Peripheral nerve ultrasound - anatomy and technique for diagnosis and procedures

Award:	Magna Cum Laude
Poster No.:	C-2342
Congress:	ECR 2014
Type:	Educational Exhibit
Authors:	S. J. Mota, F. M. G. S. Pereira da Silva, M. Gil-Pereira, H. Donato, P. Donato, F. Caseiro Alves; Coimbra/PT
Keywords:	Ultrasound, Neuroradiology peripheral nerve, Anatomy, Education, Education and training
DOI:	10.1594/ecr2014/C-2342

Learning objectives

1. Describe peripheral nerve anatomy and its anatomical relationships as a tutorial for this type of specialized ultrasound examinations.
2. Describe the appearance of peripheral nerves as seen on B mode ultrasound discussing technical details needed to improve nerve identification.
3. Illustrate common ultrasound features of peripheral nerve anatomy and their application for different clinical settings.

Background

Technical advances in US made examinations of small superficial structures possible and reliable. Currently, evaluation of peripheral nerve disorders still depends on clinical data supplemented by electrophysiological studies.

Ultrasound can be applied in the evaluation of peripheral nerve disorders, contributing for the differential diagnosis with other MSK pathologies.

Advantages are:

- High resolution due to broad-band technology - superior to MRI
- Versatility - may be moved from segment to segment, comparing with contralateral side

The exponential rise in publications regarding this topic in the past 10 years has been greatly driven by the development of image guided intervention now commonly used for selected anaesthetic procedures such as nerve blocks.

Pain-related disorders is another field for peripheral nerve ultrasound, where image guided intervention is being used for diagnosis and treatment.

Ultrasound is safe but very operator dependent thus aquiring solid anatomical knowledge of peripheral nerve anatomy is a mandatory condition.

Findings and procedure details

METHODS

Ultrasound of peripheral nerves was obtained from healthy volunteers.

The following images were obtained with a General Electronics Logiq 9 ultrasonographer. The probes used were convex transducer for deep structures (C-1-5-D), linear array (ML6-15).

NORMAL NERVE ULTRASOUND APPEARENCE

Normal nerve ultrasound closely resembles histological aspect, possessing hypoechoic fascicles (bundles of axons) surrounded by the endoneurum. There's - echogenic - connective tissue surrounding the nerve fascicles, which are grouped by the epineurum. It's appearence slightly resembles a berry.

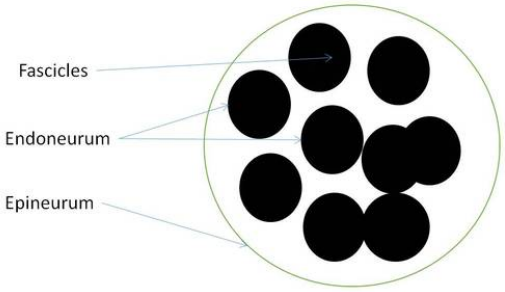
On longitudinal scan, the nerves posess a fibrilar appearence.

Size decreases distally.

Normaly nerves have no detectable doppler flow (unless injured or streched).

Nerves are also compressible, meaning a that morphological changes in fiber appearence may be seen with compression.

When crossing joints, many times nerves are involved by a retinaculum which may cause compression. Normal nerve may have a slightly hypoechoic appearance due closer packing of the fascicles.



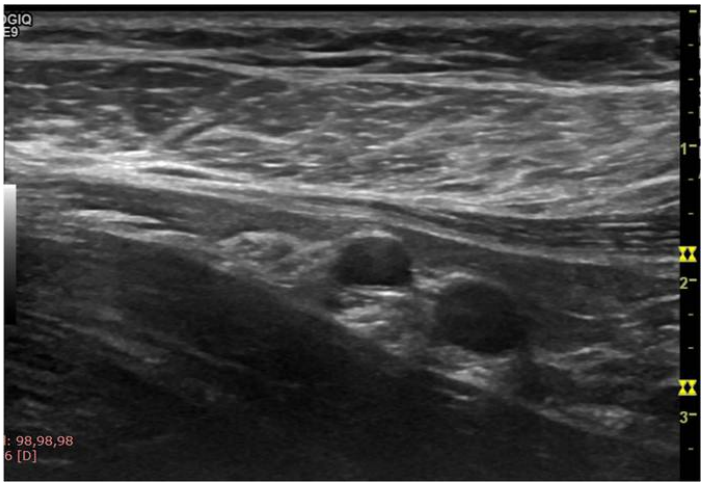


Fig. 1: Nerve histologic anatomy correlated with ultrasound aspect. Fascicles contain axons. Fascicles are envolved by the endoneurum. Fascicles are separated by echogenic connective tisseu. The epineurum further helps organize normal nerve ultrasound aspect
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

TECHNICAL OPTIMIZATION

General ultrasound rules apply.

The depth should be kept to a minimum while focus numbers should also be directed to the area of interest, and gains adjusted to be able to identify fascicles.

The **dynamic componen**t is of the uttermost importance in assessing and identifying the nerves correctly. Not only that, but also has diagnostic implications :

- Nerve instability (such as the one found in the cubital tunnel) may be assessed by examining the cubital tunnel with arm flexion and extension

Axial imaging - lift techinique - is most useful in correctly identifying the nerves.

Longitudinal images are most useful for suspected pathologic areas.

Concerning the probe frequency used, the obvious trade-off lies in resolution vs depth.

Nerve show little anisotropy. This may be useful in the carpic tunnel, as the greater anisotropy of tendons may be used to "erase" tendons by proding only a slight tilt of the probe.

Ultrasound has been described as capable of detecting several anatomical variants, inherited and developmental abnormalities.

Pathologies of peripheral nerve usually regard

- Compressive neuropathies
- Traumatic
- Inflamatory
- Neoplastic

SUPERFICIAL CERVICAL PLEXUS

Cervical plexus innervates the head, thorax, neck and the diaphragm and is composed by roots from C1-C4.

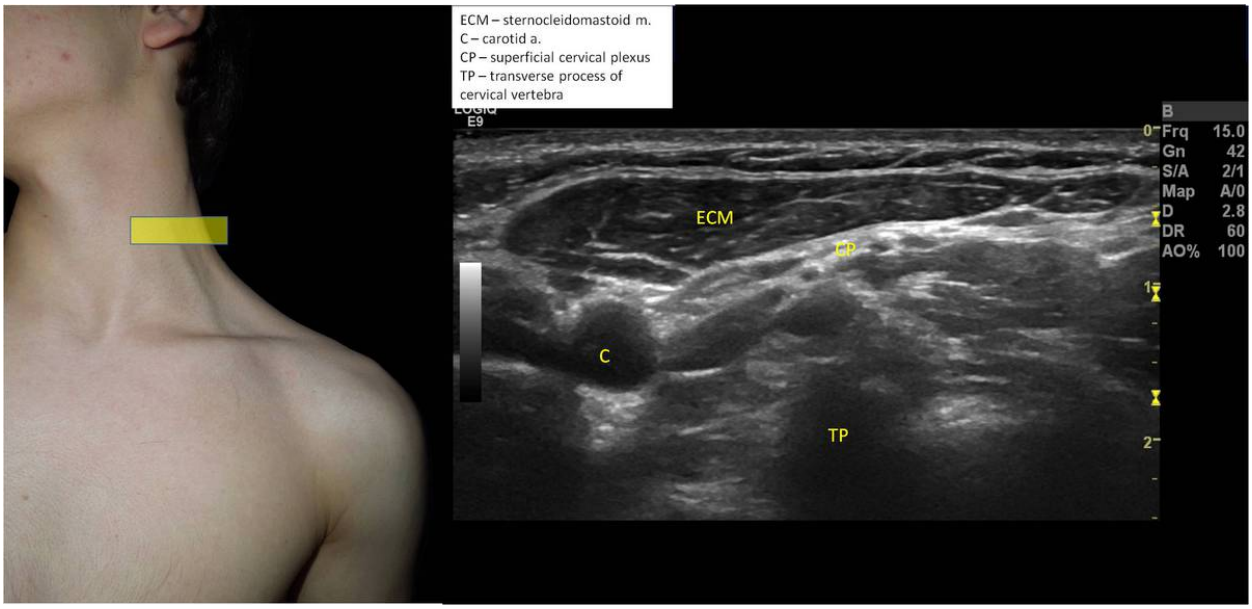


Fig. 2: Superficial cervical plexus Ultrasonographically, it may be identified by placing the patient with neck rotated to opposite side, placing the probe on the cricoid and sliding laterally to the border of the sternocleidomastoid. It is located in the posterior cervical triangle, defined by the sternocleidomastoid, trapezius muscle and clavicle. The pavement is composed by the: splenius muscle, levator scapulae and scalenus anterior and medium.

References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Fig. 3: Demonstration of lateral sweep, showing the sternocleidomastoid and the nerve fibers arising and passing posterior
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

This nerves may be blocked for: hear, neck, shoulder and clavicle fractures procedures.

In the lateral neck, propper infentification of nerve roots may be performed by identifying C7, characterized by having a single posterior tubercule.

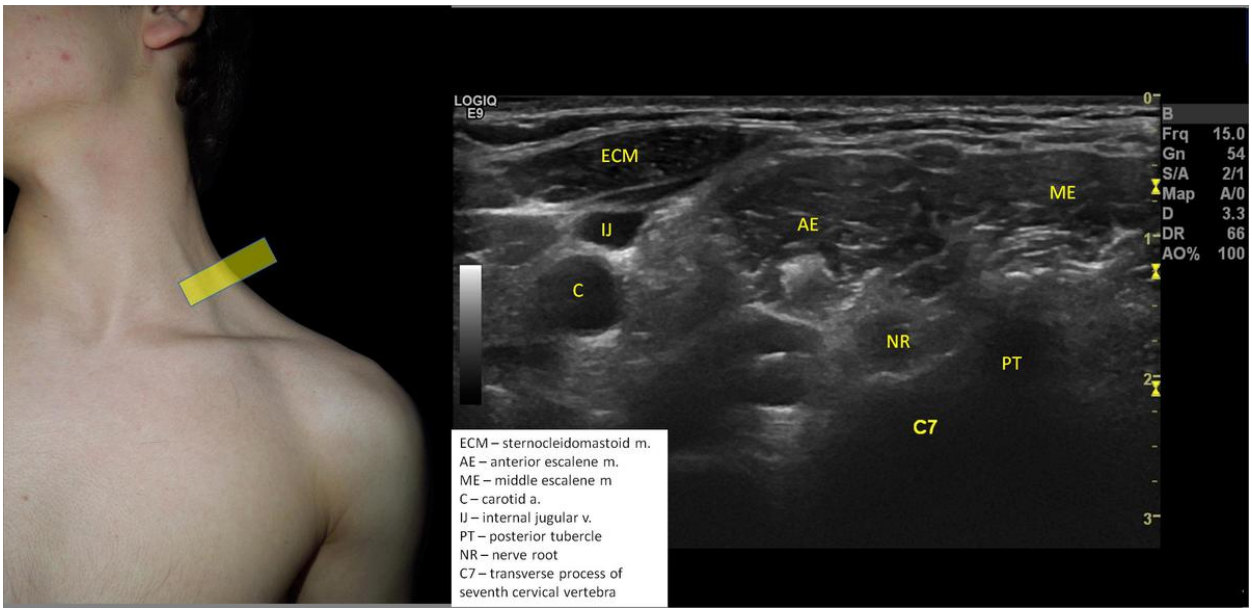


Fig. 4: Longitudinal scan through C7. Note the presence of a single tubercule on the transverse process.
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

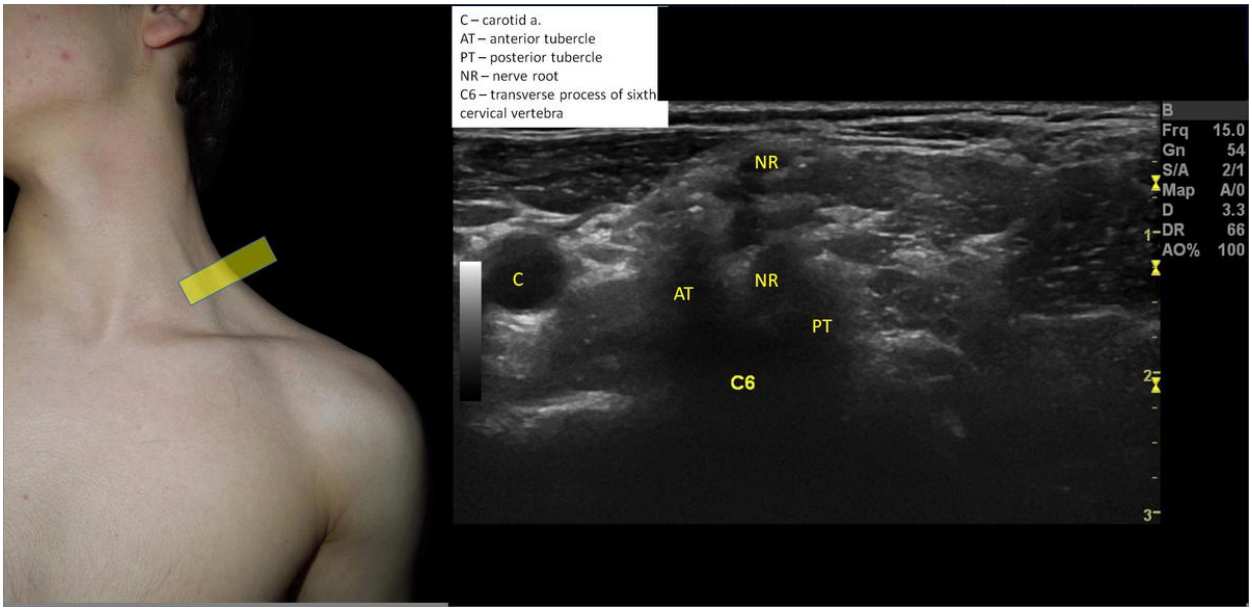


Fig. 5: Longitudinal scan through C6. Note the presence of a typical double tubercule on the transverse process.
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

After proper identification, other spine levels are easilly assessed.

Fig. 6: Demonstration of C7 as a reference level for nerve assessment in the neck
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

INTERSCALENIC APPROACH TO THE BRACHIAL PLEXUS

Brachial Plexus is composed by C5 to T1 roots. It may be pre-fixed (C4-C8) or post-fixed (C6-T2).

