEXORIS HALLUCIS LONGI – covers tendon of *flexor hallucis longus*.

VAGINA COMMUNIS TENDINUM MM. FIBULARIUM – covers tendons of *fibularis longus* and *brevis*.

VAGINA PLANTARIS TENDINIS M. FIBULARIS LONGI – covers tendon of *fibularis longus* in groove for the tendon of the *fibularis longus* on the cuboid.

VAGINAE FIBROSAE ET SYNOVIALES DIGITORUM PEDIS – covers tendons of *flexor digitorum longus* and *brevis* on toes.

13.3 Vincula

Insertion tendons of flexor digitorum superficialis and profundus are on fingers located in their common tendon sheath (see above). Their mesotenonium is organised in characteristic way into two pairs of ligaments - **vincula tendinum digitorum manus**. Through these structures runs blood supply for corresponding tendons. We recognize **short vincula** and **long vincula**, Short vinculum is usually triangular shaped and can be found distally, at insertion of the tendon. Long vinculum is longer and narrower (is adapted to movement of the tendon during muscle contraction) and is located proximally to the short vinculum of corresponding tendon. Damage to the vincula (for example traumatic) may cause cut of blood supply to tendons of flexor digitorum superficialis and profundus with corresponding clinical symptoms. Vincula are located also along other tendons (for example tendon of long head of biceps brachii). Blood vessels has also similar structures (for example anterior tibial vessels), which are firmly attached and cannot move away in fractures.

13.4 Retinacula

Retinacula are strong fibrous bands of superficial fascia, which attach insertion tendons of muscles to the bones. Retinaculum together with bones forms in these spaces osteofibrous canal, in which are tendons covered by tendon sheath (see above).

13.4.1 Retinacula of upper extremity

FLEXOR RETINACULUM – attaches to the bones insertion tendons of **flexor digitorum superficialis and profundus, flexor pollicis longus and flexor carpi radialis** in their tendon sheaths; forms on ventral side of the wrist **carpal tunnel** (see topography).

EXTENSOR RETINACULUM – attaches to the bones insertion tendons of **abductor pollicis longus, extensor pollicis brevis, extensor pollicis longus, extensor carpi radialis longus and brevis, extensor digitorum, extensor indicis, extensor digiti minimi and extensor carpi ulnaris** in their tendon sheaths.

13.4.2 Retinacula of lower extremity

FLEXOR RETINACULUM – attaches to the bones insertion tendons of **tibialis posterior, flexor digitorum longus and flexor hallucis longus** in their tendon sheaths; forms on the medial side of the talus **malleolar canal** (see topography)

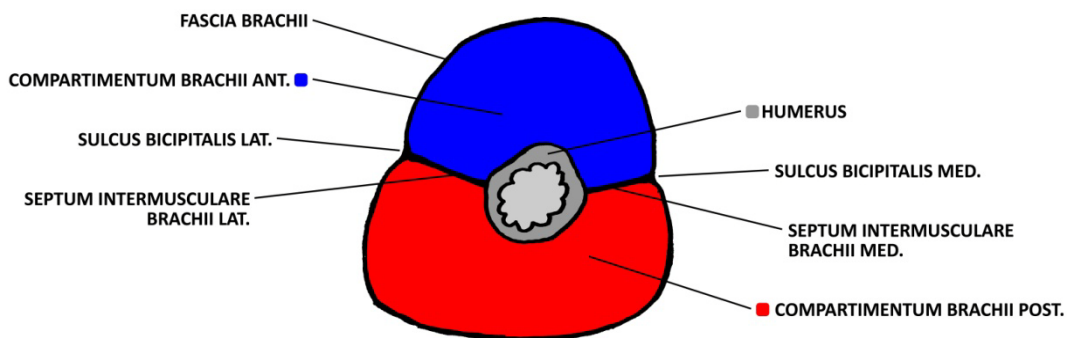
SUPERIOR AND INFERIOR EXTENSOR RETINACULA – attaches to the bones insertion tendons of **tibialis anterior, extensor hallucis longus and extensor digitorum longus** in their tendon sheaths.

SUPERIOR AND INFERIOR FIBULAR RETINACULA – attaches to the bones insertion tendons of **fibularis longus and brevis** in their tendon sheaths.

