

PERIPHERAL NERVE BLOCKS

BACK TO BASICS

Primer for registrars and residents

CONTENTS

Brachial Plexus Blocks

Interscalene¹

Supraclavicular²

Infraclavicular³

Axillary⁴

Pectoralis⁵ nerve block

Abdominal wall⁶

Femoral⁷ nerve block

Adductor canal block⁸

Popliteal⁹ sciatic nerve block

Before performing peripheral blocks trainees should draw schematic diagrams of relevant sonograms, label and be familiar with standard needle trajectories

Content is a teaching aid only, the information is not meant to replace clinical judgement for a given clinical scenario

*Note: This content is NOT intended to replace the comprehensive curricula in **Anesthesia Toolbox***

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Mandatory requirements

Before performing peripheral nerve blockade at St Vincent's Hospital, trainees are required to complete the following *Toolbox* milestones

On Line Modules

Online 1 Ultrasound Physics

Online 2 Ultrasound Machine Controls

Online 3 Ultrasound Probe Manipulation

Online 4 Ultrasound Probe and Needle Alignment

Lectures

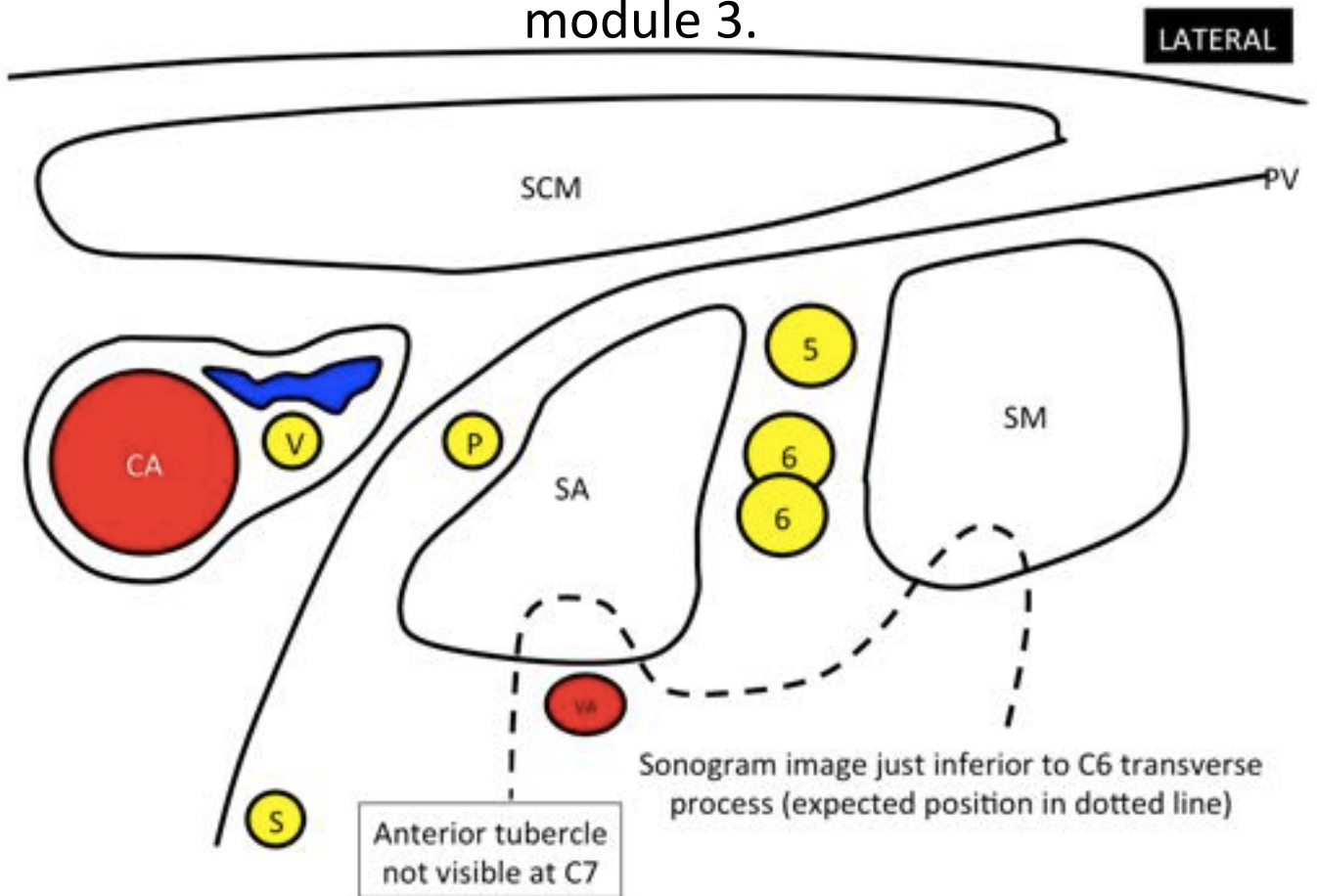
Lectures 15 and 16 Ultrasound Principles

Hands-on-Modules

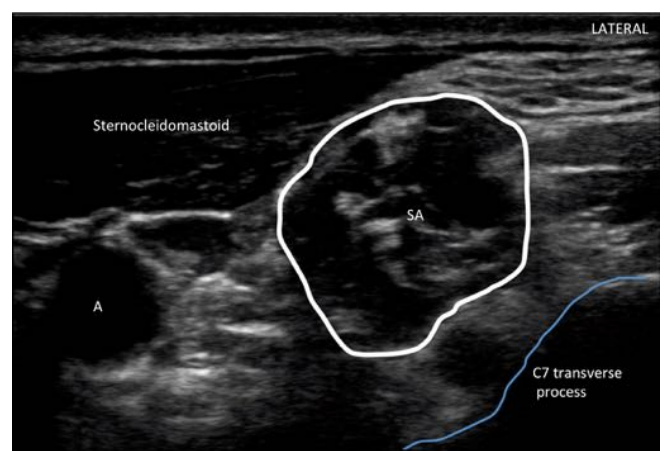
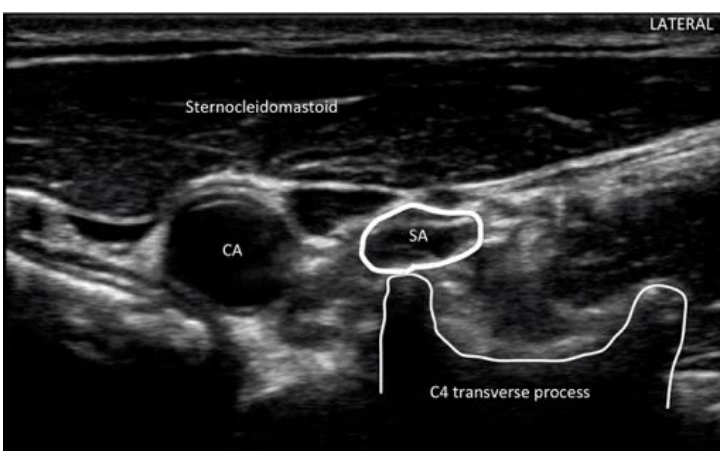
Hands-on 1: Needle Guidance under Ultrasound

1. INTERSCALENE

Toolbox: online modules 8, 10, 15; RAP lecture 3, 23; hands-on module 3.



Key structures: Sternocleidomastoid (SCM), scalenus anterior (SA) and scalenus medius (SM) muscles; C5 (5), C6 (6) spinal nerves and vagus/ recurrent laryngeal (V), sympathetic (S) and phrenic (P) nerves; Carotid (CA) and vertebral (VA) arteries. Prevertebral fascia (PV).



The scalenus anterior is a key structure. It's cross-sectional size varies significantly depending on the vertebral level. It's superior attachments are to the transverse processes of C3-C6. Note how much smaller it appears at C4 compared with C7.