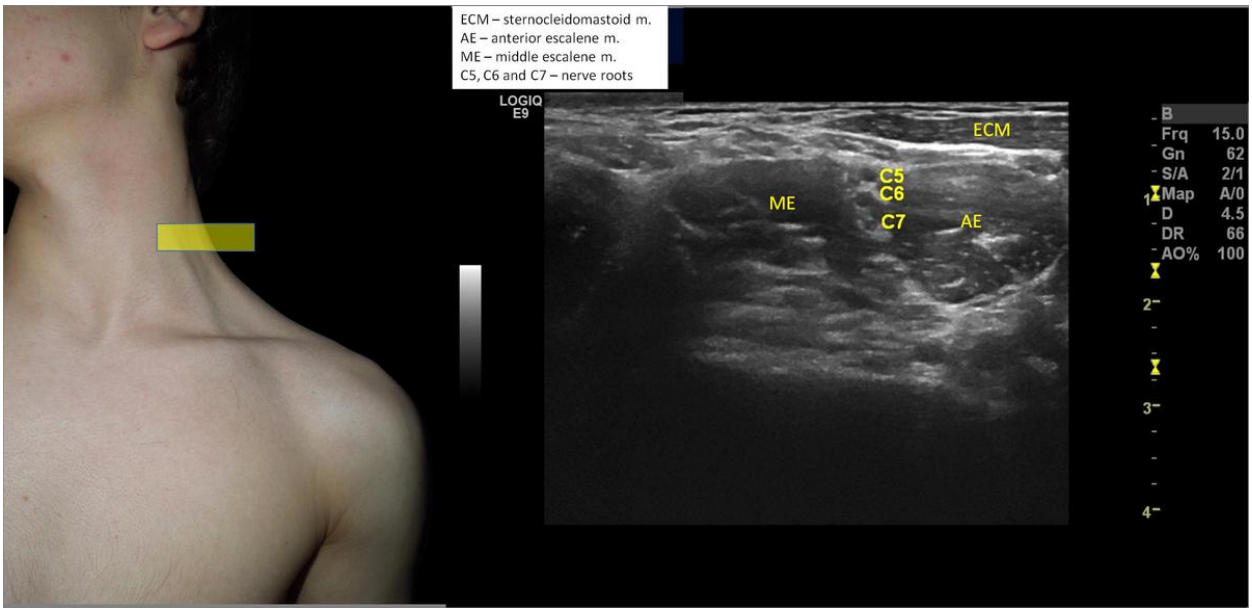


Fig. 7: Interscalenic location of the cervical plexus Roots emerge from the intervertebral holes between the middle and anterior scalene. Nerve roots then form trunks: C5-6 form the superior trunk, C7 - medium trunk, C8-T1 - inferior trunk.
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

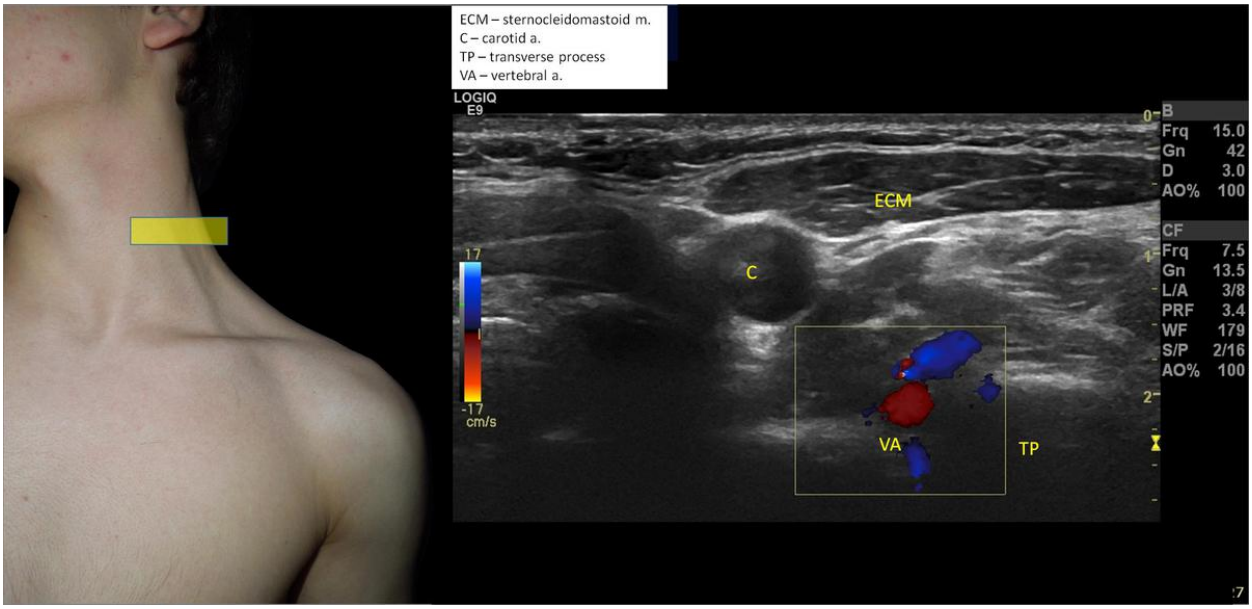


Fig. 8: Nerves are many times in close relationship with important blood vessels, such as the vertebral artery.
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

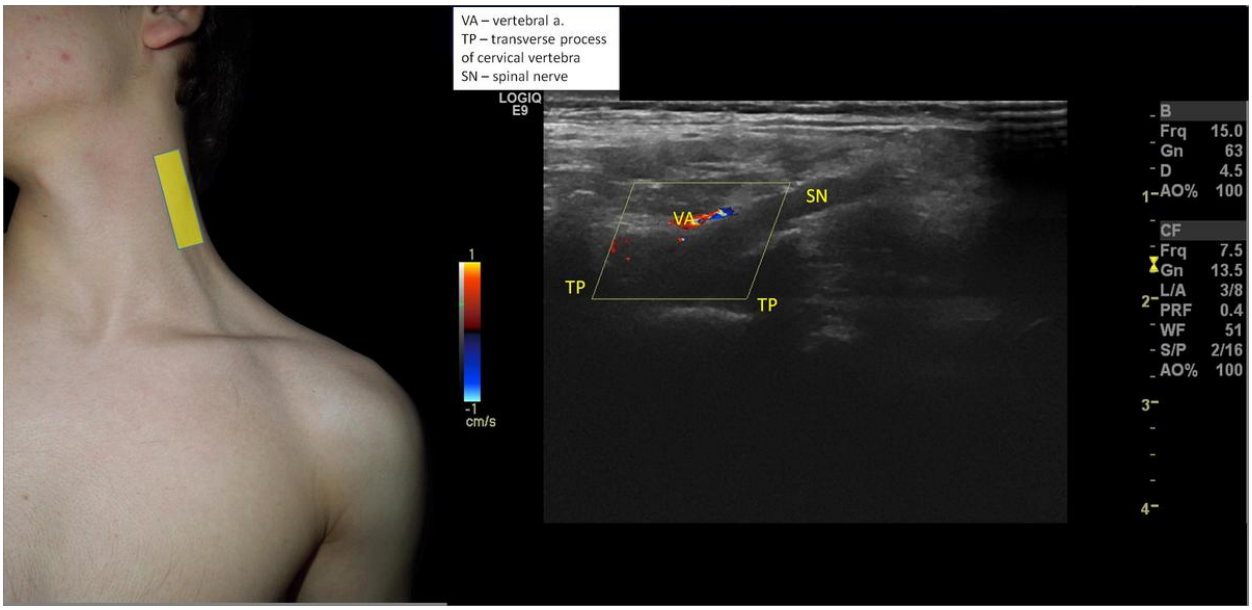


Fig. 9: Longitudinal scan of nerve leaving neck.
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Dynamic examination and "lift" technique makes it easier to have a better anatomical overview of the area

SUPRACLAVICULAR LEVEL - BRACHIAL PLEXUS

Here the the trunk division and distal trunk portions of the brachial plexus are seen

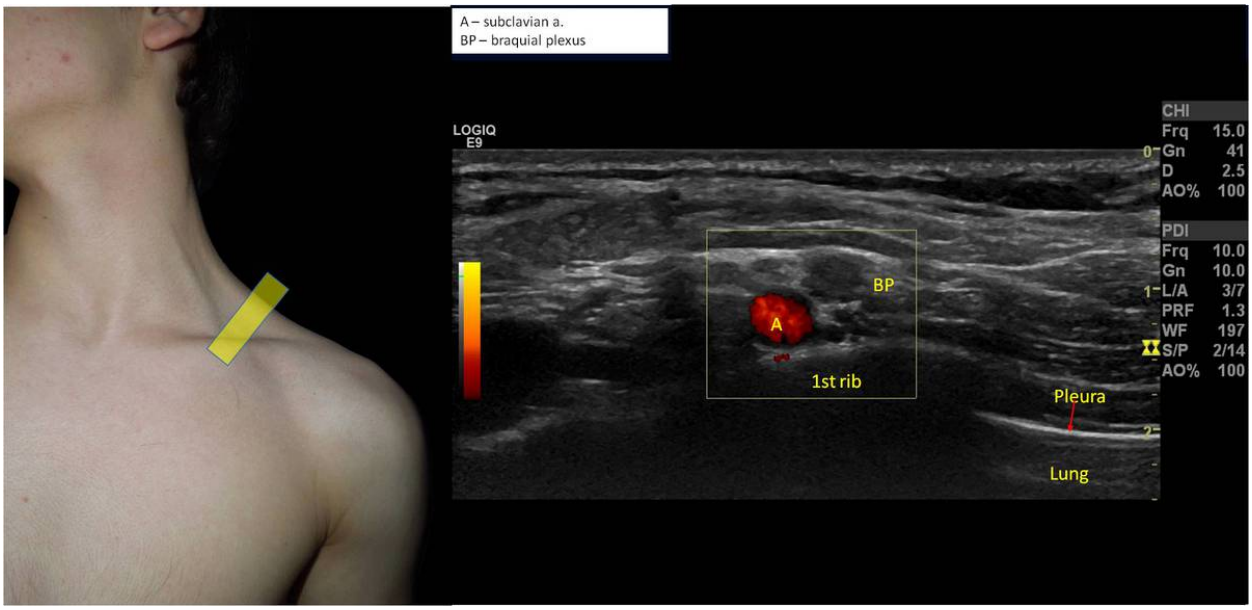


Fig. 10: Supraclavicular approach. Note the close relationship the subclavian artery (crossing the first rib) with the nerve fibers.
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

After the first rib, each trunk gives an anterior division and a posterior division.

The three trunks are responsible for the sensorial, motor and sympathetic nerve innervation of the superior limb, except for the anterosuperior shoulder (superficial cervical plexus) and inner arm (intercostobraqueal nerve).

INFRACLAVICULAR APPROACH

Inferiorly to the middle third of the clavicle, medial to the coracoid process and posterior to the great pectorial and small pectorial muscles lies the axillary artery with the brachial plexus cords closelly related to it.

- lateral cord - laterosuperior to the artery
- posterior cord - posterior to the artery
- medial cord - medial and posterior to the artery

The cord locations is very variable.

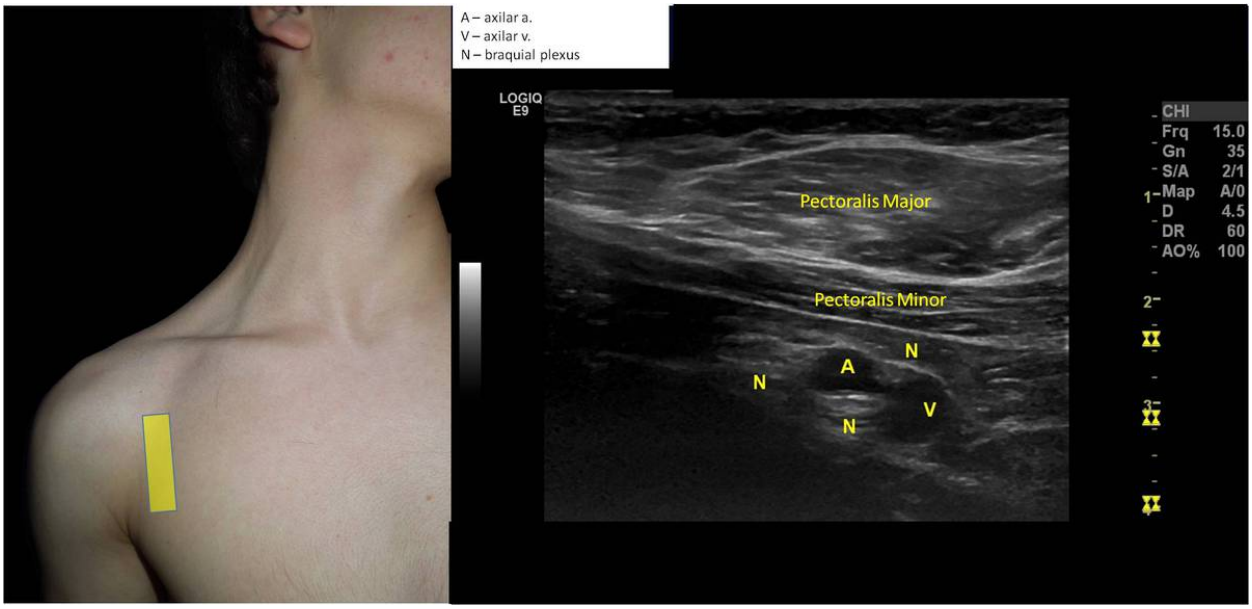


Fig. 11: Subclavicular approach to the brachial plexus. Note the nerves surrounding the axillary artery.
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Compared to the supraclavicular approach, has less technical failure, doesn't block the phrenic nerve, the cervical sympathetic chain, is further from the lung.

AXILLARY

The 3 cords give origin to the 4 terminal branches of the brachial plexus

Musculocutaneous is seen within the common tendon of the bicipitis and coracobrachialis; medially is the cubital nerve; posterior os the radial nerve; median nerve always close to the artery.

Their exact location is variable, which makes dynamic examination essential for propper assessment.

Fig. 12: Axillary nerve assessment. Dynamic examination and following f the nerves makes the nerves easier to follow
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

It is possible to further follow the nerves downstream, mainly the median nerve, musculocutaneous (to a degree), ulnar and radial nerves.

Radial nerve courses posterior to the humerus and divides into deep and superficial branches at the lateral humerus, giving a characteristic "snakeye" appearence (Fig. 13 on page 32)

The deep branch the courses between the supinator heads, where it may sometimes be compressed.

Fig. 14: Radial nerve as it courses through the supinator muscle.
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

The ulnar nerve courses medially, in the ulnar canal at the lateral epicondyle of the humerus. (Fig. 15 on page 33)

There it continues its' course downstream accompanied by the ulnar artery. (Fig. 16 on page 33)

In the wrist, it passes through the Guyon canal between the palmar carpal and flexor retinaculum. Fig. 17 on page 40

The median nerve courses close to the axillary artery. In the antecubital fossa, it passes underneath the long head of the pronator teres, where it may be compressed.

Fig. 18: Anterior forearm sweep demonstrating the median nerve course
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

The median nerve then courses to the wrist where it passes through the carpal tunnel.

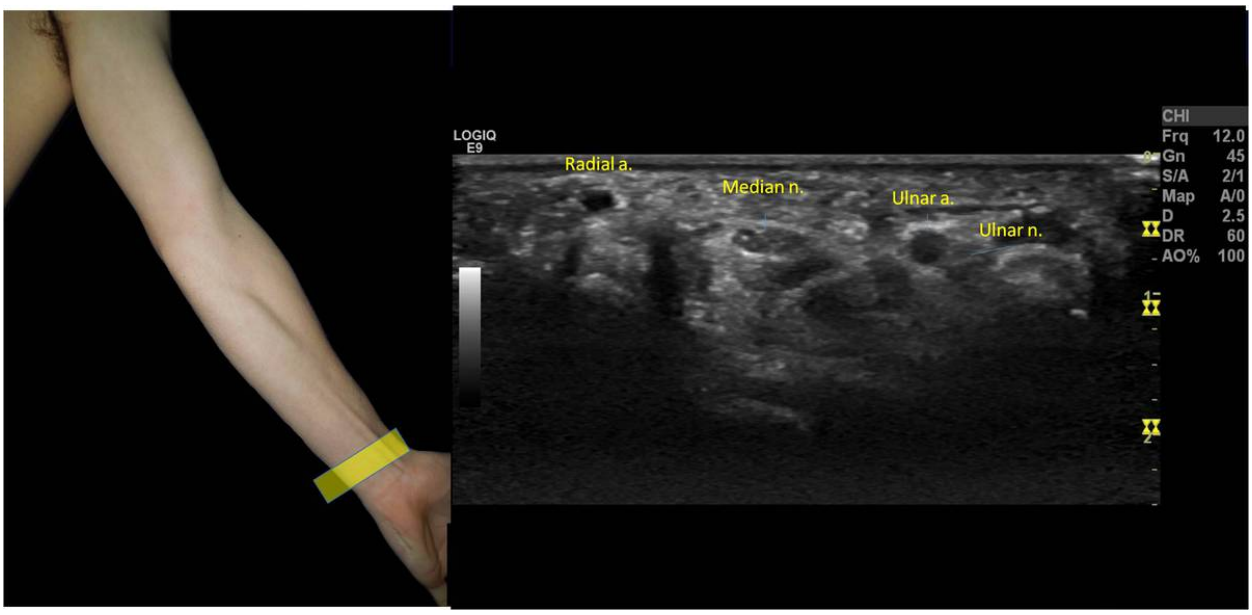


Fig. 19: Landscape view at the wrist. Note the relationship of the median nerve with the retinaculum and the flexor tendons. Note also the close relationship of the ulnar nerve with the ulnar artery
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