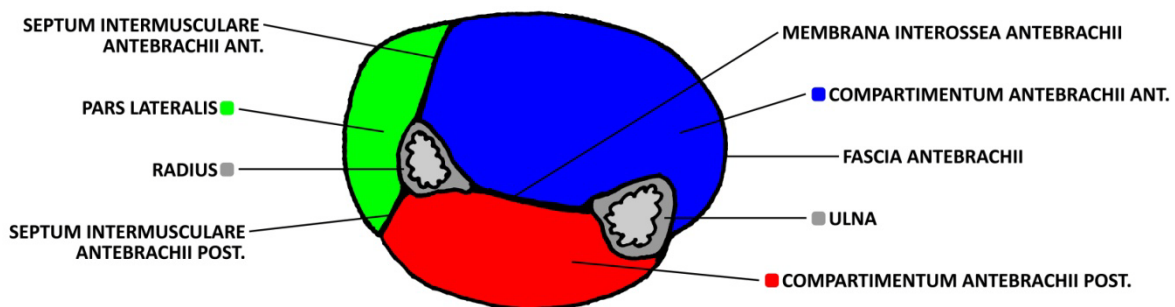
13.5 Osteofascial spaces of extremities (compartments)

Fascias don't only cover individual muscles, but also their muscle groups and as **superficial fascias** surface of each part of body. From **superficial fascias** on extremities they continue also to the depth as **osteofascial septa (intermuscular septa)**, which connect **superficial fascia** with **periosteum**. **Osteofascial septa** together with **superficial fascias** margin **osteofascial spaces (compartments)**. Some **pathologies** (for example inflammations) spreads easily through **osteofascial spaces**. Septa prevent spreading of these pathologies to surrounding compartments, however they are responsible for development of **compartment syndrome** (see below). For this reason is knowledge of osteofascial spaces for clinical medicine necessary.

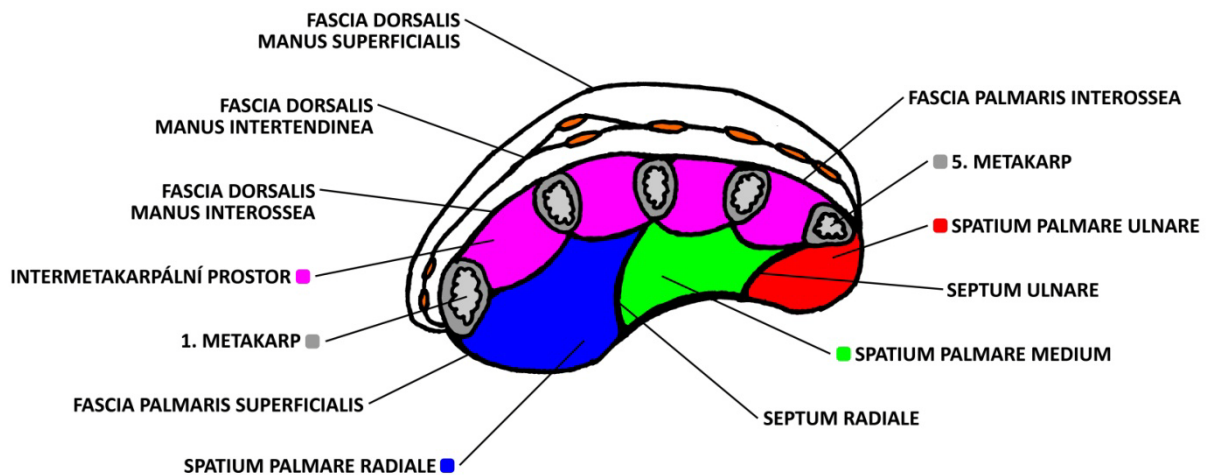
13.5.1 Osteofascial spaces (compartments) of upper extremity



There are 2 osteofascial spaces on the arm – **ANTERIOR BRACHIAL COMPARTMENT** and **POSTERIOR BRACHIAL COMPARTMENT**. They are margined by superficial fascia (**brachial fascia**) and are divided by **medial** and **lateral brachial intermuscular septa** – along the lines where the brachial fascia sends intermuscular septa, **medial and lateral bicipital grooves** are formed. Individual spaces contain **anterior and posterior muscle groups of the arm**.



On the forearm there are 3 osteofascial spaces – **ANTERIOR ANTEBRACHIAL COMPARTMENT**, which is divided into superficial and deep part, **POSTERIOR ANTEBRACHIAL COMPARTMENT** and third space is its **LATERAL PART**. Superficial fascia (**antebrachial fascia**) on the forearm merges with periosteum of **dorsal edge of ulna**. Individual spaces are separated by **interosseous membrane** and by two septa coming from the radius – **anterior and posterior intermuscular antebrachial septa**. **Anterior compartment** contains **ventral group of the muscles of the forearm**, **posterior compartment** contains **dorsal group of the muscles of the forearm**, its **lateral part** contains **lateral group of the muscles of the forearm**.