KEY STRUCTURES

- STERNOCLEIDOMASTOID
- CAROTID SHEATH
- PREVERTEBRAL FASCIA
- PHRENIC NERVE
- SCALENUS ANTERIOR
- SCALENUS MEDIUS
- BRACHIAL PLEXUS (TRUNKS/DIVISIONS)

INNERVATION OF THE SHOULDER

- SUPRASCAPULAR NERVE (C5, C6: branch of upper trunk)
- AXILLARY NERVE (C5, 6: branch of the posterior cord)
- SUPRACLAVICULAR NERVE (branch of the cervical plexus, in close proximity to upper trunk)
- Injecting at the C5 – C6 level (upper trunk) facilitates reduced use of local anaesthetic, reducing side-effects

INDICATIONS

- SHOULDER SURGERY (e.g. arthroscopy, arthroplasty, rotator cuff repair, subacromial decompression)
- PROXIMAL HUMERAL SURGERY (e.g. ORIF, megaprosthesis)

CONTRAINDICATIONS

- Contralateral paresis of the recurrent laryngeal or phrenic nerve
- Contralateral pneumonectomy or pneumothorax
- Reduced pulmonary reserve (relative contraindication)

SUGGESTED LOCAL ANAESTHETIC DOSES

- 10 – 20 ml 0.2 - 0.75% ropivacaine (at the C5 – C6 level)

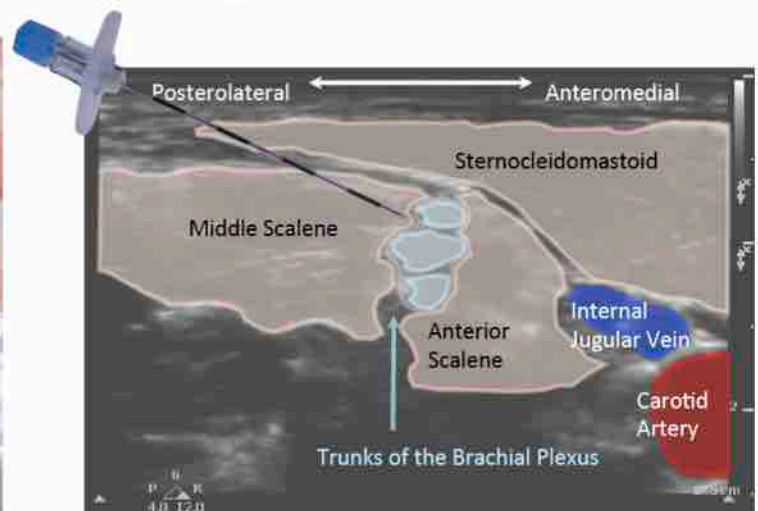
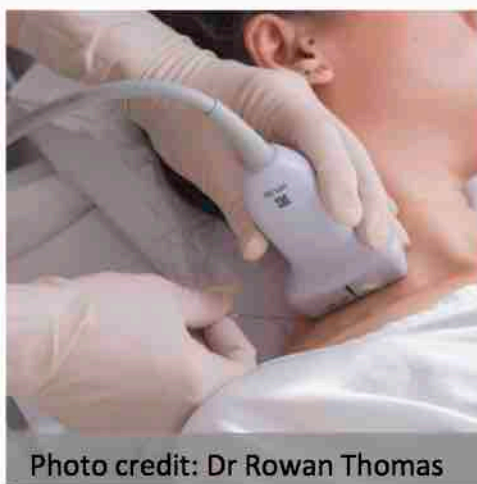
TRANSDUCER

- High frequency linear transducer: Upper bandwidth 13 - 15 MHz appropriate, width: 25 – 50 mm

NEEDLE 50 mm

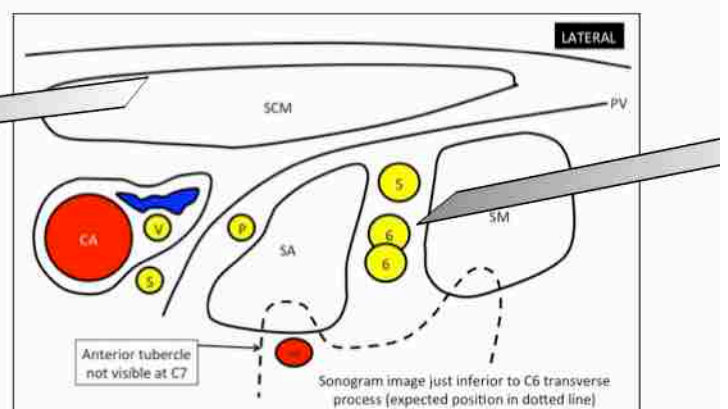
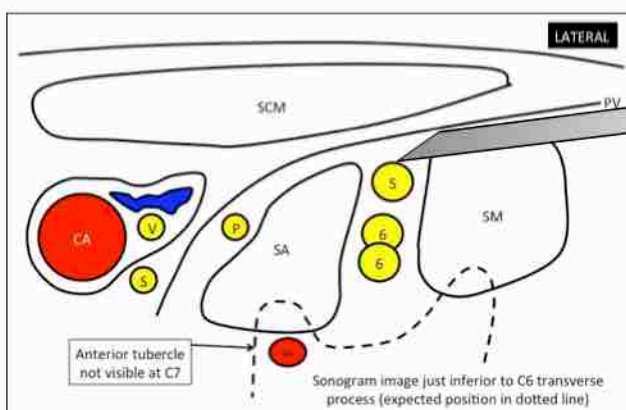
TIPS

- Avoid excessive needle instrumentation, the needle tip positions in the images below may provide perineural spread with no further movement



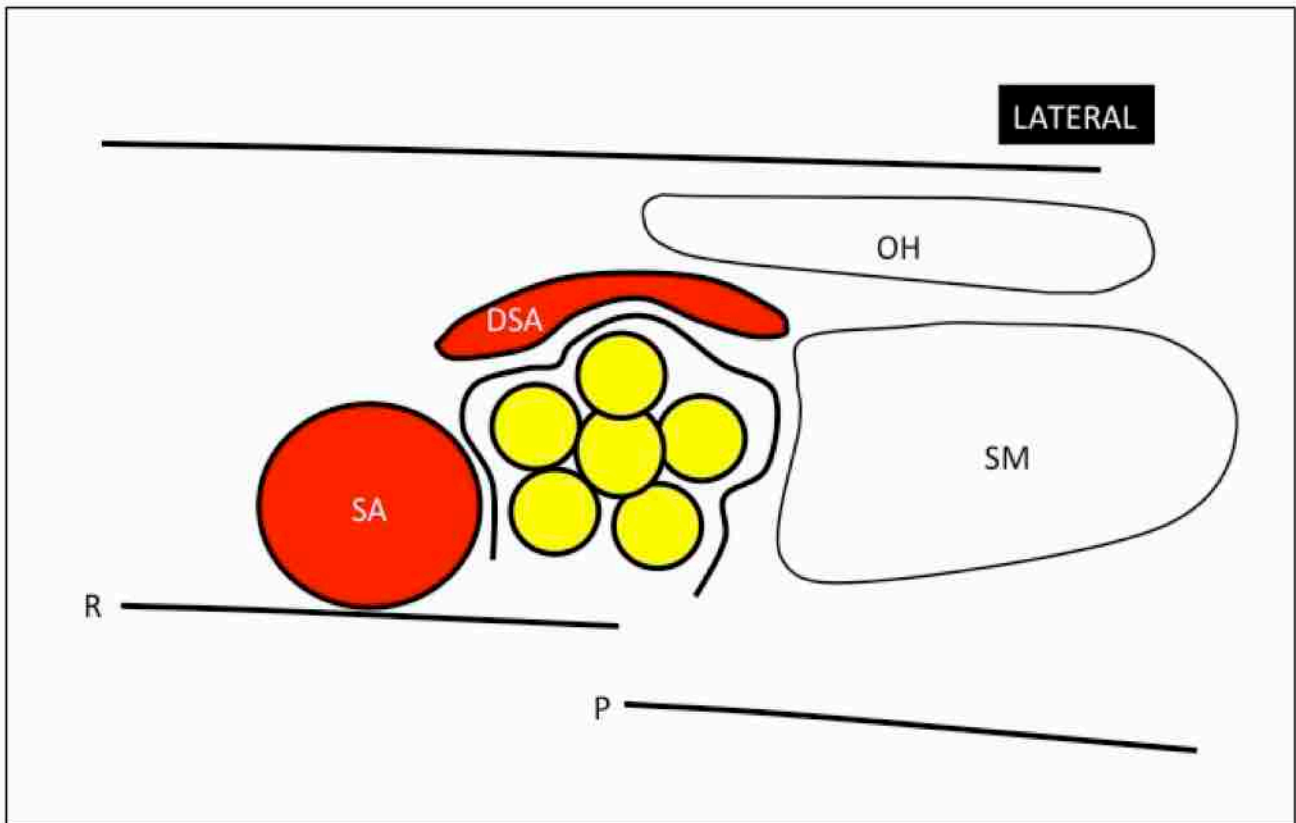
Needles used are for demonstration purpose only

Examples: cease needle trajectory at these points and hydro-dissect



2. SUPRACLAVICULAR

Toolbox: online module 8, RAP lecture 3, 23; hands-on module 3



Ensure that the needle tip is always visible and superficial to the 1st rib (R). The brachial plexus above the rib is usually superficial. Occasionally, the plexus at the supraclavicular level is deeper and the needle trajectory may be challenging. The pleura (P), should be identified before performing this block and is imaged slightly deep to the 1st rib. The transducer position and orientation influences the ultrasound image of SA and its relationship to first rib and muscles. The brachial plexus divisions (yellow structures) are deep to the prevertebral fascia. This region is highly vascular (e.g. dorsal scapular artery (DSA) and subclavian artery (SA). Scalenus medius, (SM) and the omohyoid (OH).