PARAVERTRAL SPACE

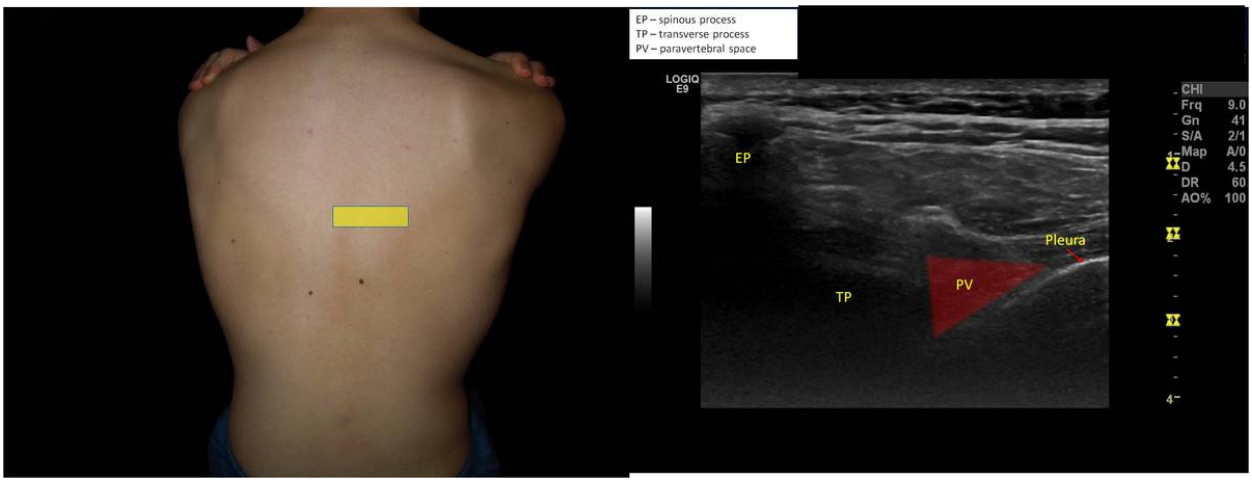


Fig. 20: Longitudinal scan of the paravetebral space. The space itself is triangular, defined with a medial base and a lateral apex. There lies the fat tissue involving the intercostal nerve, the dorsal nerve, the intercostal vessels and the sympathetic chains.
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

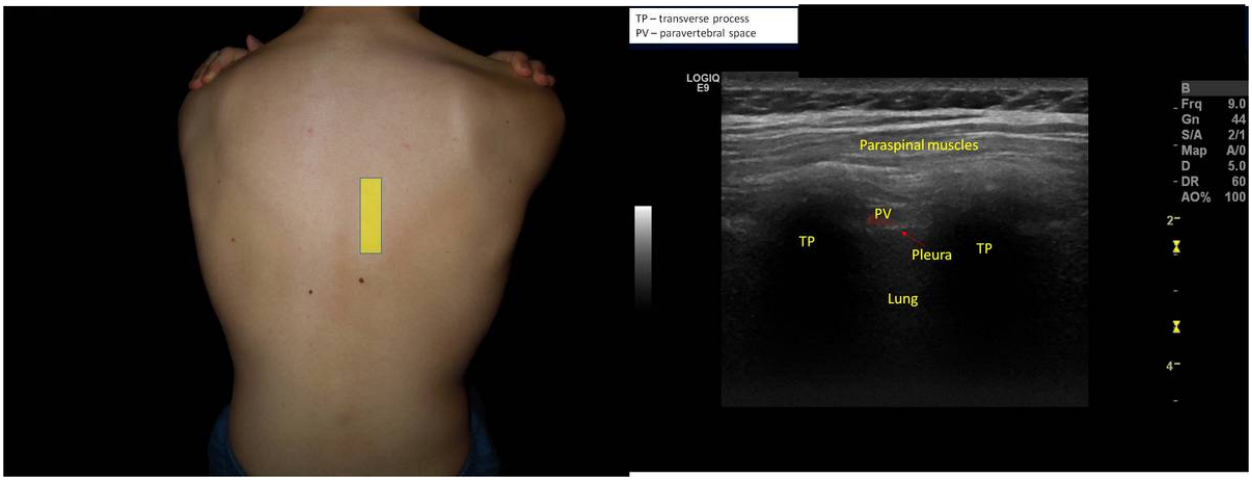


Fig. 21: Sagittal scan of the paravertebral space.
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Common indications for paravertebral blocking

- Surgical anesthesia or post-op analgesia for thoracoabdominal procedures
- Breast surgery
- Thoracic surgery
- Analgesia for trauma or rib fractures
- Diagnosis and treatment for chronic pain of thoracic pathologies such as post-thoracotomy neuralgia and post-herpetic neuralgia
- Treatment of palmar hyperhidrosis

The paravertebral space is placed lateral to the entire spinal cord. It is defined as a paraspinal block, which makes it more like a central nerve block because the nerve roots are covered with duramater.

Blocking here produces a segmental, ipsilateral somatic and sympathetic blocking.

ABDOMINAL NERVES

Nerves responsible for sensitive innervation of skin and the peritoneum are T6-L1.

Most are localized between the internal oblique and the transverse oblique muscle.

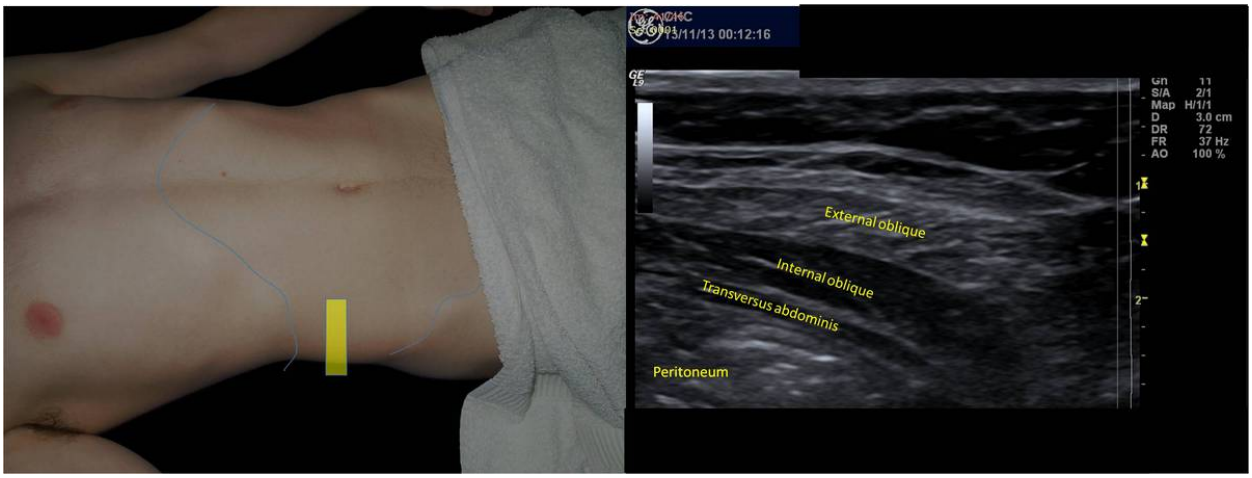


Fig. 22: Abdominal wall axial scan. The plane between the transversus abdominis and internal oblique is used as a guide for anesthesic placement - TAP procedure.
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

L1 nerve is different. It pierces the internal oblique # across it's way, next to the anterosuperior iliac spine. Anteriorly, before the rectus abdominis, it pierces the external oblique.

T12 and T1 originate the ilioinguinal and iliohypogastric nerves.

Transversal abdominal plane block (TAP) may be used for analgesia during and post-operation. May also be used for subcutaneous infusion pumps.

The ilioinguinal and iliohypogastric nerves are, themselves possible to be blocked for hernia, orquidopexia, varicocele, hydrocele, prostatectomy, cesarean.

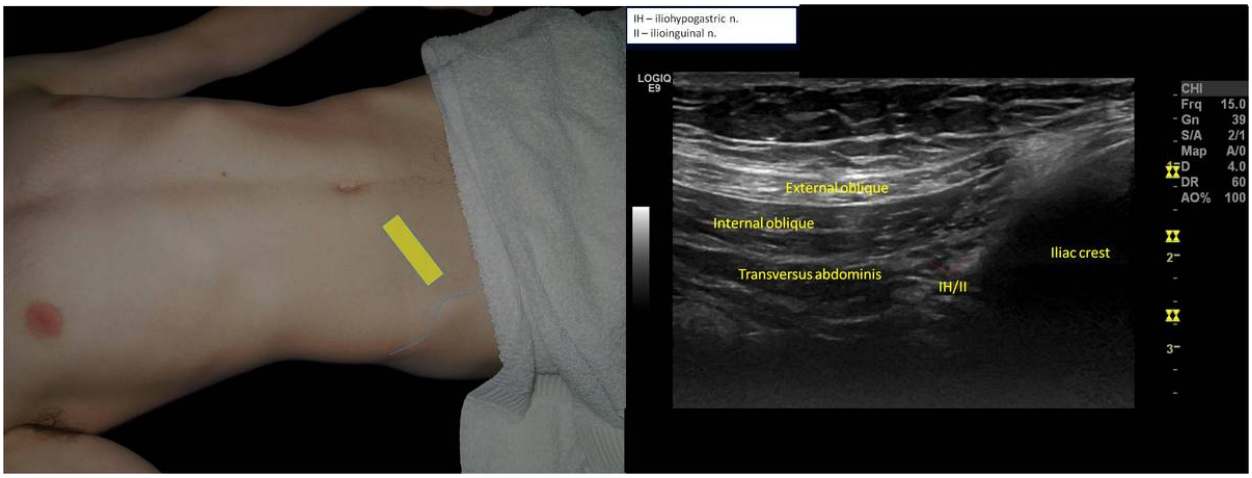


Fig. 23: Midpoint between the umbilicus and the anterosuperior iliac spine is used as a guide for identifying the ilioinguinal and iliohypogastric nerves
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

The ***lumbar plexus*** is formed by junction of the anterior roots from L1-L4, which may have contribution from T12.

The plexus itself lies in a fascial plane within the psoas muscle.

The nerves which constitute the lumbar plexus are, from superior to inferior

- Iliohipogastric
- Ilioinguinal
- (genitofemural)
- Lateral femoral cutaneos
- Femoral nerve
- Obturator nerve

Blocking the lumbar plexus, given it's overall difficulty, it is advised to use both ultrasound and electrostimulation.

Fig. 24: Axial scan of the lumbar region.
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Femoral nerve

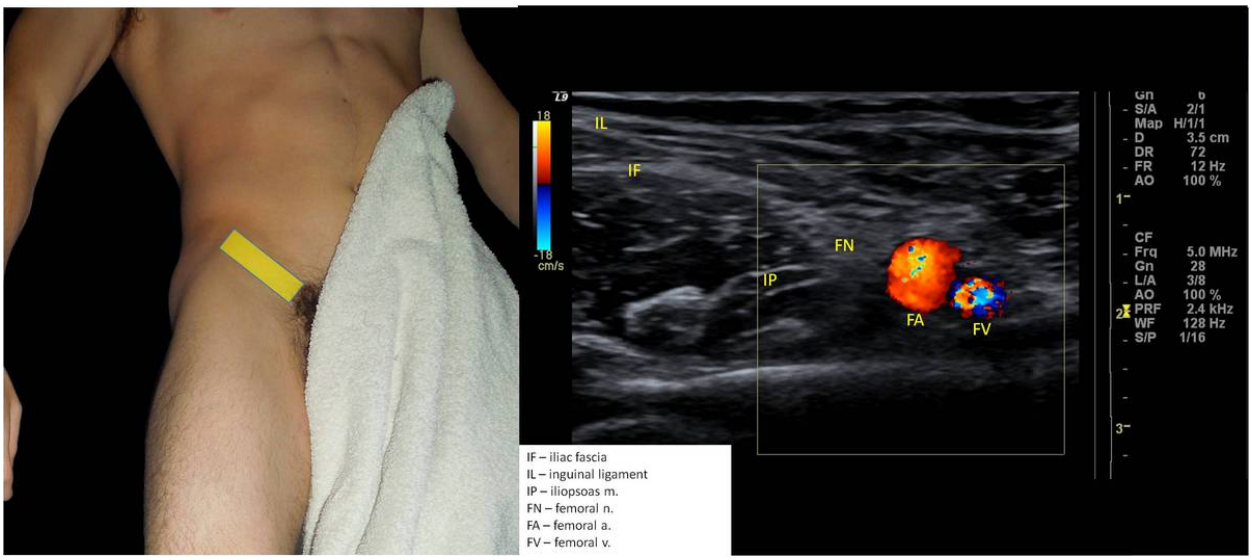


Fig. 25: Inguinal region, showing the typical localization of the femoral nerve.
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

The major nerve from the lumbar plexus, formed by the posterior division of the L2-L4 nerves, innervates the skin in the anteromedial thigh; and the leg extensor muscles. Terminal branch is the safen nerve which innervates the skin in the medial leg, ankle and foot.

May be blocked in knee surgeries.

When assessing the inguinal fossa, it is important to also observe the most important landmarks:

- Pectinate muscle
- Iliopsoasmuscle
- Adductor longus
- Rectus femoris
- Tensor fascia lata

Lateral cutaneous thigh nerve

- Originates from L2-L3
- Is lateral to the psoas muscle
- Travels caudally and obliqually towards the anterosuperior iliac spine

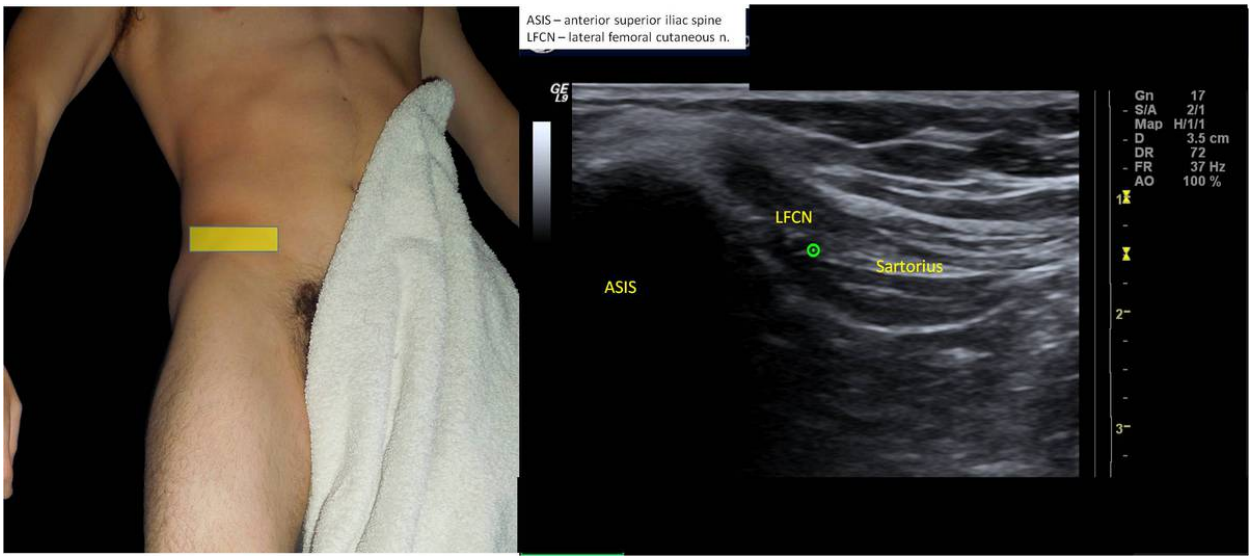


Fig. 26: Lateral femoral cutaneous nerve passing inferior to the inguinal ligament adjacent to the anterosuperior iliac crest.
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Blocking the nerve may be used in lower limb surgery or as a diagnostic procedure for paresthetic meralgia.

<u>Obturator nerve</u>

Fig. 27: Longitudinal scan of the medial thigh, showing the location of the obturator nerve branches. This nerve innervates most addutor muscles (except for the pectneus which is usually innervated by the femoral nerve). Scan is made by placing the probe in

the medial side of the thigh, below inguinal fold, and scanning medially to the femoral vein.
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT
Originates from the ventral divisions of the lumbar plexus, from L2-L4.

In the obturator canal it divides into anterior and posterior branches.

Blocking the obturator nerve, besides the usual surgical indications, may be used for spastic adutor syndromes (hemiplagia / paraplegia) or for treatment of some cases of pubalgia.

SCIATIC NERVE

The sacral plexus is formed by the roots from L4-S3, originating 7 nerves

- 6 colaterals and 1 terminal - the sciatic nerve

Sacral plexus roots are anterior to the sacrum.

They emerge medialy to the iliopsoas, converging to the sciatic foramen, leaving the pelvis through here.