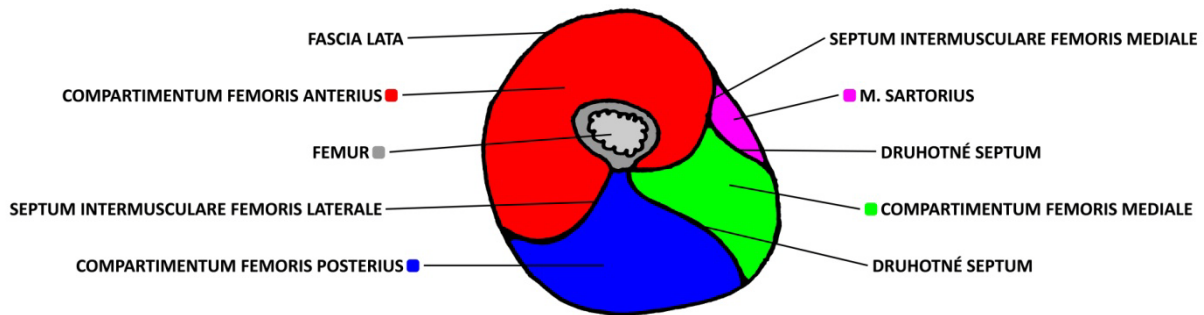


In the hand, there are 3 spaces on the palmar side (**RADIAL PALMAR SPACE, MIDDLE PALMAR SPACE** and **ULNAR PALMAR SPACE**), more distally and deeply there are also **INTERMETACARPAL SPACES**. **Superficial fascia of the hand** has two parts. On the dorsal side there is **superficial dorsal fascia of the hand**, on which in the depth **intertendineous dorsal fascia of the hand** continue (contains tendons of extensors on the dorsum of the hand) and **interosseous dorsal fascia of the hand** (connects dorsal surfaces of the metacarpals – margins **intermetacarpal spaces** dorsally). On ventral side of the hand **superficial palmar fascia** covers thenar and hypothenar eminence and is connected with periosteum of **1st and 5th metacarpal**. This fascia sends two septa – **radial septum** (to the 3rd metacarpal) and **ulnar septum** (to the 5th metacarpal). In the depth to these septa merge with **palmar interosseal fascia**, which on the ventral side separates **intermetacarpal spaces** from other spaces – **radial palmar space, middle and ulnar**.

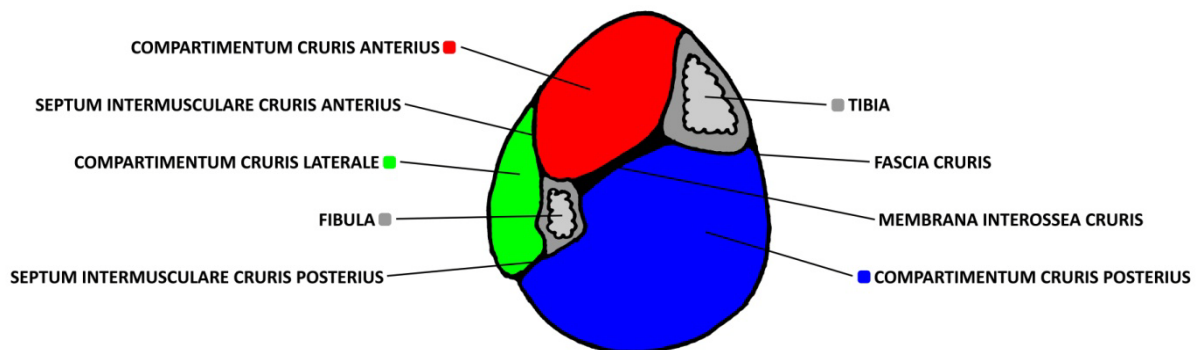
Radial palmar space contains **muscles of the thenar** and tendon of **flexor pollicis longus**, which divides muscles by innervations, **medial palmar space** contains **tendons of flexors of the fingers** and **lumbricales**, **ulnar palmar space** contains **muscles of hypothenar**.

Speciality of **medial palmar space** is its connection to the **carpal tunnel**, through which **inflammation** can spread easily in proximal way to the forearm to **Paron's space** – other osteofascial spaces of the hand are closed.