KEY STRUCTURES

- SCALENUS MEDIUS
- OMOHYOID
- PREVERTEBRAL FASCIA
- DORSAL SCAPULAR ARTERY
- SUBCLAVIAN ARTERY
- BRACHIAL PLEXUS (DIVISIONS)

INDICATIONS

- Mid-distal humeral fractures
- Major elbow surgery
- Major forearm surgery (e.g. ORIF radius)*
- Wrist arthrodesis/arthroscopy*
- Carpal, metacarpal ORIF*#
- Arterio-Venous access

**Axillary approach also effective*

#Suggest axillary approach if surgery in ulnar nerve distribution

CONTRAINDICATIONS

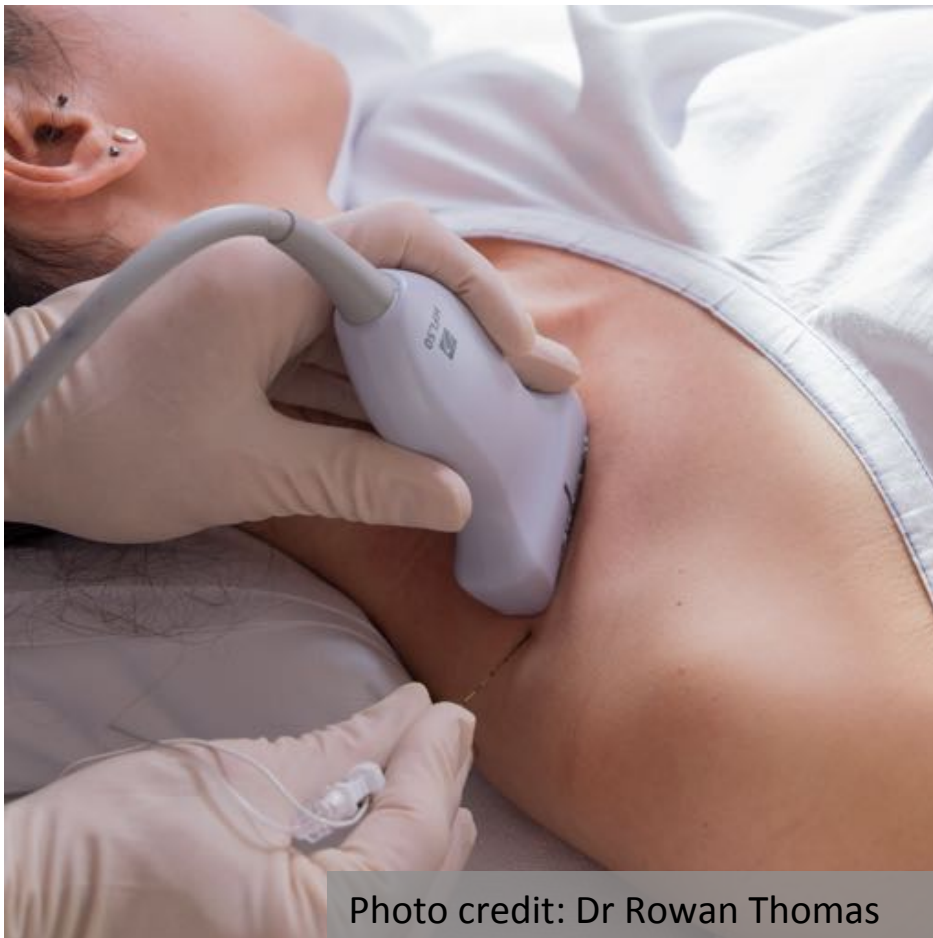
- Contralateral paresis of the recurrent laryngeal or phrenic nerve
- Contralateral pneumonectomy or pneumothorax
- Reduced pulmonary reserve (relative contraindication)

SUGGESTED LOCAL ANAESTHETIC DOSAGES

- Surgical anaesthesia and analgesia: 20 – 30 mL 0.6 - 0.75% ropivacaine
- Surgical anaesthesia: 20 – 30 mL 2% lignocaine + epinephrine 1:200,000 (e.g. reno-vascular access)
- Post-operative analgesia alone: 20 – 30 mL 0.2 – 0.5% ropivacaine

TRANSDUCER

- High frequency linear transducer: Upper bandwidth 13 - 15 MHz appropriate, width: 25 – 50 mm



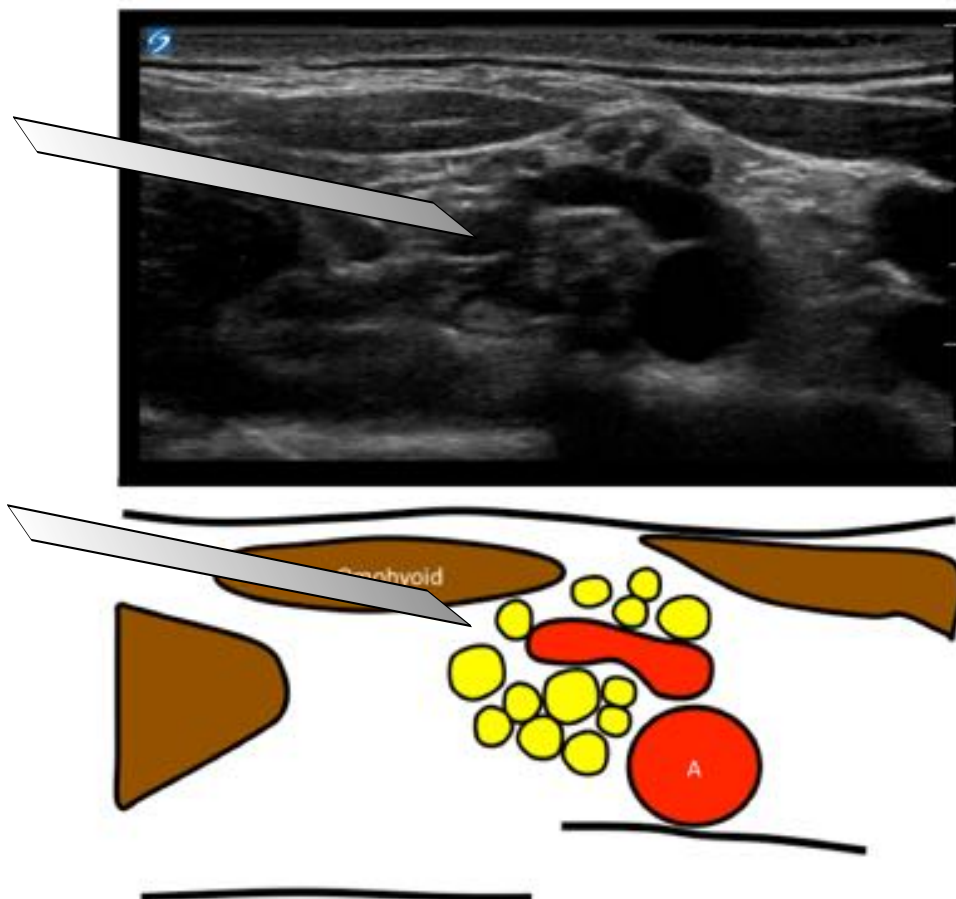
Note: the above linear transducer has a width of 50 mm, this may necessitate the use of a longer needle compared to use of a transducer with a smaller footprint, for example, 25 mm width