- When leaving, the sciatic nerve is anterior to the piriformis, goes caudally and posterior to the ischial surface

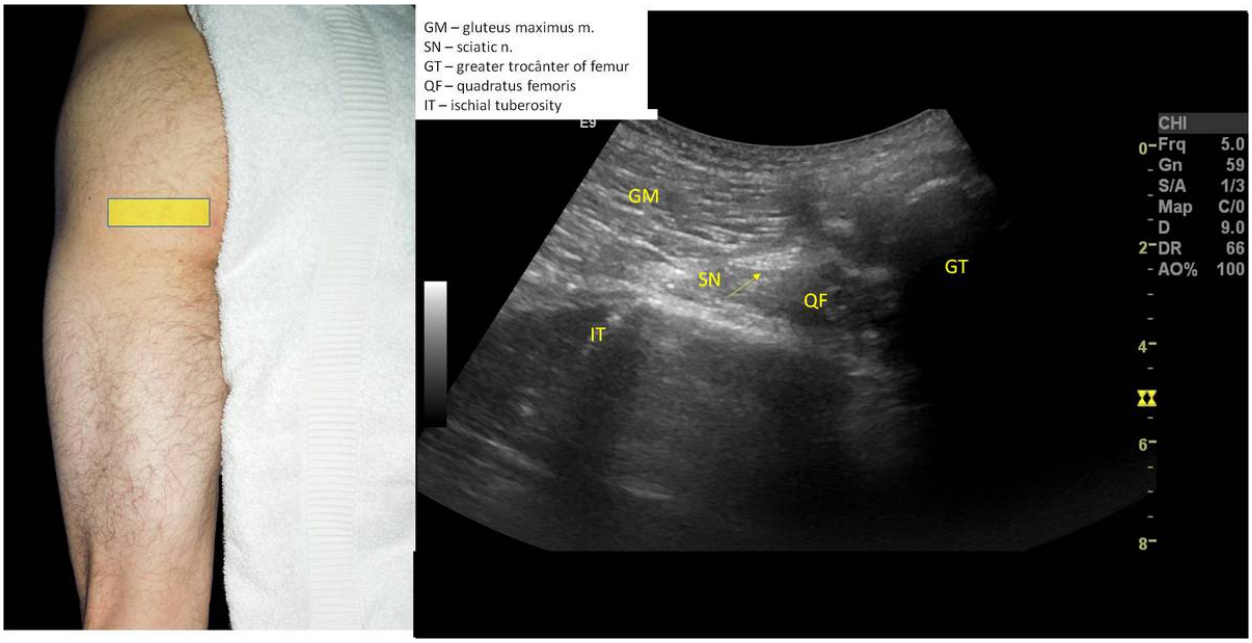


Fig. 28: Sciatic nerve over the quadratus femuris, between the typical bony landmarks: the greater tuberosity and the ischial tuberosity.
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

- In the gluteal region, the sciatic is anterior to the gluteus maximus and posterior to the gemelis, internal obturator and femoral quadratum

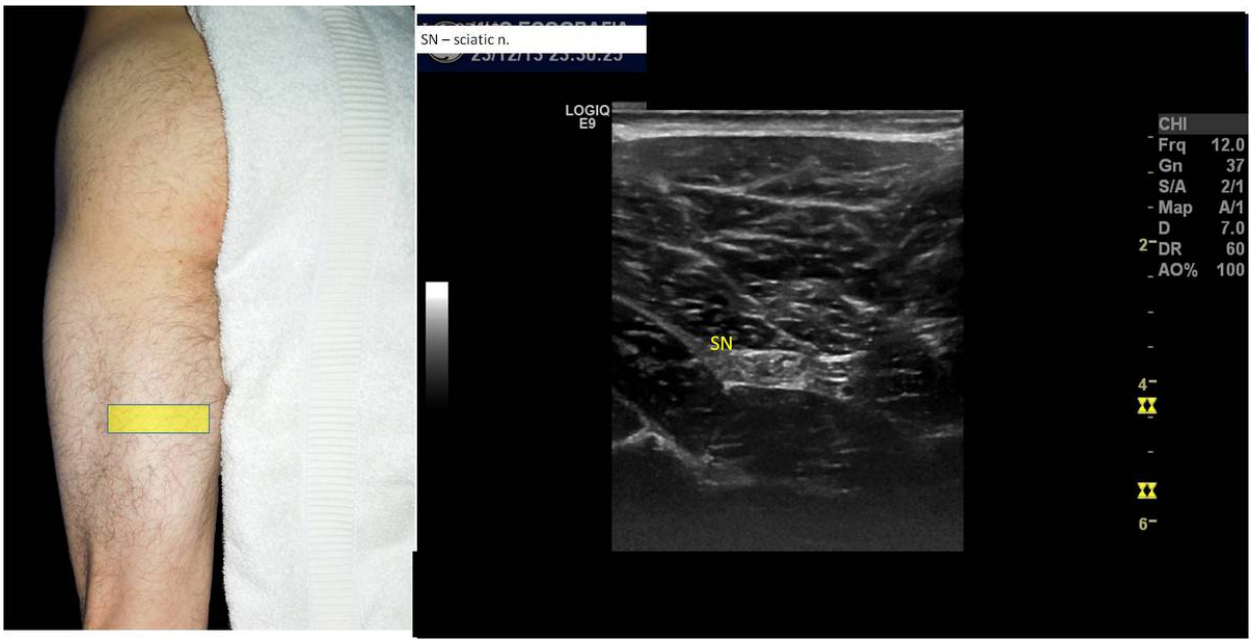


Fig. 29: The sciatic nerve lies between the bicipitis femoris (lateral) and the semimembranous (medial)
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

- About # way through the femur, it gives out the TIBIAL NERVE and the COMMON PERONEAL NERVE.

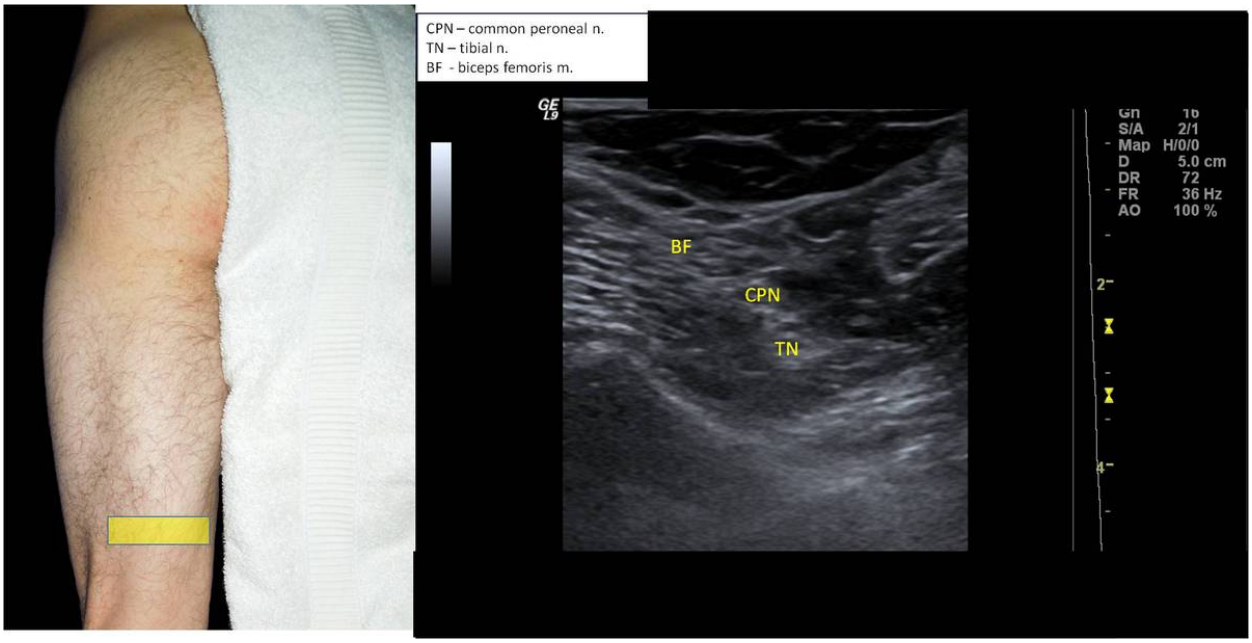


Fig. 30: Sciatic nerve bifurcation
References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

COMPRESSIVE NEUROPATHIES

Nerve instability (such as the one found in the cubital tunnel) may be assessed using the dynamic capabilities of the US examination.

Compressive syndromes may develop acutely or chronically. "Neuropraxia" correspond to the transitory abnormalities caused by an focally disturbed nerve (with higher latency) which tend to resolve with time.

Notable examples are the radial paresthesia ("Saturday night radial palsy") or fibular palsy ("crossed leg peroneal palsy).

Chronic compression may cause focal ischemic changes, structural changes and persistent deficit.

- Nerve flattening should be regarded as a main sign of compression
- Reduced nerve mobility on the compressed site.
- Axon loss may be associated ith nerve enlargement due to endoneural edema.
- Loss of fascicular patter
- Swelling proximally.
- Hypervasclar pattern

Carpal tunnel patients have an enlarged nerve nerve at the carpal tunnel. An enlargement of 2 mm in cross sectional at the carpal tunnel comparing the proximal median nerve to the has been described with an 100% accuary in detecting carpal tunnel syndrome.

Indirect signs of denervation constitute may be the only evidence of compressive neuropathy. On MRI, acute denervation (homogeneous hyperintense pattern on T2 and STIR) has a different aspect than late denervation (hyperintense T1 pattern, related to fatty infiltration).

- On ultrasound, they have both an increased reflectivity which may be hard to differentiate based on imaging alone.

Compared to electrophysiological studies, US can be an important adjunct in uncertain nerve conduction studies, may detect abnormal findings in nerve surroundings (masses, anomalous muscles).

TRAUMA

Complete nerve lacerations show fiber disruption with fascicle retraction, with a wavy course of nerve ends.

The outer nerve sheet may be intact, in which case a spindle neuroma may form (irregular hypoechoic swelling, without nerve discontinuity).

CONTUSION

Most trauma is self limited with no US changes. Repeted minor trauma may induce some called "traumatic neuritis", showing nerve swelling and thickening.

PENETRATING

The nerve response to trauma consists of axonal random growth. This may lead to the formation of an hypoechoic mass. When ends are distant and severed a terminal neuroma (hypoechoic mass in continuity with the severed nerve)

The distance between two ends of a severed ends is an important factor in determining the surgical approach.

RHEUMATOLOGIC

Some rheumatologic disorder may lead to a Vasculitis related neuropathy as a result of necrotizing angiopathy of small nerve arteries, a so called mononeuropathy multiplex. Because this patients may also posess entrapment neuropathies, ultrasound may aid in detecting an differentiating nerve pathologies, as entrapment alters nerve morphology, whereas mononeuropathy multiplex doesn't.

NEOPLASTIC CONDITIONS

Benign nerve tumors are usually composed by the Schwannoma and the neurofibroma. The malignant peripheral nerve sheat is more frequently composed by the sarcomatous transformation of a neurofibroma.

Other neoplasms (hemangiomas, lymphomas, ganglion cysts) may develop within the nerve, dissecting nerves.

Extrinsic soft tissue neoplasms may also envolve the nerve.

Categorical diagnosis is not possible with ultrasound characteristics. It's merits are the detection of a soft tissue mass, defining it's extension, relationship with adjacent structures and surrounding muscles.

Ultrasound guidance may be confidently performed, and is usually extremely painful, so careful anesthesia should be used.

ULTRASOUND GUIDED INTERVENTION

Ultrasound is a versatile and accessible way of detecting nerves and targeting them. The application of nerve blockage ranges from analgesic procedure to anesthetic procedures.

It is essential to be aware of the fortunally rare complications possible with nerve blocking drugs such as Lydocaine, Ropivacaine or Ropivacaine.

Firstly, the maximal dosing should be repected (Lydocaine is 4,5mg/Kg without epinephrine and 7mg/Kg with epinephrine). Directed nerve blocks usually far from those doses, which is an obvious advantage.

Systemic toxicity may occur if there's and inadverted intravascular injection or overdosing. Symptoms usually begin with central nervous symptoms (metalic taste, tongue and lips aresthesia, tinitus) that may evolve to spasms, consulsions or coma. Injection should be stopped at once and if convulsions occur, anti-convulsive therapy should be started.

The cardiovascular system is usually more resistant than the CNS, but more difficult to treat. Cardiopulmonary resussitation may be necessary.

Direct nerve injury may occur. If pain is elicited during the procedure, the needle should be withdrawn and redirected

As with any other invasive technique, hematomas and infeccion may occur, so asseptic care should be enforced. Cloro-hexidine is the antiseptic of choice, but poses a slight risk of nerve injury. Single-shot techniques have a lesser chance of causing infective changes

Type of blockage	Complications	Recommended volume
Superficial cervical plexus	Blocking recurrent laryngeal nerve	5-10 mL
Interscalenic	Epidural or total spine block; Horner syndrome; Phrenic nerve block	5-15 mL
Supraclavicular	Pneumothorax	20-40 mL
	Phrenic nerve block	
	S. Horner	
Infraclavicular	Pneumotorax	20-30 mL
Axilar	No specific complications	20-30 mL
Thoracic paravertebral	Pneumothorax	15 mL OR 0,4 mL/Kg
	Epidural block	
	S. Horner	
TAP	Hollow viscus damage	0,4 mL/Kg
	Transient femoral block	
Ilio-inguinal/ilio-hypogastrico	No specific complications	0,1-0,3 mL/Kg
Lumbar plexus	Kidney injury	0,3 mL/Kg
	Epidural or total spine block	
Femoral nerve	No specific complications	20-40 mL
Lateral cutaneous thigh nerve	No specific complications	2-3 mL

Safen nerve	No specific complications	5-20 mL
Obturator nerve	No specific complications	5-10 mL/branch
Sciatic (transgluteal approach)	No specific complications	20-30 mL
Sciatc (popliteal)	No specific complications	30-40 mL

Images for this section:

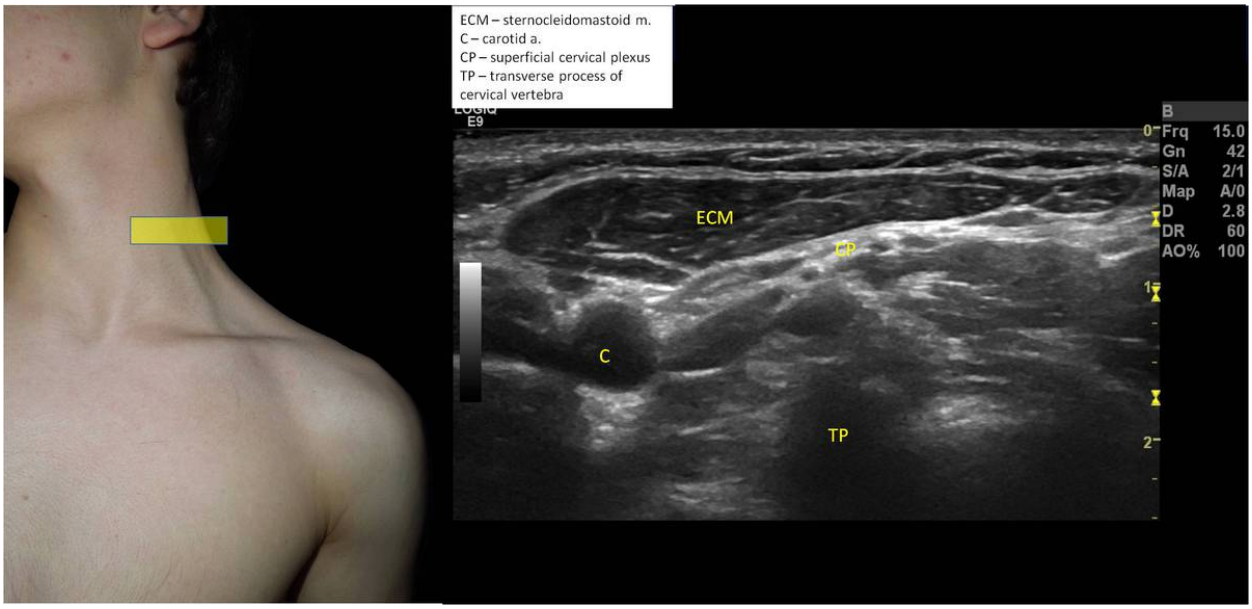


Fig. 2: Superficial cervical plexus Ultrasonographically, it may be identified by placing the patient with neck rotated to opposite side, placing the probe on the cricoid and sliding laterally to the border of the sternocleidomastoid. It is located in the posterior cervical triangle, defined by the sternocleidomastoid, trapezius muscle and clavicle. The pavement is composed by the: splenius muscle, levator scapulae and scalenus anterior and medium.