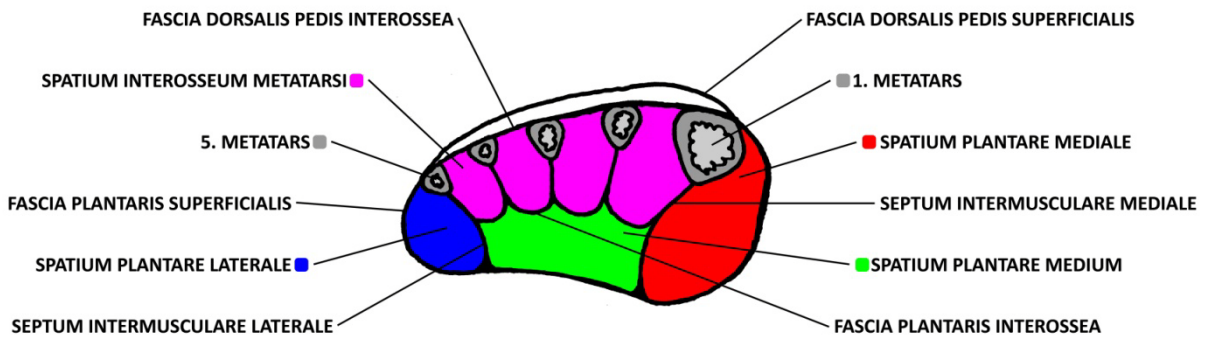
13.5.2 Osteofascial spaces (compartments) of lower extremity



In region of the thigh there are 3 osteofascial spaces – **ANTERIOR FEMORAL COMPARTMENT**, **POSTERIOR FEMORAL COMPARTMENT** and **MEDIAL FEMORAL COMPARTMENT**. Superficial fascia is called **fascia lata**, which sends **lateral intermuscular femoral septum** (separates anterior and posterior compartment) and **medial intermuscular femoral septum** (separates anterior and medial compartment) to the femur (to **lips of linea aspera**). Other **secondary septa** are formed by merging of fascias of neighbourinh muscle groups, which separate medial compartment from the other two. **Anterior compartment** contains **ventral group of muscles of the thigh** (all with exception of **Sartorius**, which lies in **fascia lata**), **posterior compartment** contains **posterior group of muscles of the thigh**, **medial compartment** contains **adductors (medial group of muscles of the thigh)**.



Also on the crura there are 3 osteofascial spaces – **ANTERIOR CRURAL COMPARTMENT**, **POSTERIOR CRURAL COMPARTMENT**, which is divided to **SUPERFICIAL AND DEEP** and **LATERAL CRURAL COMPARTMENT**. Superficial fascia (**crural fascia**) is attached to anterior edge and medial surface of tibia. Each compartment is separated from other by **interosseous membrane** and by two septa between **fibula** and **crural fascia** – **anterior and posterior crural intermuscular septum**. **Anterior compartment** contains **anterior group of muscles of the leg**, **posterior compartment** contains **posterior group of muscles of the leg** (superficial part of **gastrocnemius** and deep part of **soleus**), **lateral compartment** contain **fibular muscles**.



On the foot there are, like on the hand, 3 osteofascial spaces on the plantar side - **LATERAL PLANTAR SPACE**, **MIDDLE PLANTAR SPACE** and **MEDIAL PLANTAR SPACE**, completed by **INTERMETATARSAL SPACES**. Superficial fascia of the foot has two layers – on the surface is **fascia of the dorsum of the foot**, more deeply is located **interosseal fascia of the dorsum of the feet** (which covers **intermetatarsal spaces** dorsally). Between layers of **fascia of the dorsum of the foot** lie muscles and tendons of the dorsum of the foot. Also fascia of the plantar side has two layers – **superficial plantar fascia** (formed in similar way as in hand) and **interosseal plantar fascia** (covers **intermetatarsal space** from plantar side). **Superficial plantar fascia** sends **medial intermuscular septum** (to 1st metatarsal) and **lateral intermuscular septum** (to 5th metatarsal). These septa separates space between **superficial plantar fascia** and **interosseal fascia** to **lateral, middle and medial plantar space**.

Inside **medial plantar space** we can find **flexor digitorum brevis**, **tendons of flexor digitorum longus**, **lumbricales**, **tendon of flexor hallucis longus**, **quadratus plantae** and **transverse head of abductor hallucis**. **Lateral plantar space** contains **muscles of the 5th digit**.

13.5.3 Compartment syndrome

The compartment syndrome is a specific type of muscle injury. It occurs in the first hours after an injury of the muscle or after injuries of the long bones in the leg region, but also in forearm, femur or humerus. Essential is **increased pressure in the fascial space** – mostly caused by **intramuscular bleeding** or **oedema**. That leads to constriction of blood vessels and to **ischemia of muscle tissue with possible necrosis**. That is the biggest complication of the compartment syndrome, which may have implications for the muscle functions, prognosis of the whole extremity and to the overall state of the patient. Treatment of the compartment syndrome is usually surgical, known as **fasciotomy** (or also **dermatofasciotomy**) – cut through the fascia (and skin) in order to reduce the pressure in the fascial space. Non-invasive treatment is usually not sufficient and is used rarely.