NEEDLE 50 – 100 mm

TIPS See below

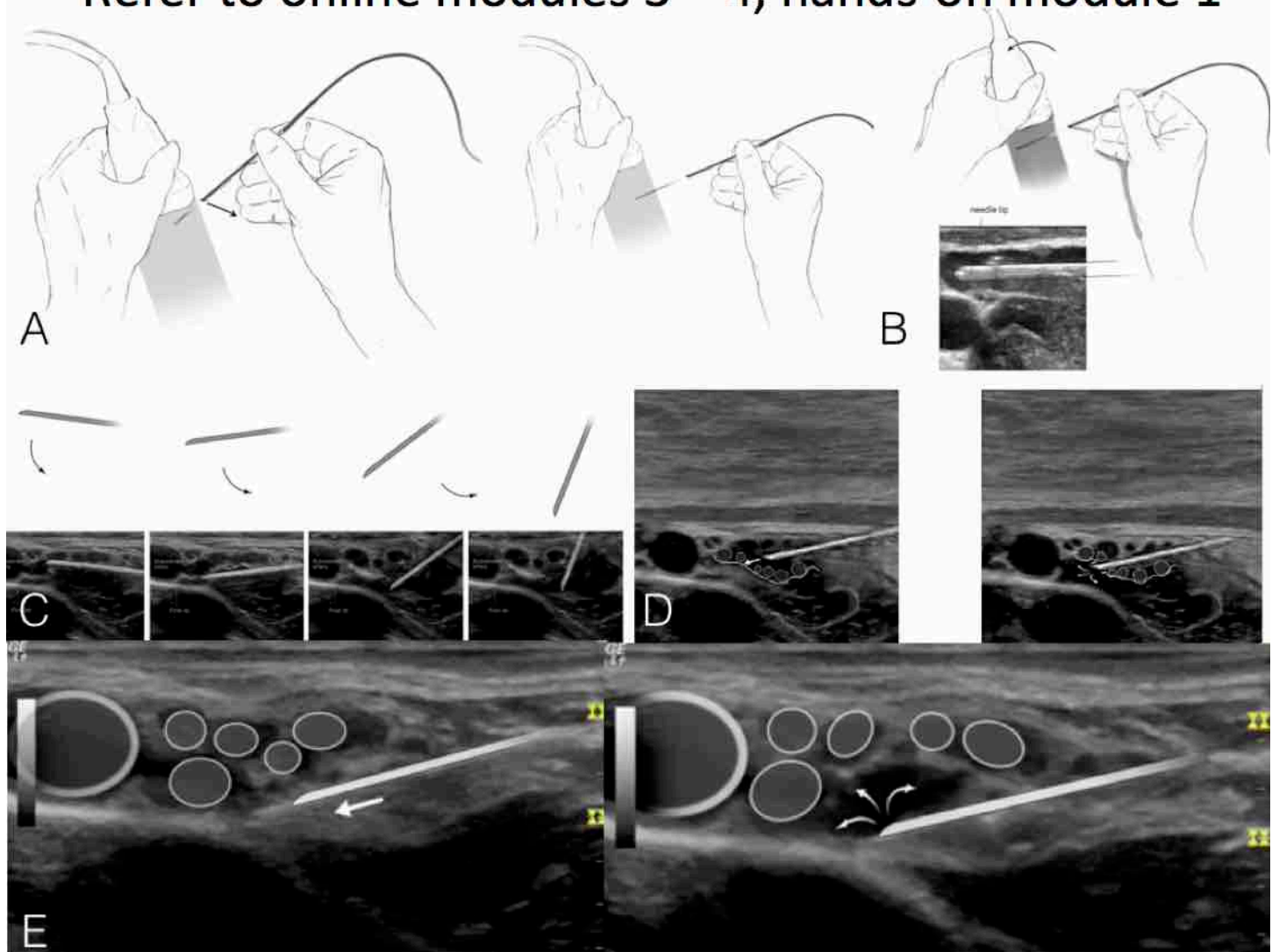
VASCULARITY RELEVANT TO BLOCKS ABOVE THE CLAVICLE

Many regions are highly vascular, one example is the dorsal scapular artery, frequently imaged when performing supraclavicular blockade. It is important to perform colour Doppler imaging in the planned needle trajectory.



A few strategies for needle imaging and controlling spread of local anaesthetic.

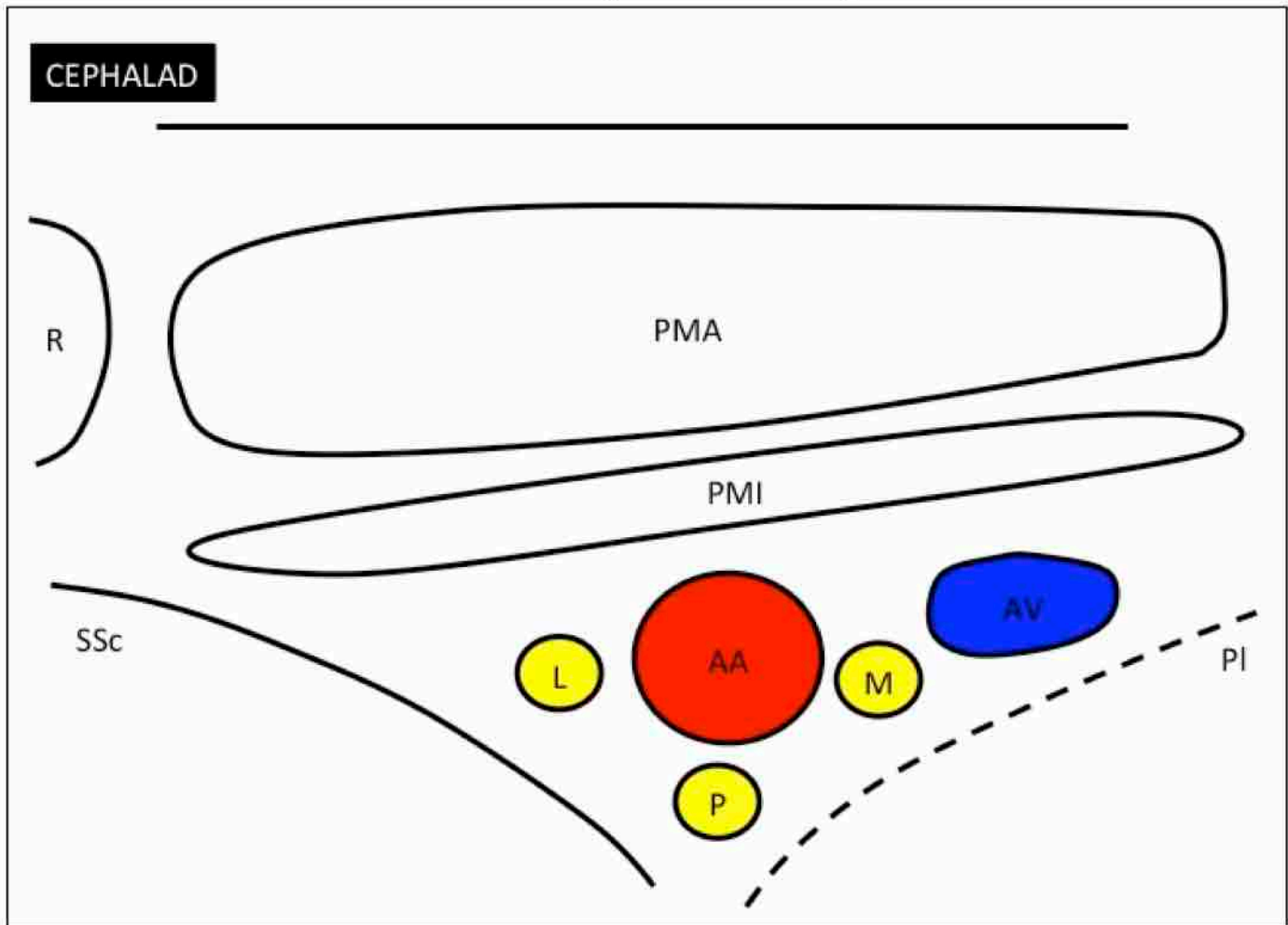
Refer to online modules 3 – 4, hands-on module 1