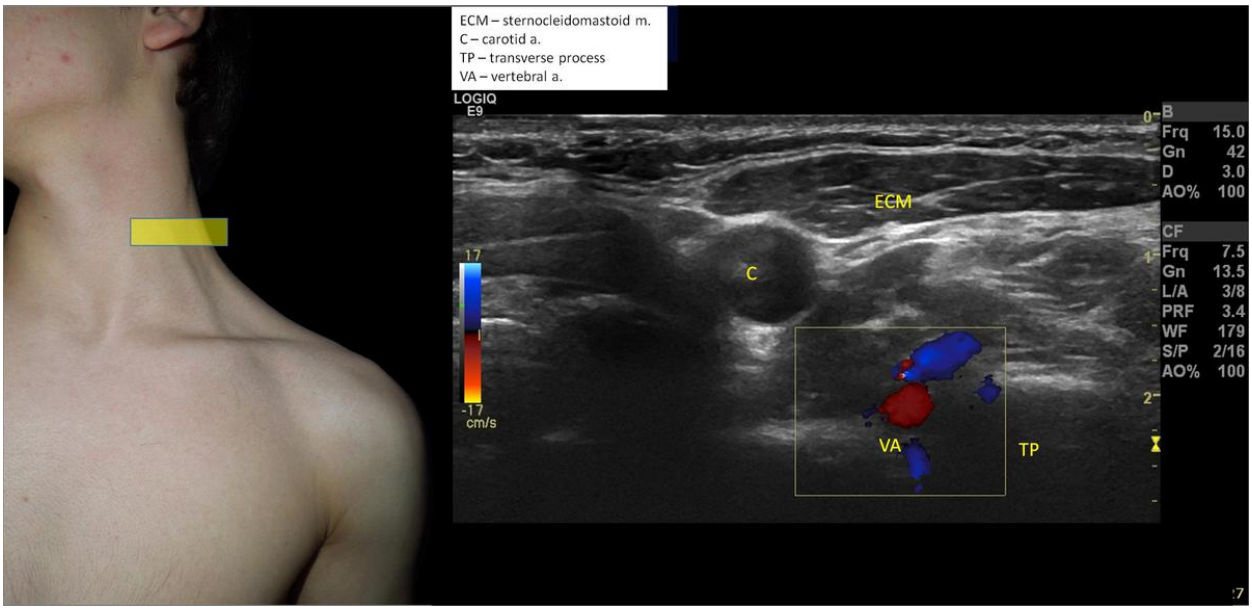


Fig. 8: Nerves are many times in close relationship with important blood vessels, such as the vertebral artery.

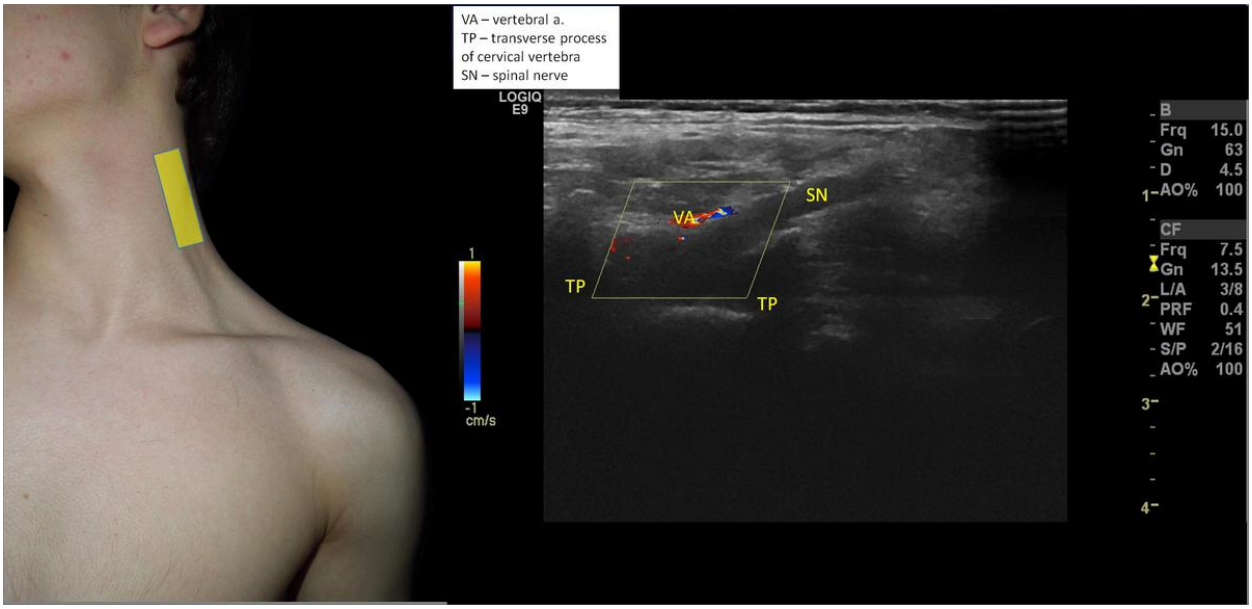


Fig. 9: Longitudinal scan of nerve leaving neck.

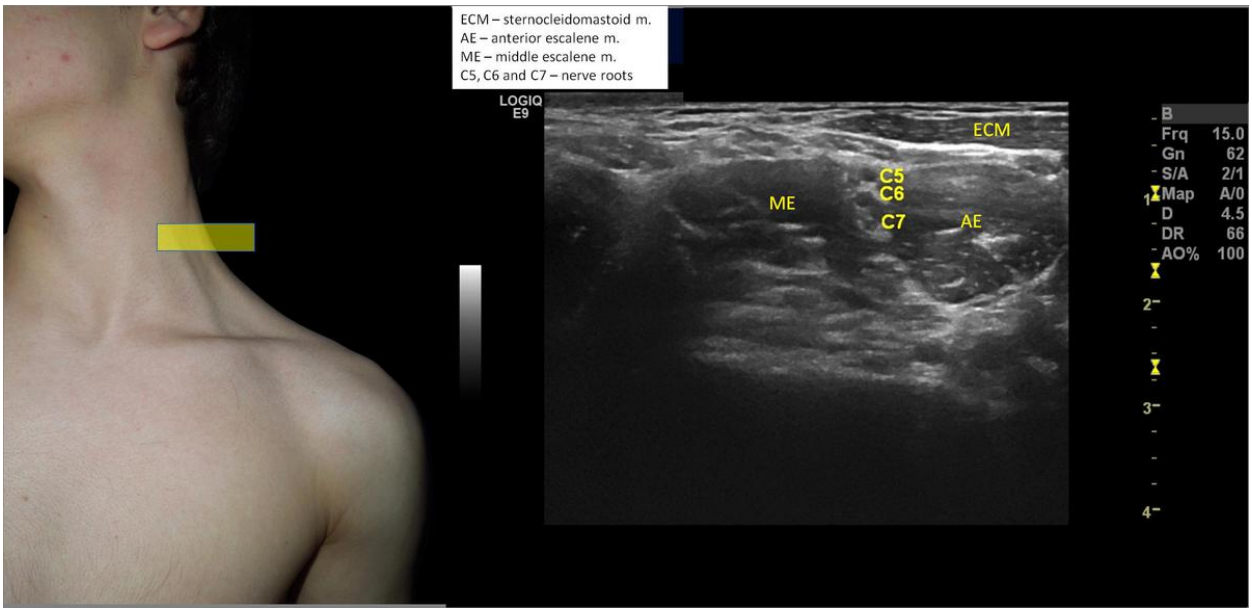


Fig. 7: Interscalenic location of the cervical plexus Roots emerge from the intervertebral holes between the middle and anterior scalene. Nerve roots then form trunks: C5-6 form the superior trunk, C7 - medium trunk, C8-T1 - inferior trunk.

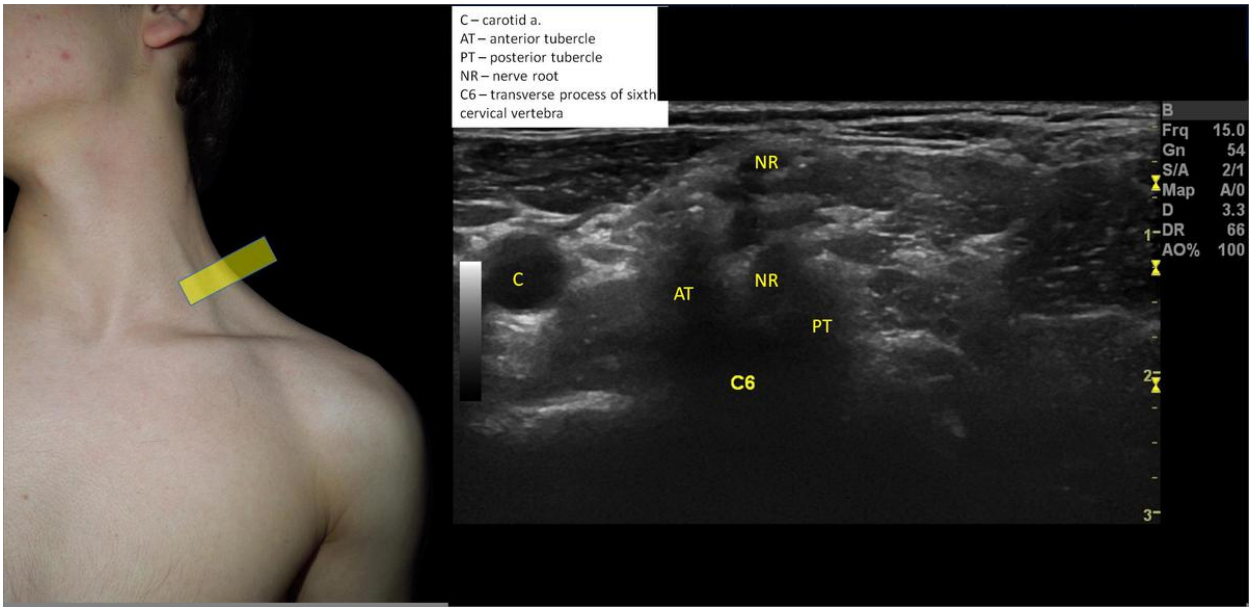


Fig. 5: Longitudinal scan through C6. Note the presence of a typical double tubercule on the transverse process.

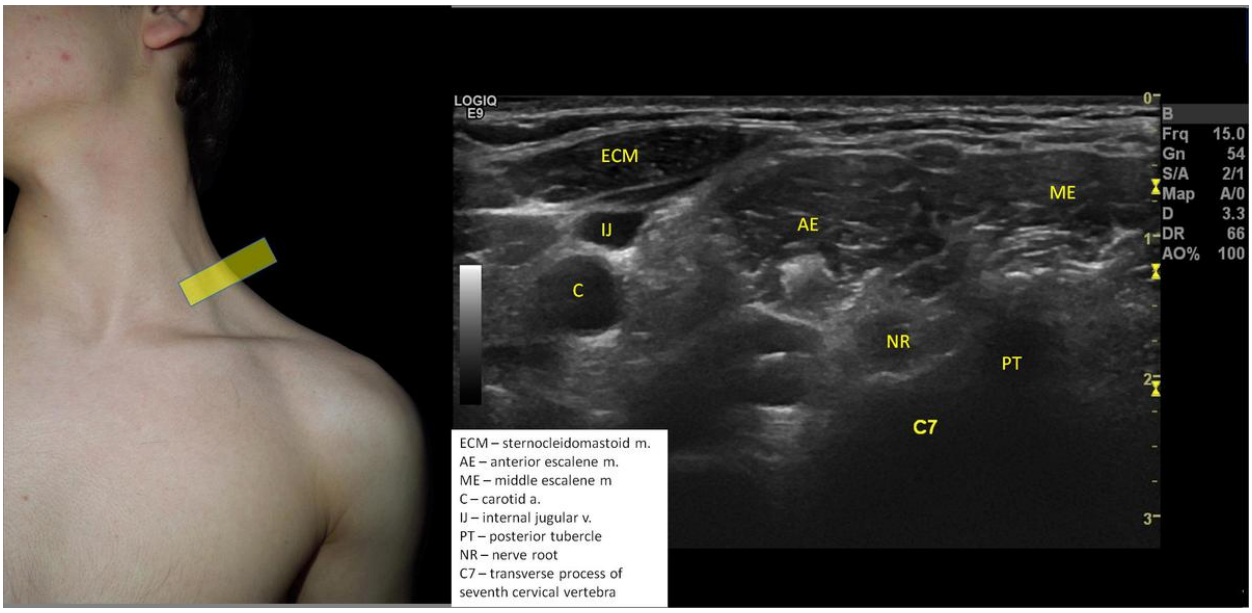


Fig. 4: Longitudinal scan through C7. Note the presence of a single tubercule on the transverse process.

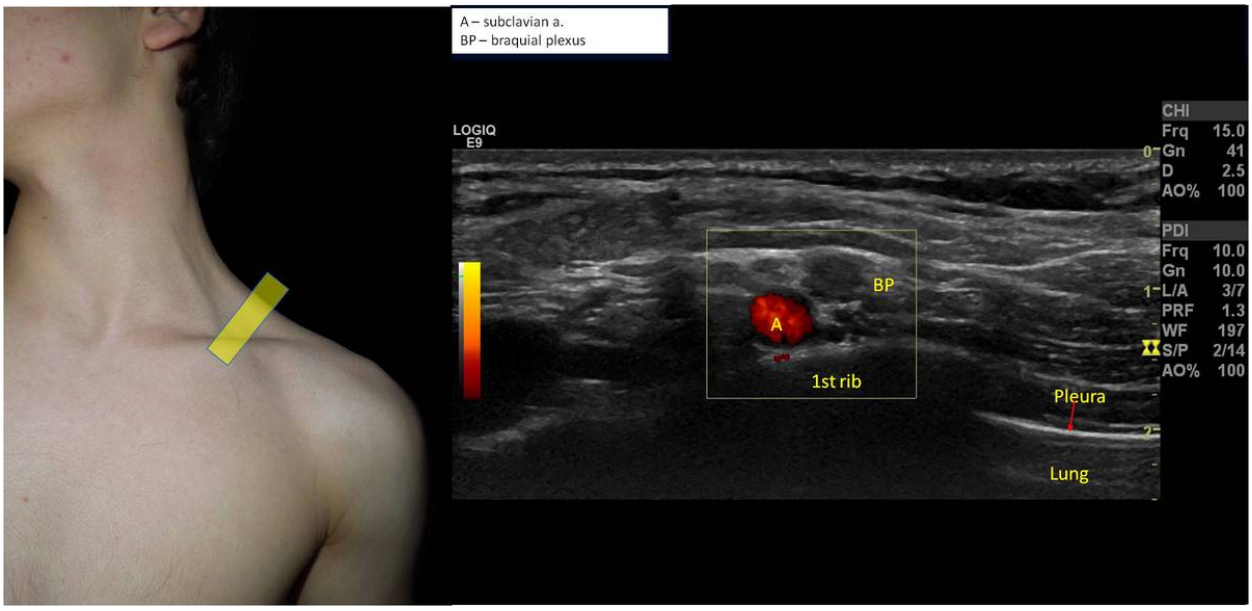


Fig. 10: Supraclavicular approach. Note the close relationship the subclavian artery (crossing the first rib) with the nerve fibers.

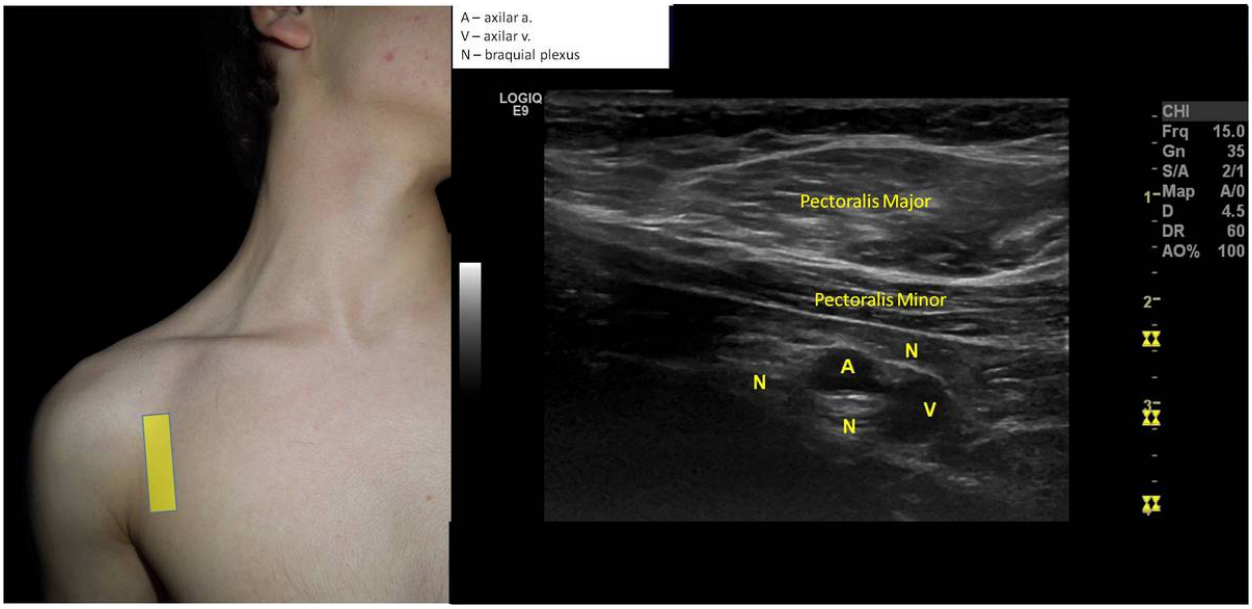


Fig. 11: Subclavicular approach to the brachial plexus. Note the nerves surrounding the axillary artery.

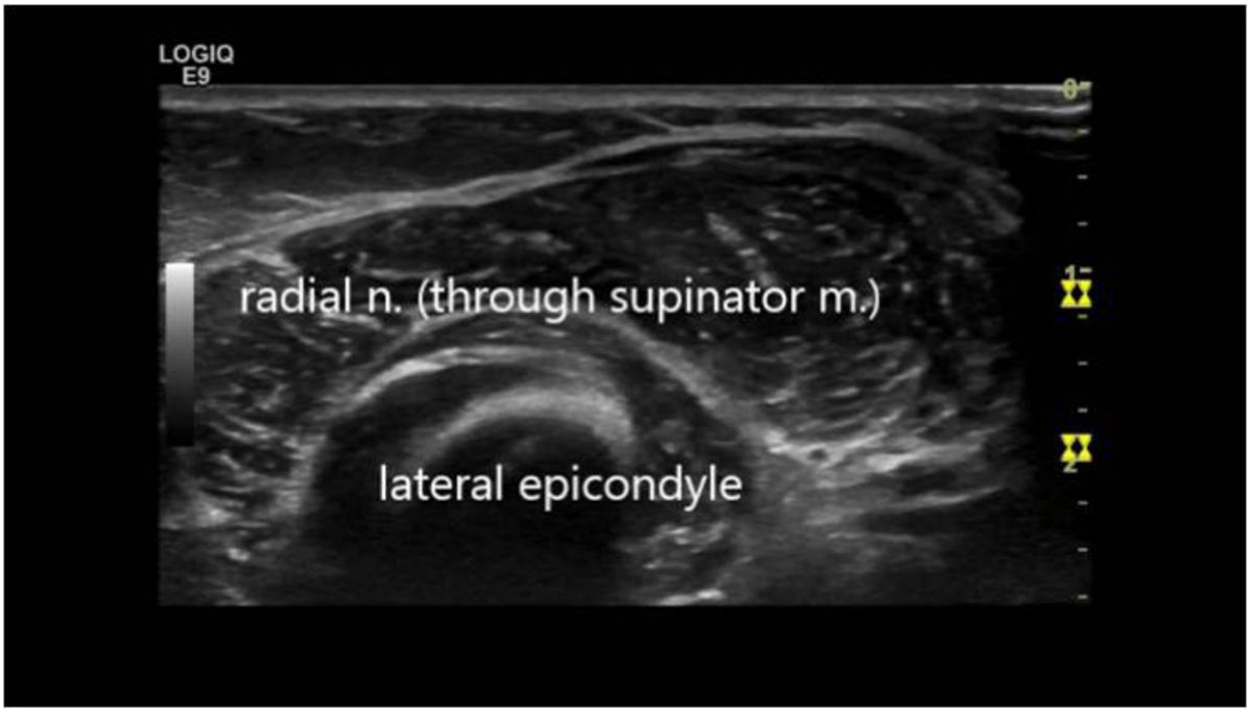


Fig. 32: Radial nerve course through the supinator muscle.

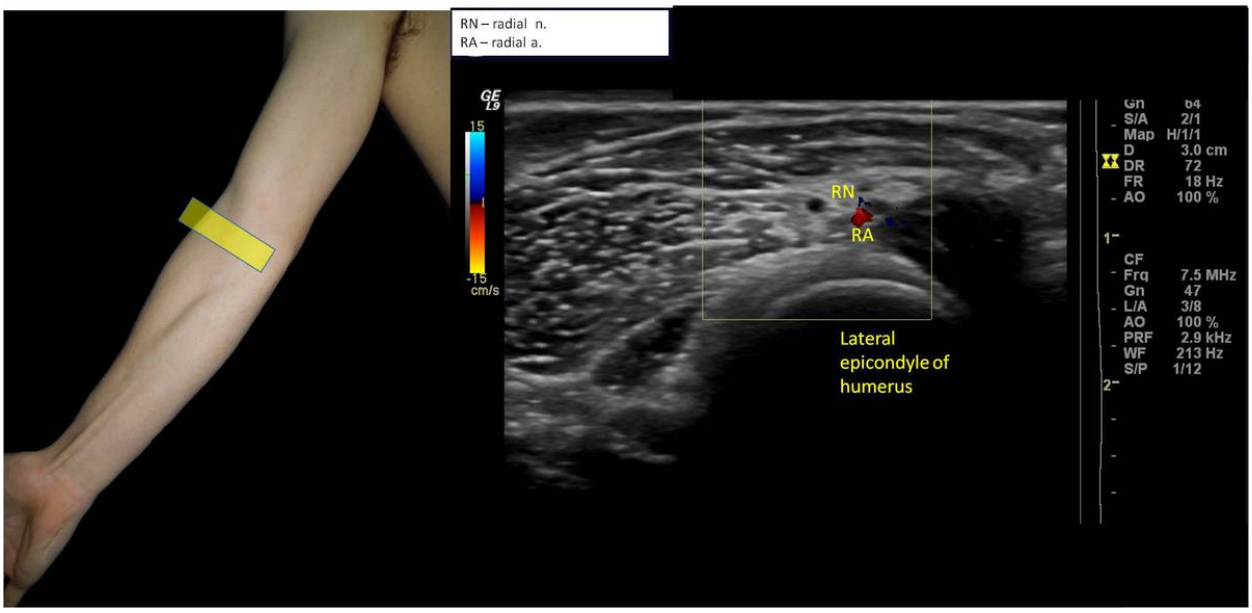


Fig. 13: Characteristic "snake-eyes" appearence of the radial nerve deep to the brachioradialis muscle, as it divides into deep and superficial branches.

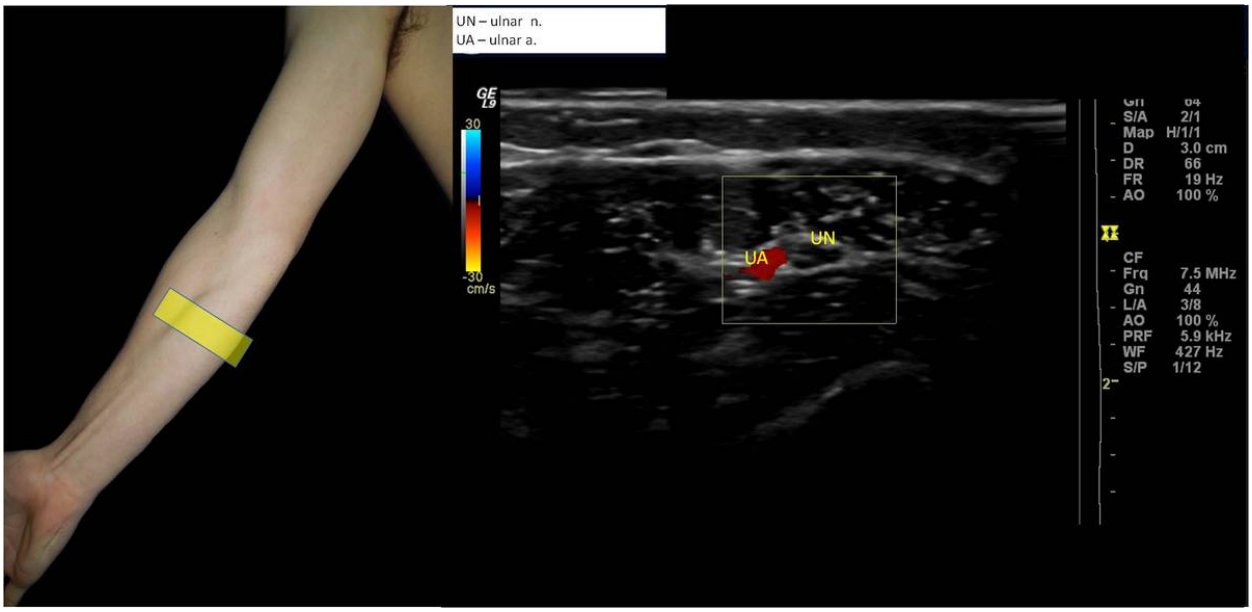


Fig. 16: Ulnar nerve coursing with its correspondent artery.

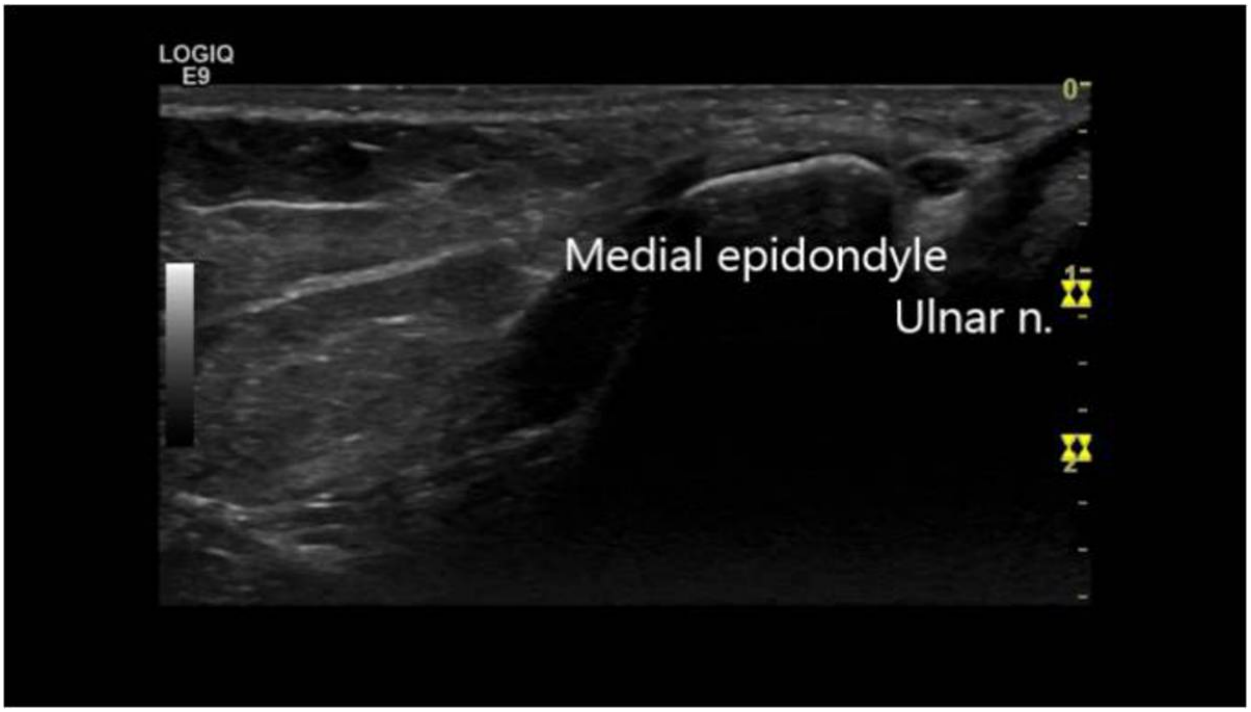


Fig. 15: Ulnar canal at the elbow.

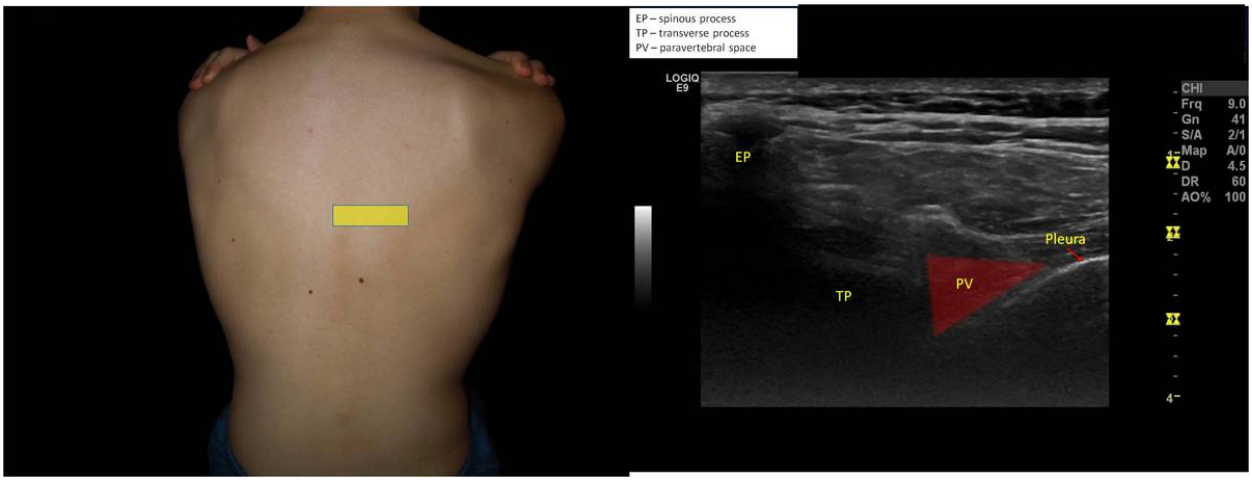


Fig. 20: Longitudinal scan of the paravetebral space. The space itself is triangular, defined with a medial base and a lateral apex. There lies the fat tissue involving the intercostal nerve, the dorsal nerve, the intercostal vessels and the sympathetic chains.

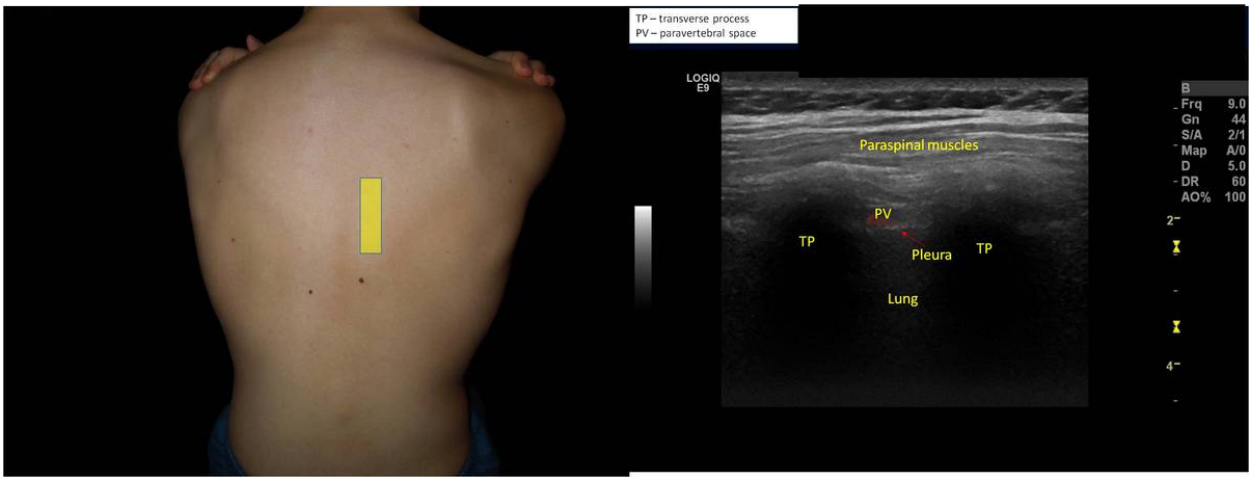


Fig. 21: Sagittal scan of the paravertebral space.