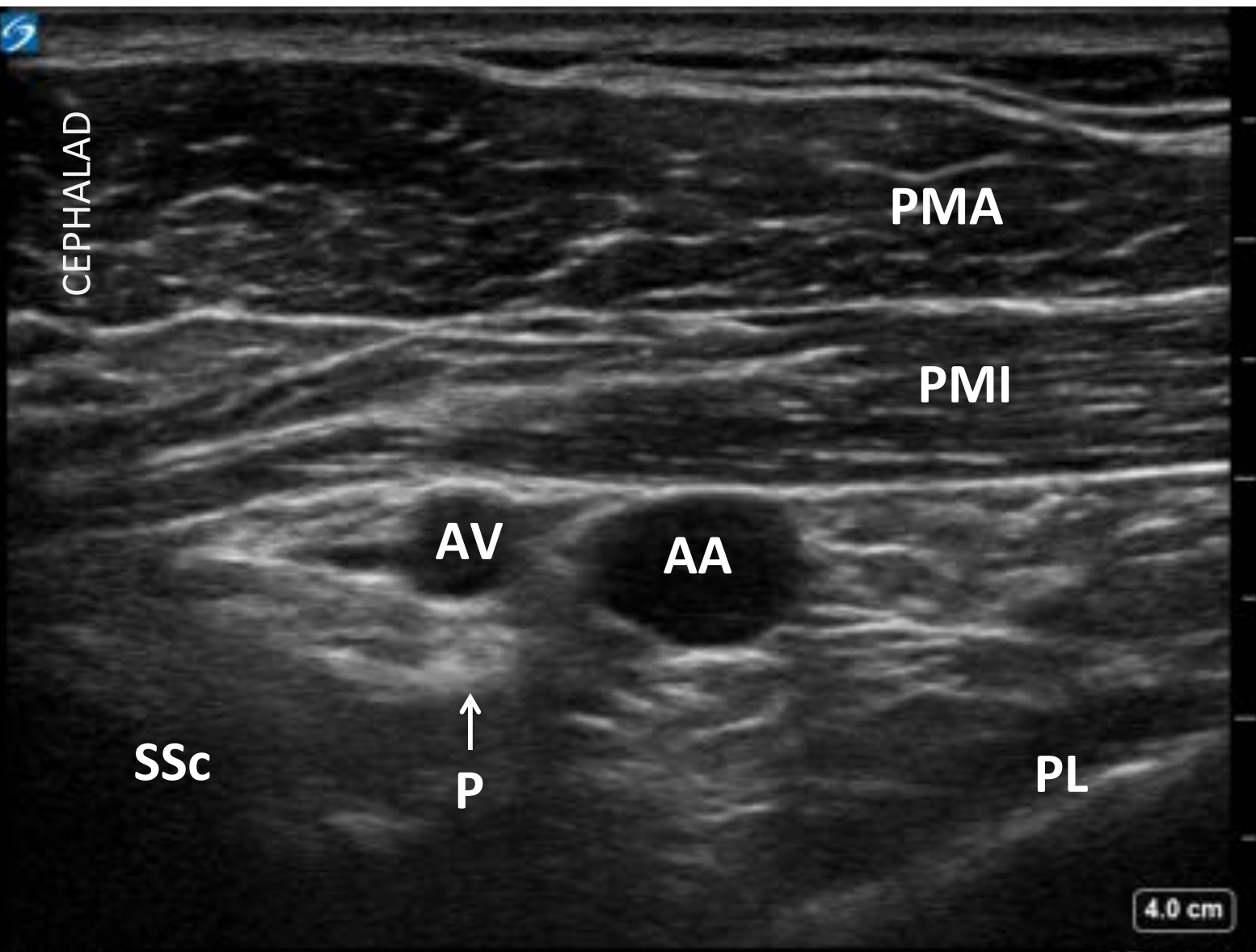
Strategies on improving needle visualization and/or spread of local Injectate during supraclavicular blockade and other techniques are illustrated. A. **Separate the needle from the transducer** to facilitate a more shallow needle trajectory. B. **Rocking transducer** in its long axis. C. **Use step-down approach**, so that the initial trajectory is superficial, and once the needle is in-plane, then progressively increase the angle more steeply towards the target. D. **Use fascial planes** to direct spread of local anaesthetic. E. **Hydro-dissect** with the injectate to assist in identifying the targets and needle tip.

3. INFRACLAVICULAR

Toolbox: online modules 11; RAP lecture 3; hands-on module 6



Key structures: Pectoralis major and minor (PMA, PMI), axillary artery (AA) and vein (AV). The lateral (L), posterior (P) and medial (M) brachial plexus cords. Subscapularis (SSc) or pleura (PI) may be seen depending on transducer position.



Key structures: Pectoralis (PMA) major and minor (PMI), axillary artery (AA) and vein (AV). The lateral, posterior (P) and medial brachial plexus cords may be imaged. Posterior cord is most important target. Subscapularis (SSc) muscle or pleura (PL) may be seen depending on transducer position.

KEY STRUCTURES

- PECTORALIS MAJOR
- PECTORALIS MINOR
- AXILLARY ARTERY
- AXILLARY VEIN
- SUBCLAVIAN ARTERY
- BRACHIAL PLEXUS (CORDS)
- SUBSCAPULARIS

INDICATIONS

- MAJOR ELBOW SURGERY
- MAJOR SURGERY DISTAL TO ELBOW
- USEFUL LOCATION TO PLACE CATHETER

CONTRAINDICATIONS

- Contralateral pneumonectomy

SUGGESTED LOCAL ANAESTHETIC DOSAGES

Same as for supraclavicular block

TRANSDUCER

- High or intermediate frequency linear transducer. Transducer width may be important, some practitioners prefer smaller footprint 25 – 38 mm, consider use of small footprint curvilinear probe.

NEEDLE 100 mm

TIPS

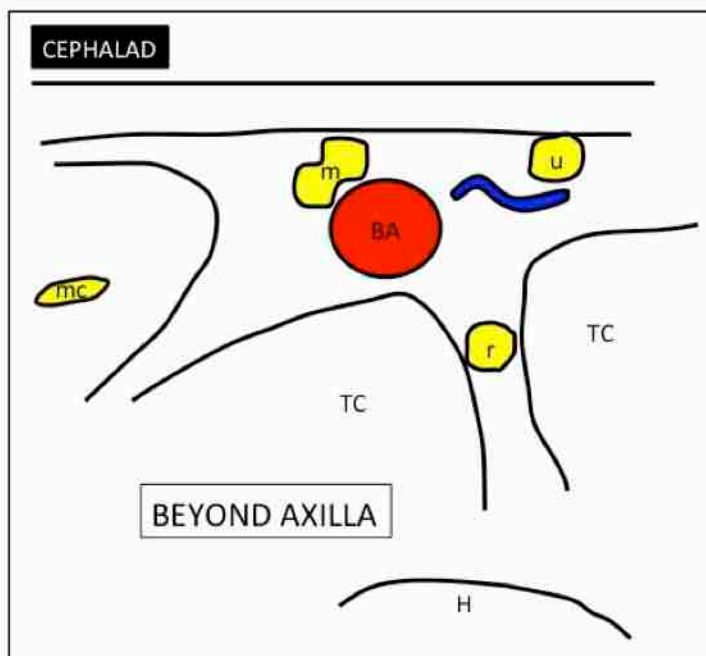
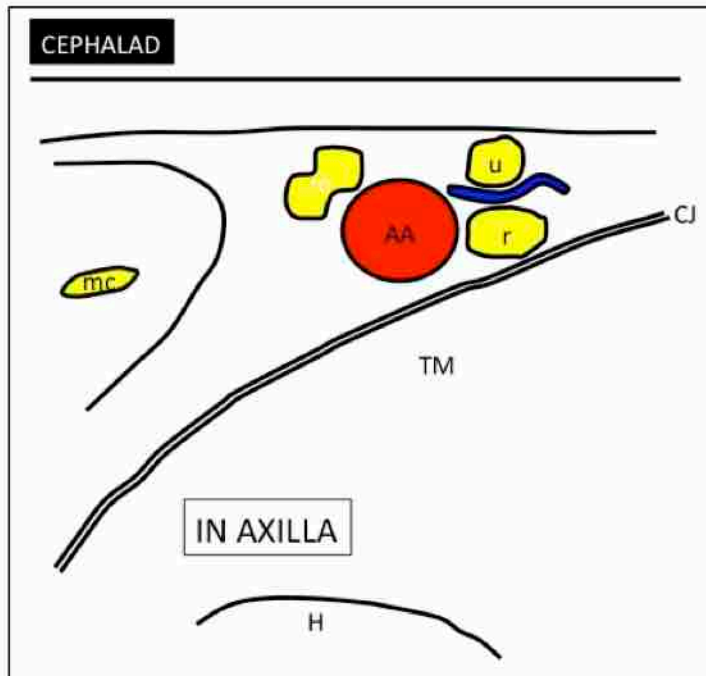
- Abducting the upper extremity results in the clavicle moving cephalad, creating more space for the needle between the cephalad margin of the transducer and the clavicle