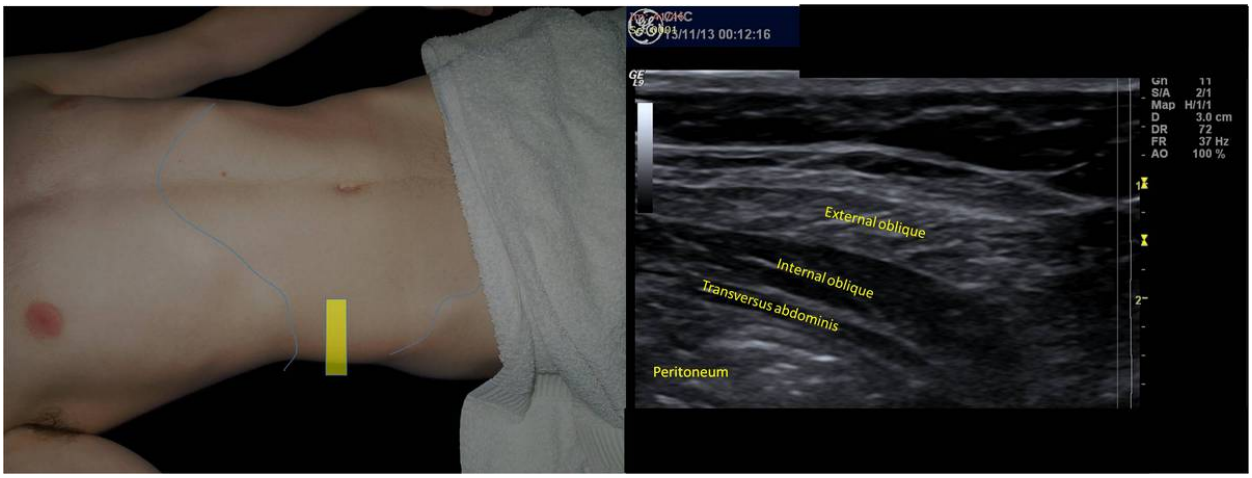


Fig. 22: Abdominal wall axial scan. The plane between the transversus abdominis and internal oblique is used as a guide for anesthesic placement - TAP procedure.

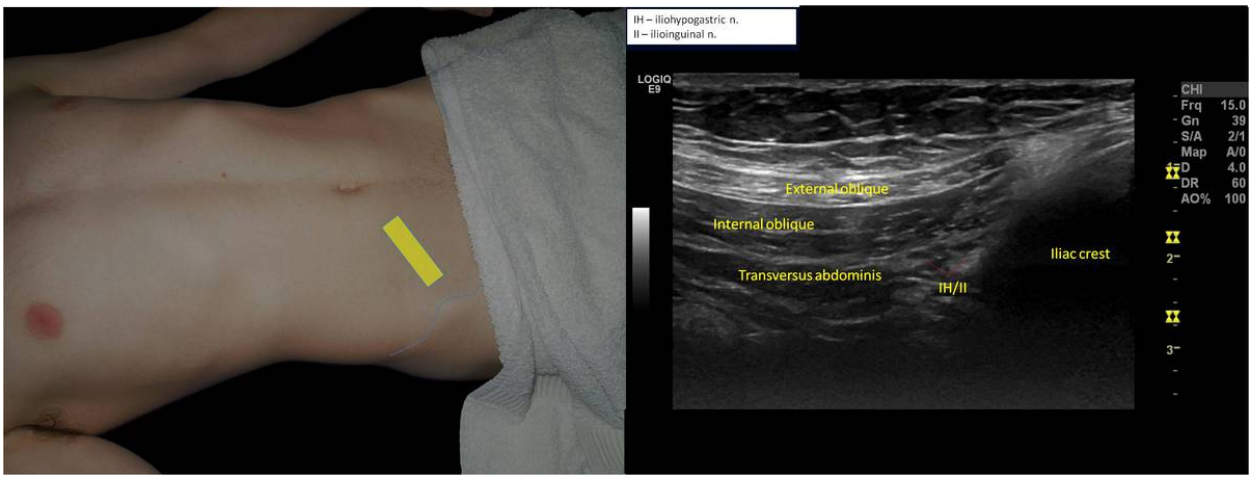


Fig. 23: Midpoint between the umbilicus and the anterosuperior iliac spine is used as a guide for identifying the ilioinguinal and iliohypogastric nerves

Fig. 31: Longitudinal scan identify transverse apophyses Start caudally at the sascrum and move cephalad, so that the first space encoutered is L5 / S1 After this, the upper transverse apophyses are correctly identified Place the probe so that it focus the L2 to L4 transerse apophyses. The acousic shadow is refered as the trident The psoas muscle is assessed through the trident In the psoas muscle, hyperechoic striation correspond to the lumbar plexus. However, given the fibrilar nature of the muscle, one must not jump to conclusions Nerve fibers are usually more oblique, thickned. Placing the probe more latearlly, makes us lose the typical trident appearence, but allows us to identify the quadratus lombarum and the kidney.

Fig. 24: Axial scan of the lumbar region.

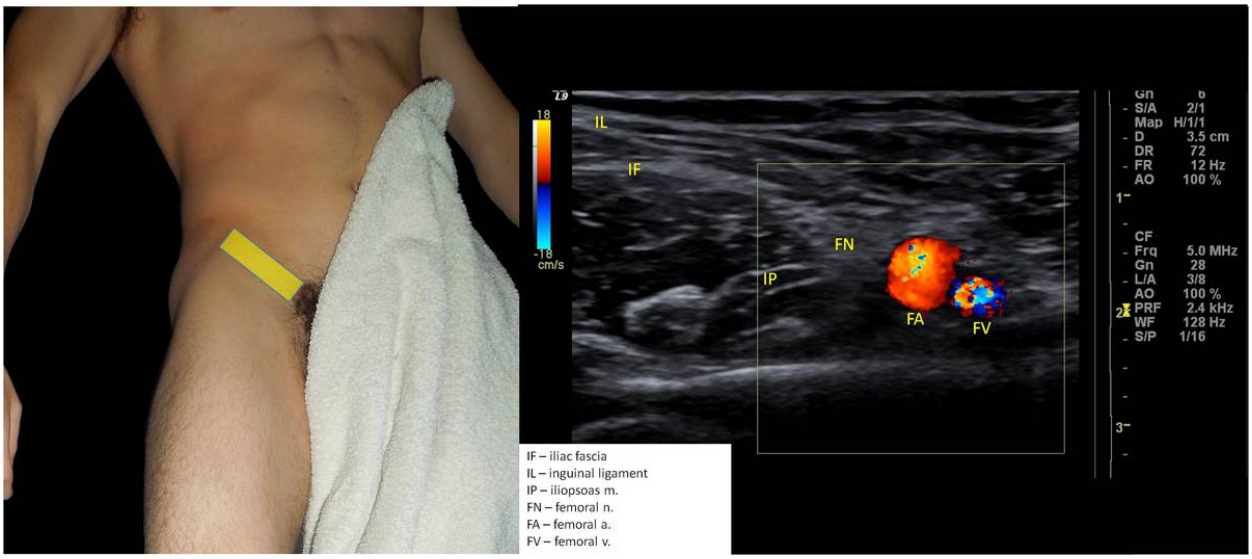


Fig. 25: Inguinal region, showing the typical localization of the femoral nerve.

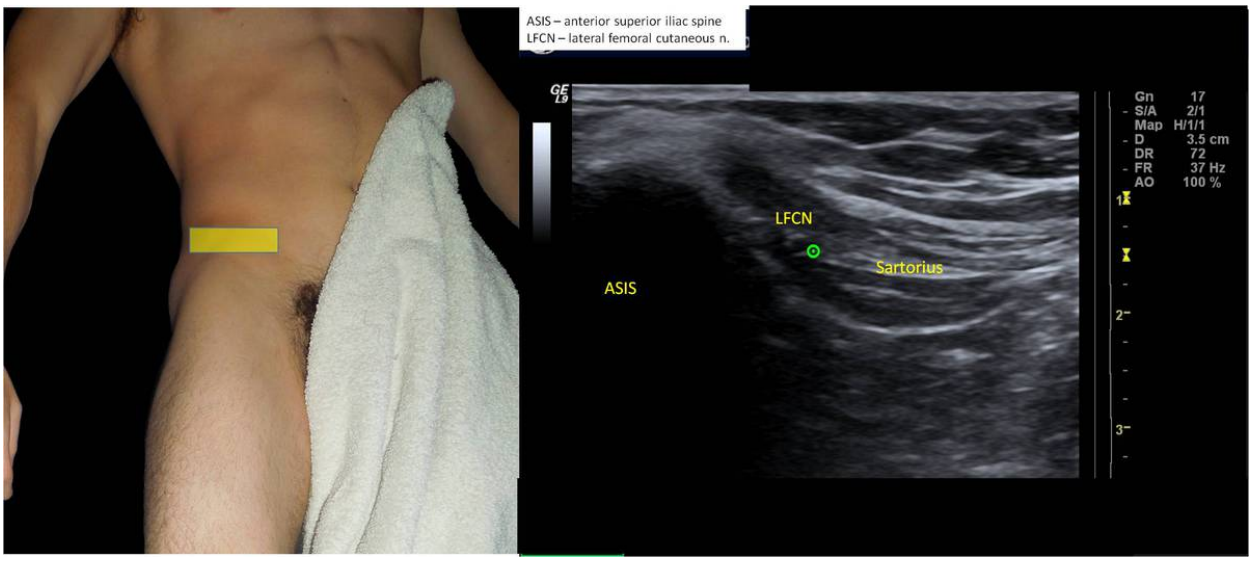


Fig. 26: Lateral femoral cutaneous nerve passing inferior to the inguinal ligament adjacent to the anterosuperior iliac crest.

Fig. 27: Longitudinal scan of the medial thigh, showing the location of the obturator nerve branches. This nerve innervates most addutor muscles (except for the pectneus which is usually innervated by the femoral nerve). Scan is made by placing the probe in the medial side of the thigh, below inguinal fold, and scanning medially to the femoral vein.

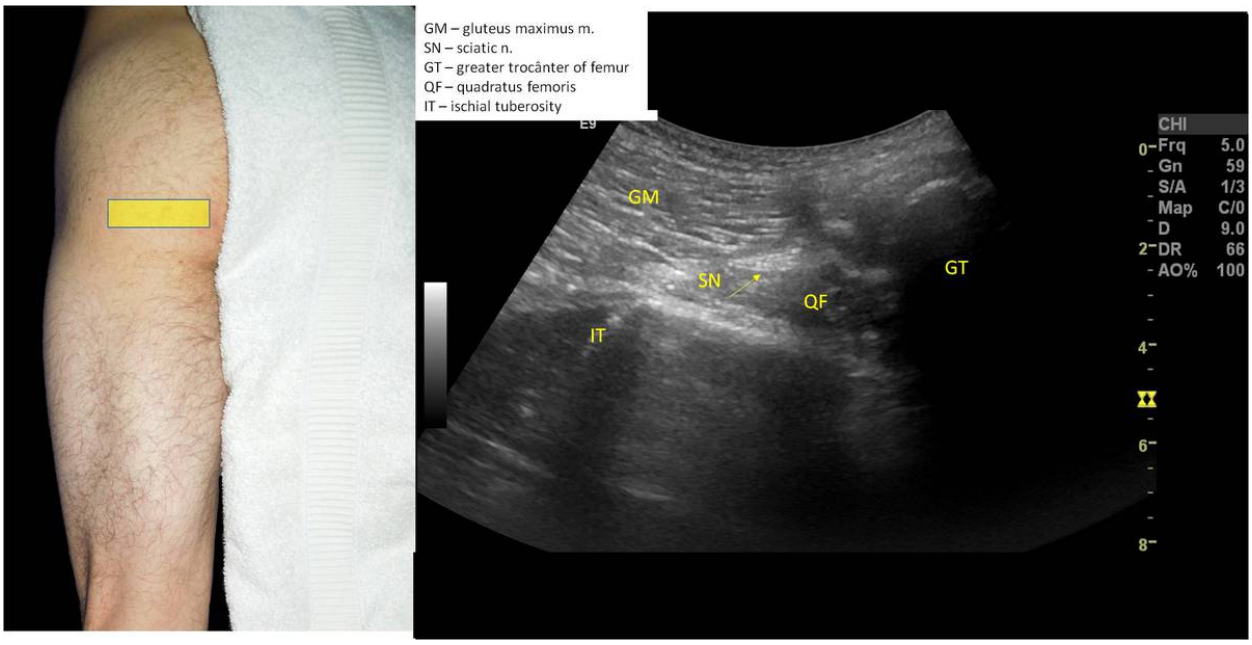


Fig. 28: Sciatic nerve over the quadratus femuris, between the typical bony landmarks: the greater tuberosity and the ischial tuberosity.

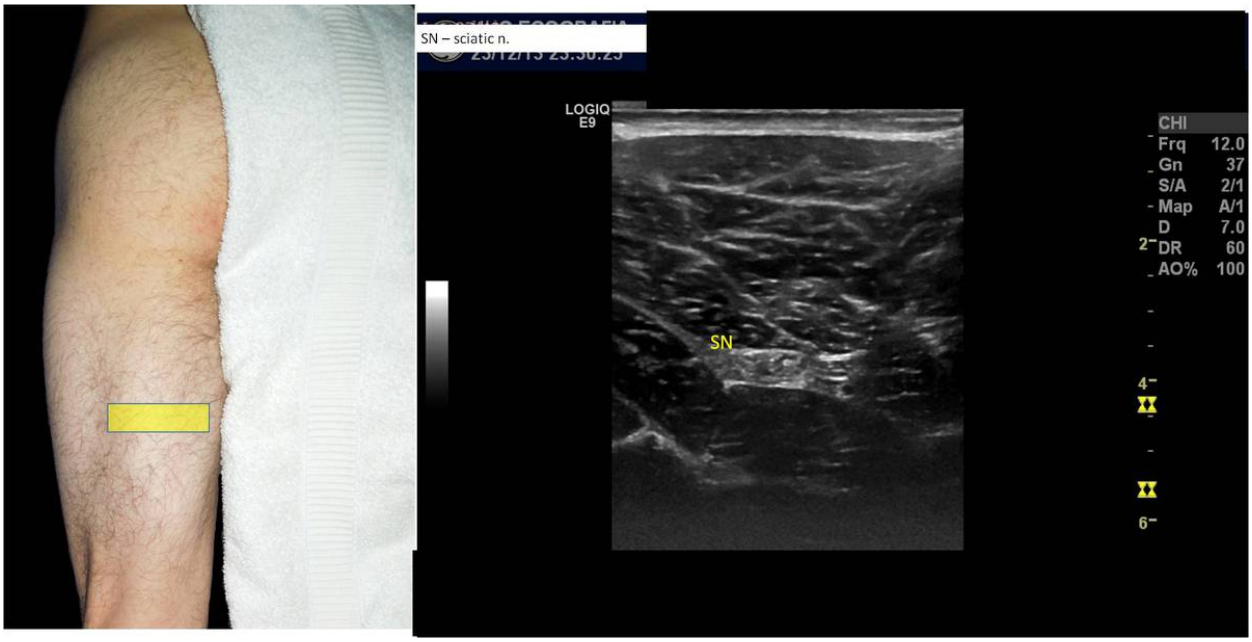


Fig. 29: The sciatic nerve lies between the bicipitis femoris (lateral) and the semimembranous (medial)