Photo credit: Dr Rowan Thomas

4. AXILLARY

Toolbox: online modules 16; RAP lecture 3; hands-on module 6



Note significant change in sonographic appearance when the transducer is moved from within the axilla to just distal to the axilla. The conjoined tendon (CT) and teres major (TM) can only be seen when the transducer is within the axilla. The radial nerve (R) has a close relationship with this conjoined tendon but more distally may be seen between the heads of the triceps (TC). Distal to the axilla, the median nerve (M) maintains a close relationship to the brachial artery (BA), whilst the ulnar nerve (U) stays close to the superficial fascia of the arm. One or more veins are often close to the ulnar nerve. The musculocutaneous nerve (MC) is often seen within the coracobrachialis muscle.

KEY STRUCTURES TO IMAGE

- AXILLARY VESSELS
- BICEPS/CORACOBRACHIALIS, TRICEPS
- CONJOINED TENDON OF THE LATISSIMUS DORSI AND TERES MAJOR
- HUMERUS
- TERMINAL BRANCHES OF BRACHIAL PLEXUS

INDICATIONS

- Major forearm surgery (e.g. ORIF radius and ulnar), ulnar shortening, wrist arthrodesis/arthroscopy
- Carpal ORIF, carpectomy, metacarpal ORIF, proximal phalanx ORIF
- Fasciectomy hand, Dupuytren's contracture, A-V fistula, amputations, major tendon/nerve repair

Local anaesthetic infiltration (rather than plexus blockade) is routinely used for minimally invasive and/or distal procedures of the hand/fingers (e.g. Carpal tunnel release, trigger finger release)

SUGGESTED LOCAL ANAESTHETIC DOSAGES

- 20-30 mL 0.75% ropivacaine (surgical anaesthesia and analgesia). Consider 3-5 mL lignocaine selectively applied to musculocutaneous nerve to allow earlier elbow flexion.
- 2% lignocaine + adrenaline 1:200,000 (surgical anaesthesia only, e.g. renovascular access)
- Consider 0.2 - 0.375% ropivacaine for postoperative analgesia only or 0.2% ropivacaine if early neurological assessment required

TRANSDUCER

- High or intermediate frequency linear transducer.