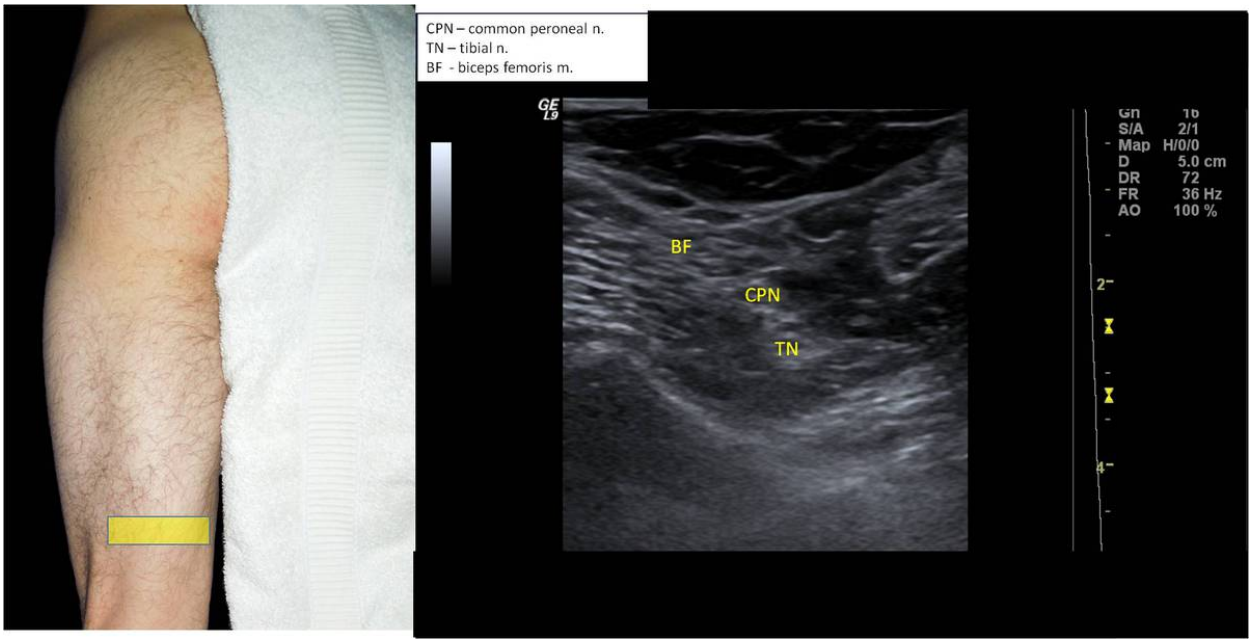


Fig. 30: Sciatic nerve bifurcation

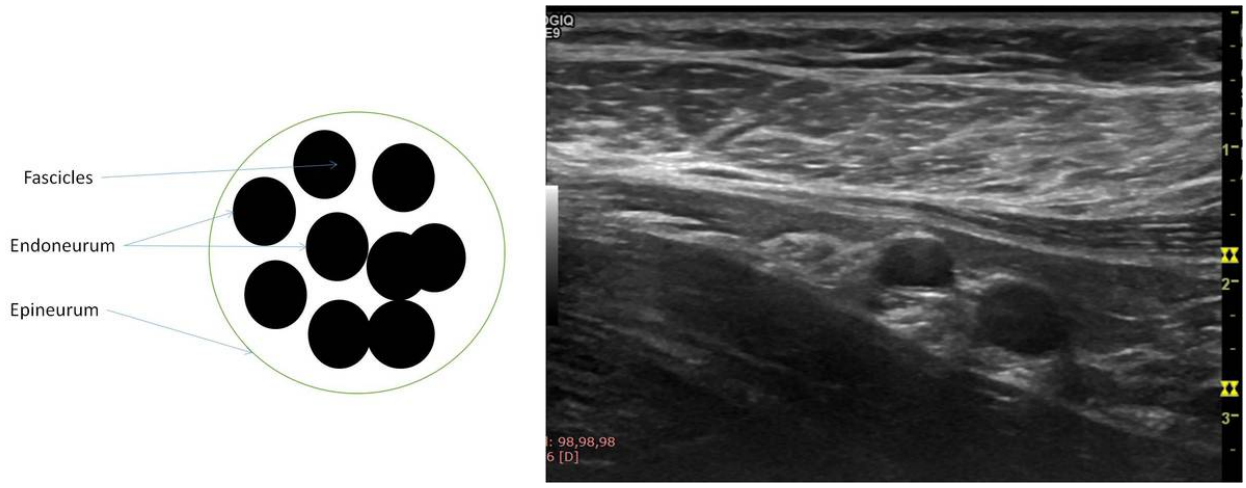


Fig. 1: Nerve histologic anatomy correlated with ultrasound aspect. Fascicles contain axons. Fascicles are envolved by the endoneurum. Fascicles are separated by echogenic connective tisseu. The epineurum further helps organize normal nerve ultrasound aspect

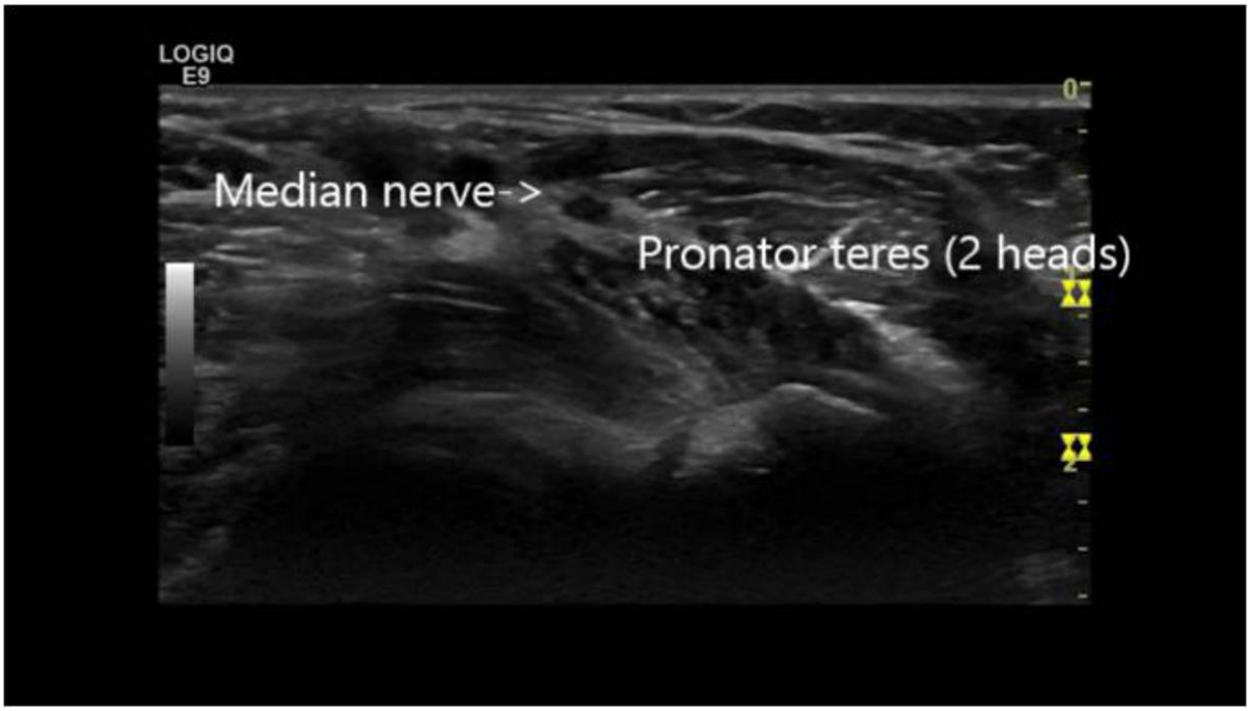


Fig. 33: Median nerve passing underneath the long head of the pronator teres at the antecubial fossa

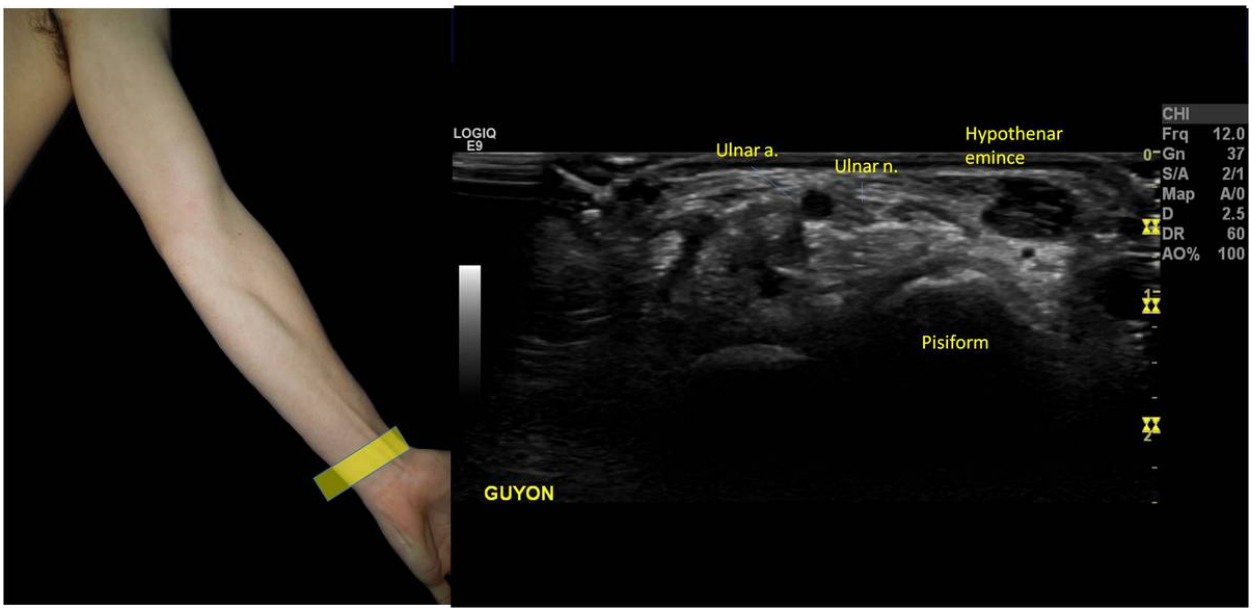


Fig. 17: Guyon canal

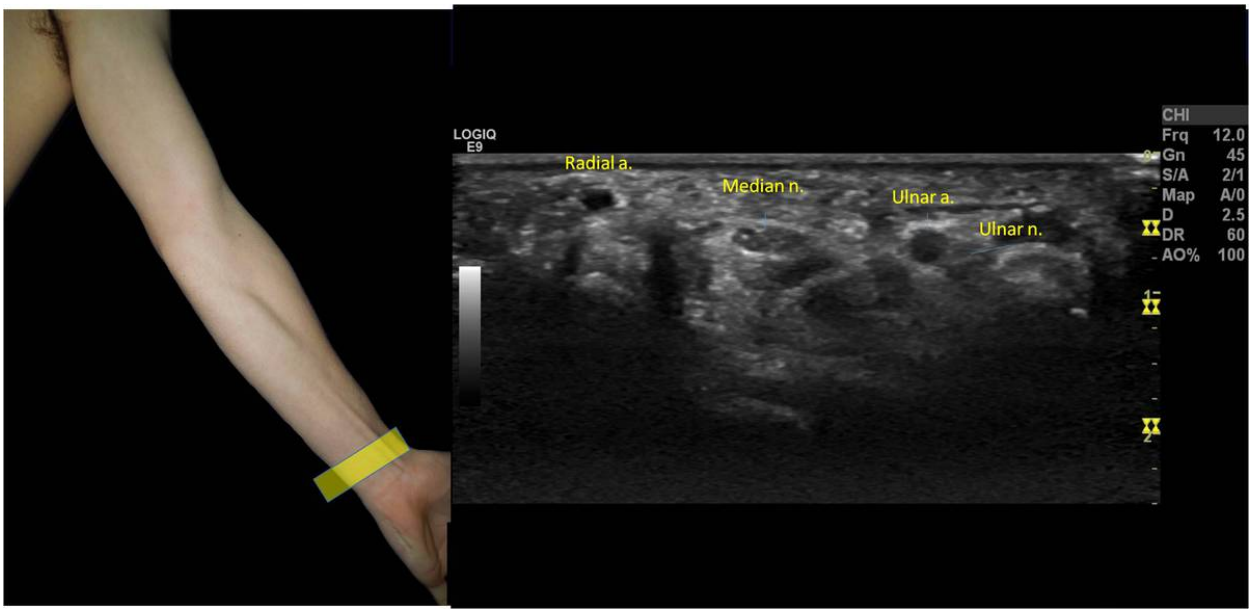


Fig. 19: Landscape view at the wrist. Note the relationship of the median nerve with the retinaculum and the flexor tendons. Note also the close relationship of the ulnar nerve with the ulnar artery

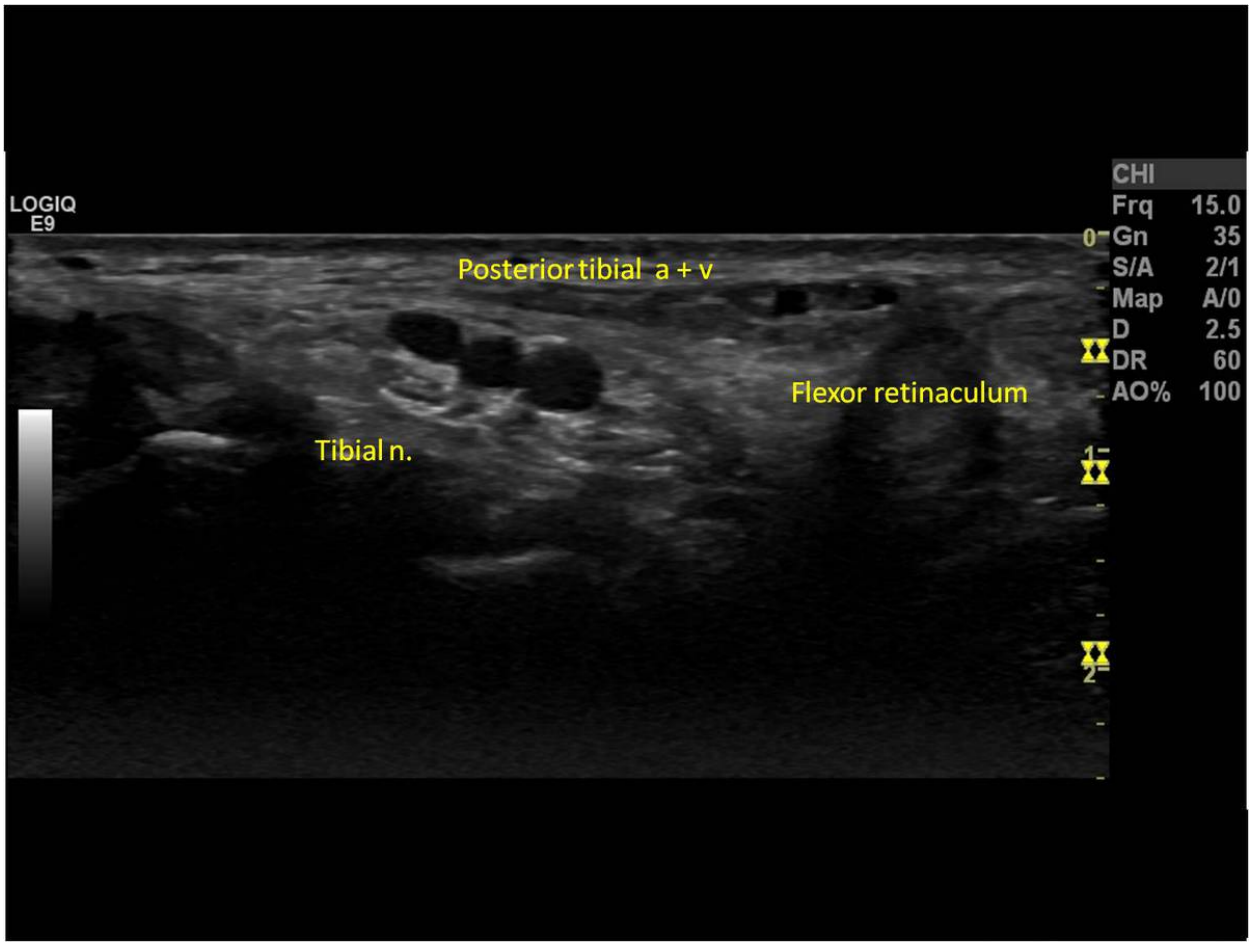


Fig. 34: Tarsal tunnel showing the tarsal nerve.

Fig. 12: Axillary nerve assessment. Dynamic examination and following f the nerves makes the nerves easier to follow

Fig. 6: Demonstration of C7 as a reference level for nerve assessment in the neck

Fig. 14: Radial nerve as it courses through the supinator muscle.

Fig. 3: Demonstration of lateral sweep, showing the sternocleidomastoid and the nerve fibers arising and passing posterior

Fig. 18: Anterior forearm sweep demonstrating the median nerve course

Conclusion

We believe that sonography is inexpensive, widely available, has no contraindications, and allows rapid, detailed imaging of the entire length of the major peripheral nerves of both limbs.,

Personal information

F.M.G.S. Pereira da Silva, H.Donato, P. Donato, F. Caseiro Alves
Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra

S. J. Mota, M. Gil-Pereira
Anesthesiology Department, University Hospital of Coimbra

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