NEEDLE 50 – 100 mm

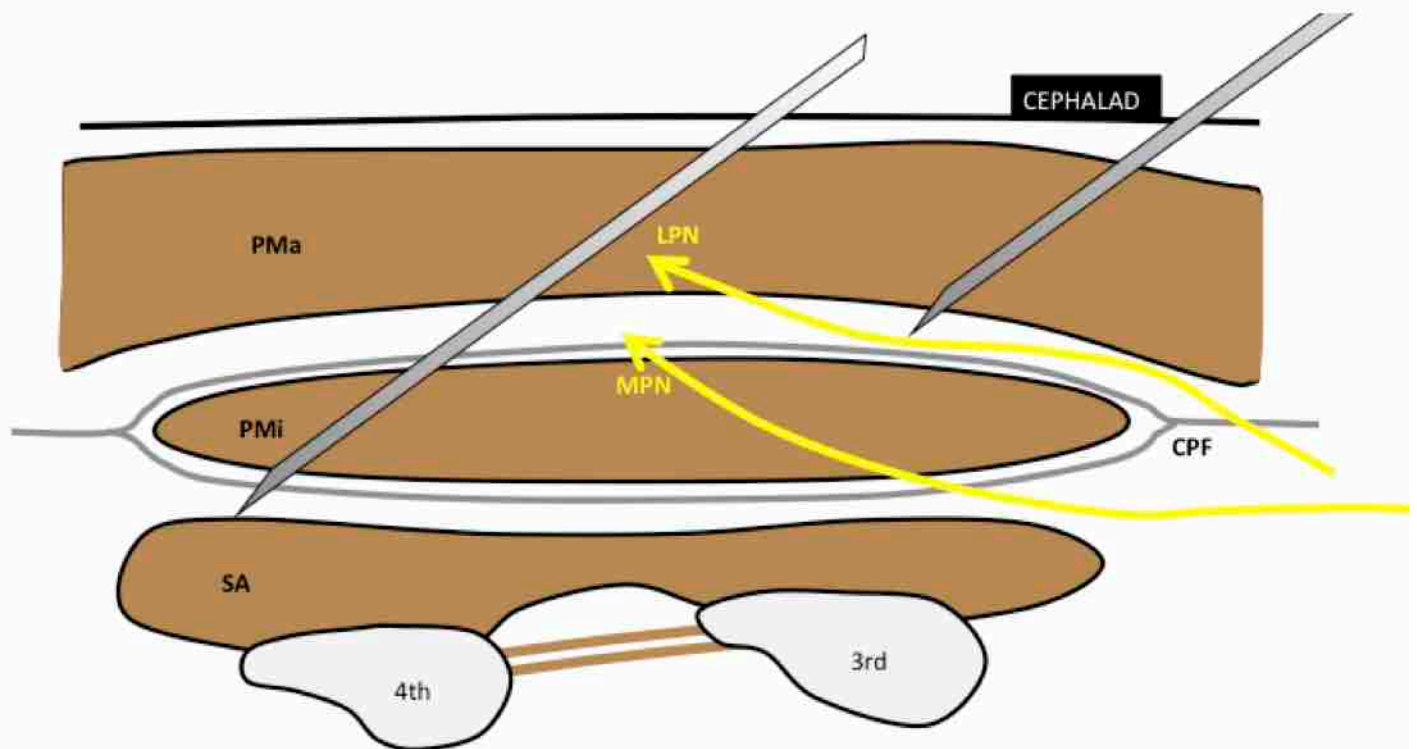
TIPS

- Trace the nerves to elbow and return
- Consider deep target (radial) first



Photo credit: Dr Rowan Thomas

5. PECTORAL NERVE I AND II



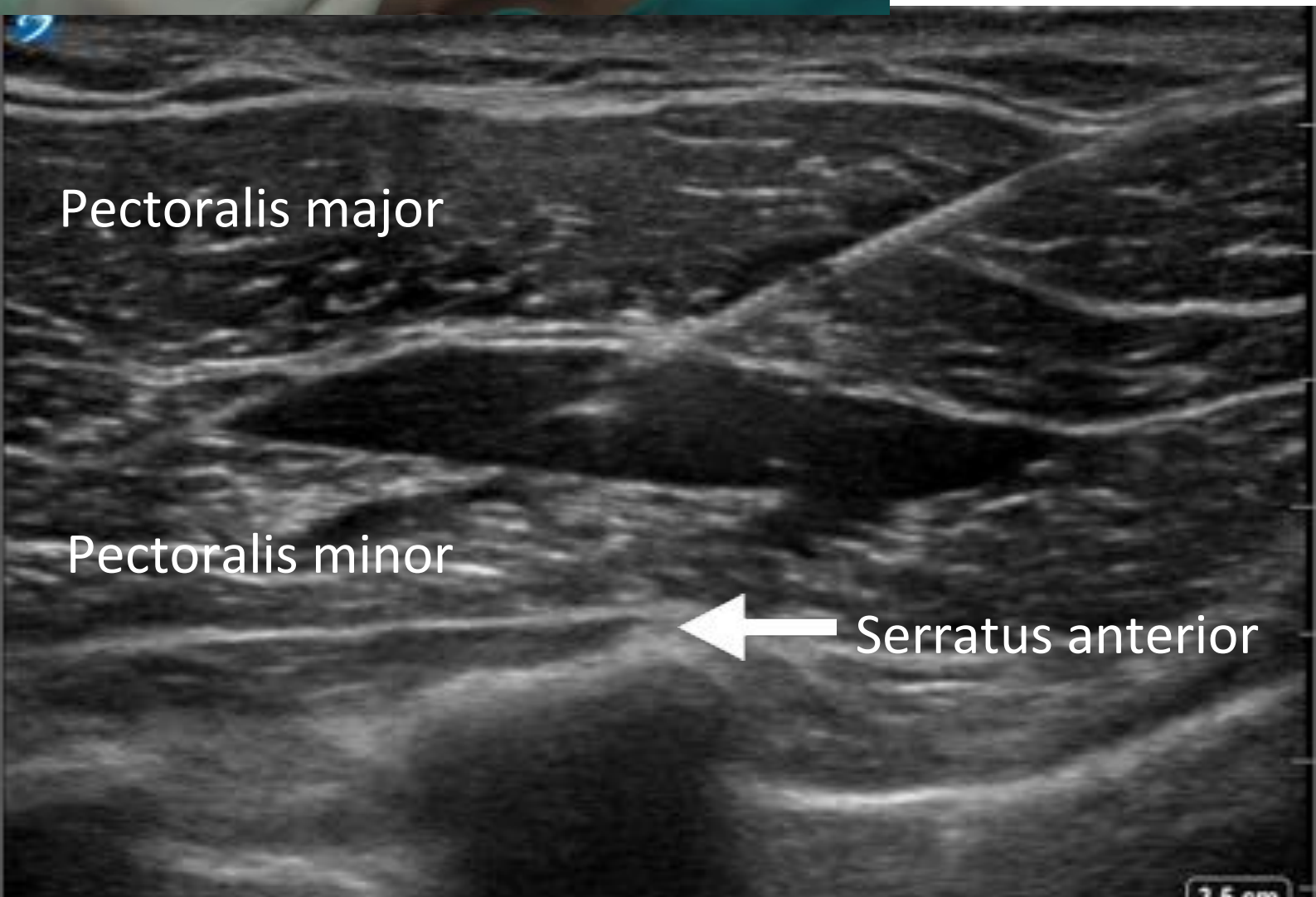
KEY STRUCTURES TO IMAGE

- PECTORALIS MAJOR MUSCLE (PMa)
- PECTORALIS MINOR MUSCLE (PMi)
- 2ND TO 5TH RIBS (3rd and 4th shown in above diagram)
- PLEURA
- SERRATUS ANTERIOR (SA)
- CLAVIPECTORAL FASCIA
- AXILLARY ARTERY AND VEIN
- PECTORAL BRANCH OF THORACOACROMIAL ARTERY

PECs I blockade – lateral and medial pectoral nerves



PECs I: aim to inject over 3rd rib between pectoralis major and minor muscles



Pectoralis major

Pectoralis minor

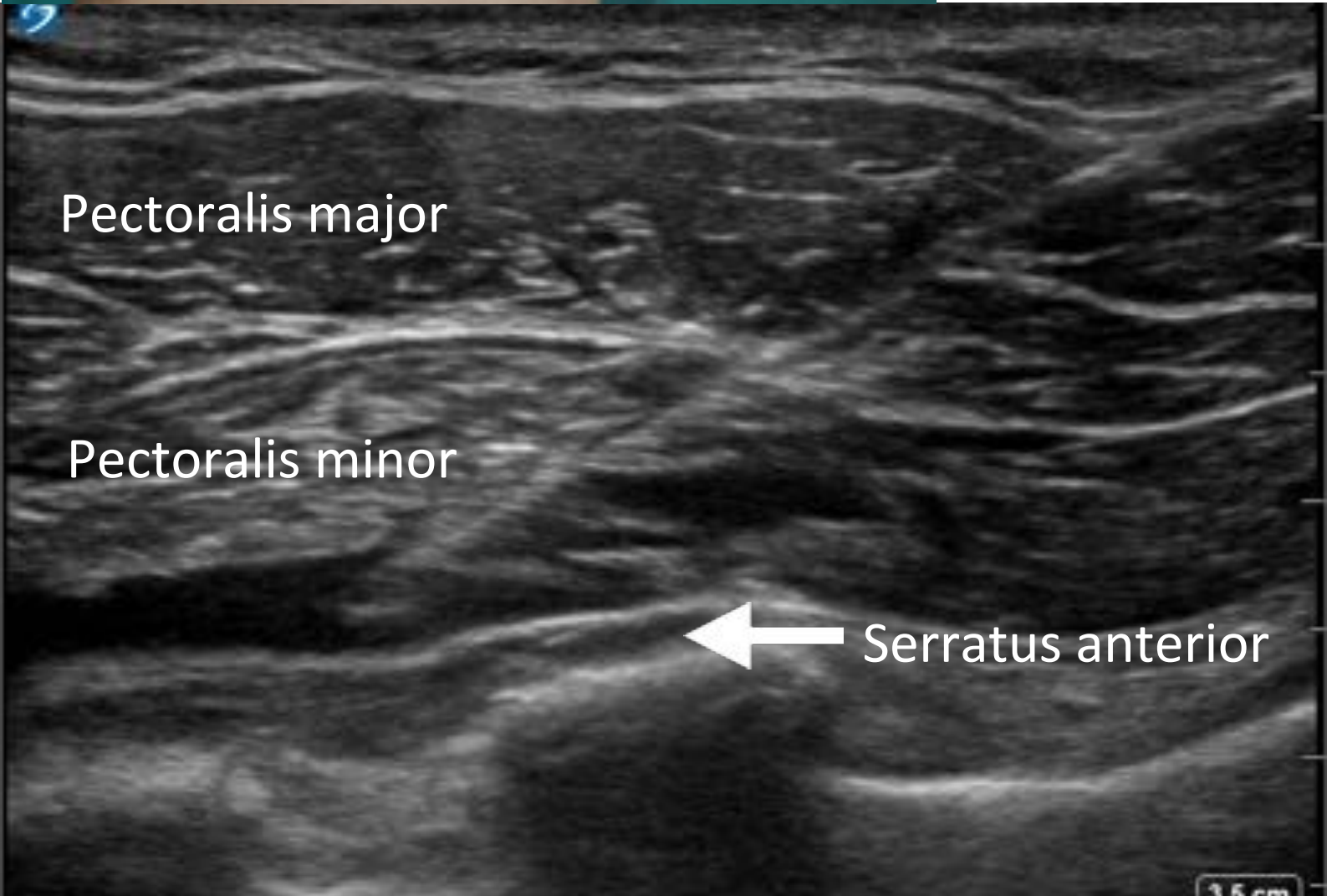
← Serratus anterior

3.5 cm

PECs II blockade – intercostal nerves



PECs II: aim to inject over 4th rib between pectoralis minor and serratus muscles



Pectoralis major

Pectoralis minor

← Serratus anterior

BACKGROUND

The PECTORALIS blocks, PEC's I and II blocks were developed as a simpler alternative to paravertebral blockade for breast surgery. PEC's I block will provide lateral and medial pectoral nerve blockade, blocking afferents to pectoralis major and minor muscles. PEC's II block provides intercostal block providing cutaneous anaesthesia. Generally, PEC's I and II are performed together

INDICATIONS

- BREAST SURGERY

SUGGESTED LOCAL ANAESTHETIC DOSAGES

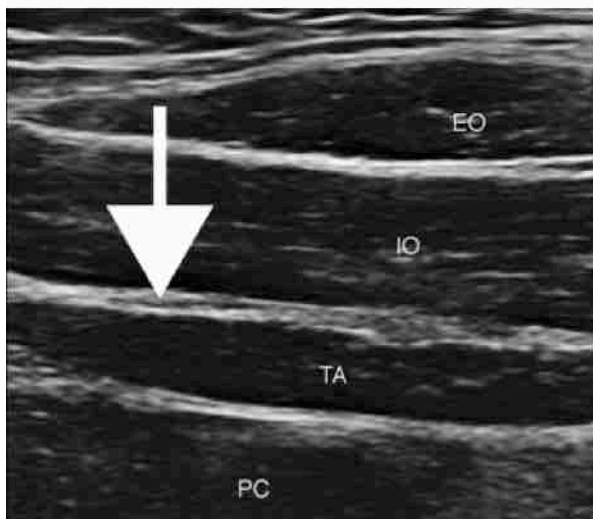
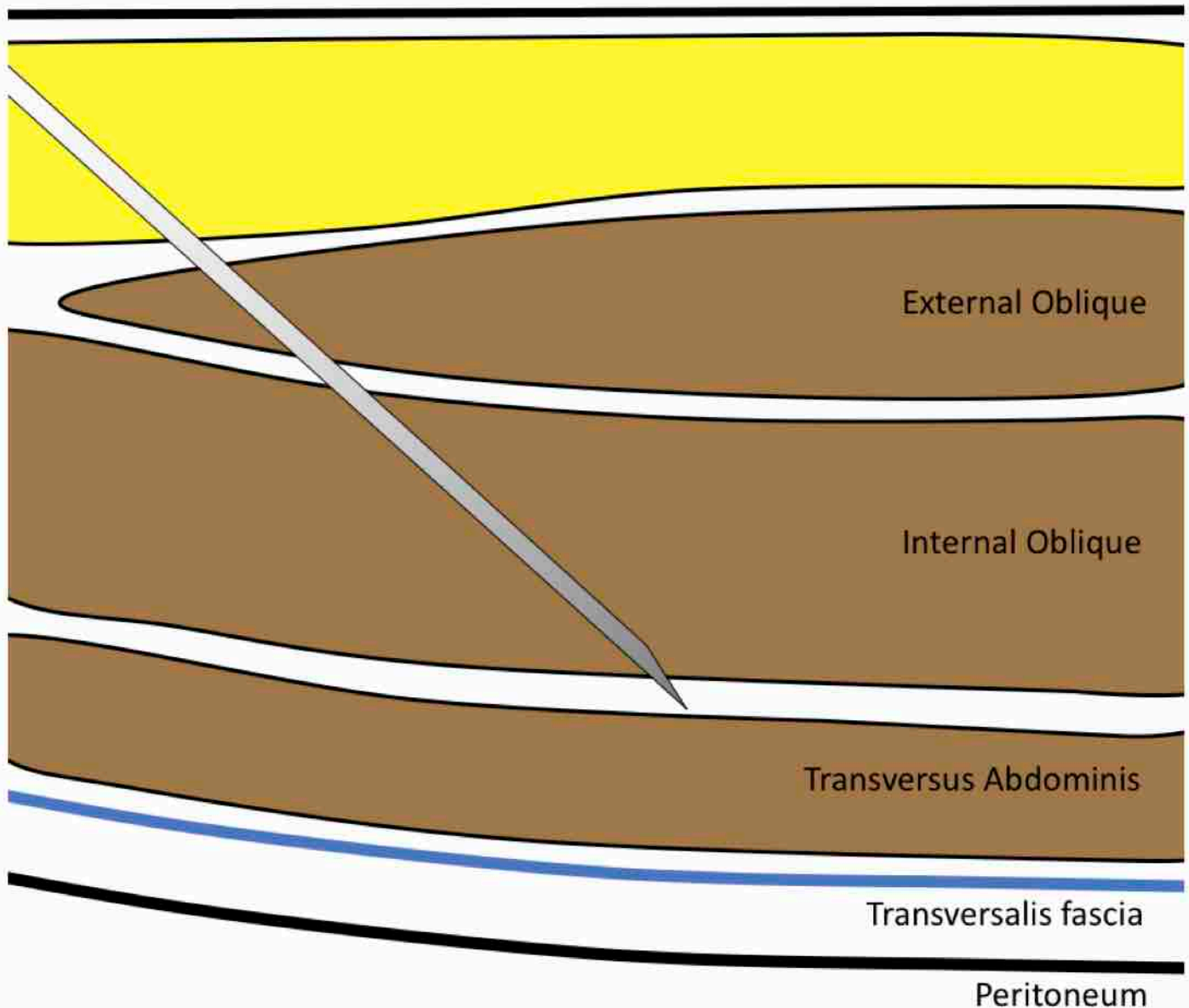
- PECs I block 0.2 mL/kg of 0.375 - 0.45 %ropivacaine
- PECs II block 0.25 mL/kg of 0.375 - 0.45% ropivacaine
- Alternatively 10 and 20 mL of volume at PECs I and II respectively

TRANSDUCER

- High or intermediate frequency linear transducer. Curvilinear transducer in some individuals.

NEEDLE 50 – 100 mm

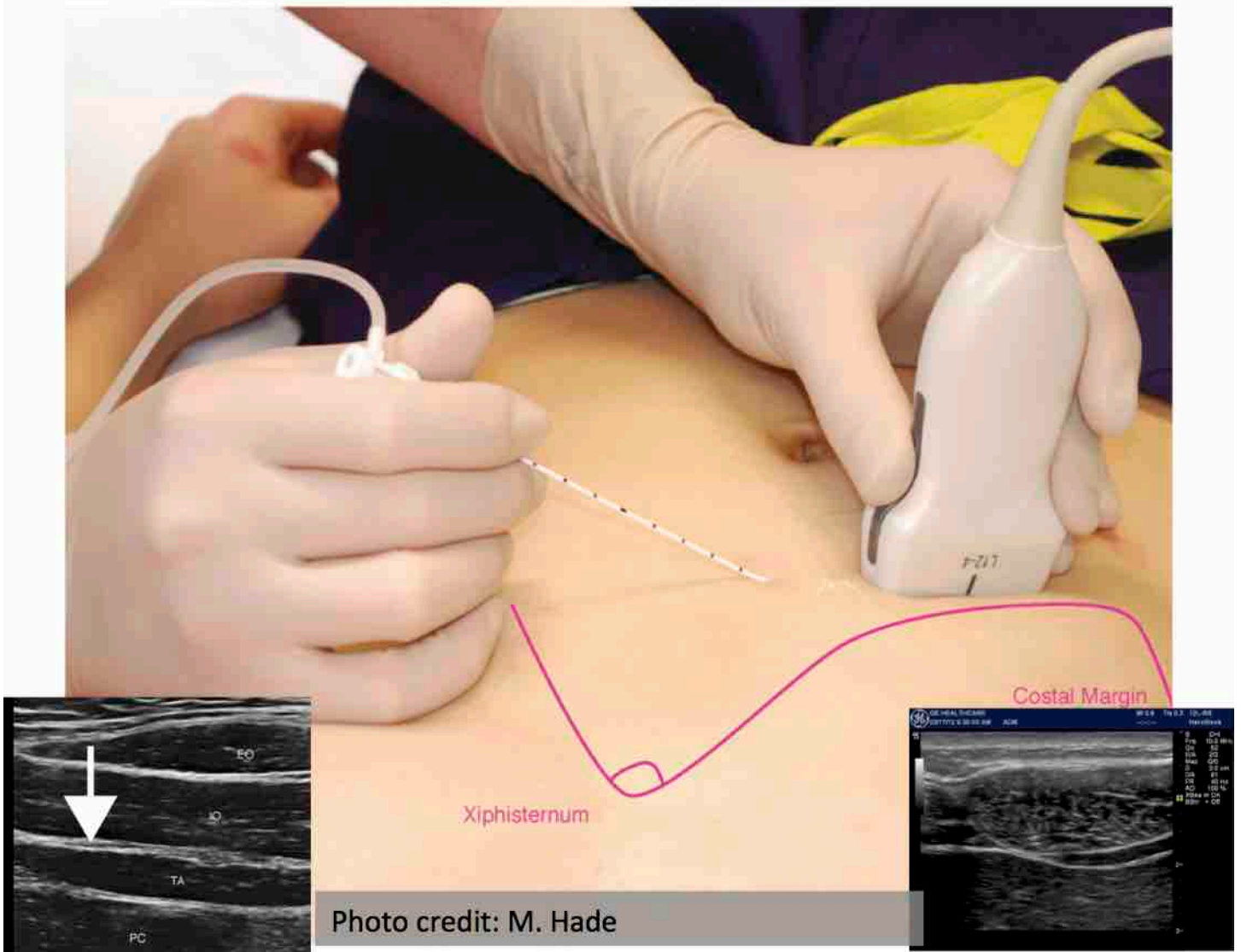
6. ANTERIOR ABDOMINAL WALL BLOCKS



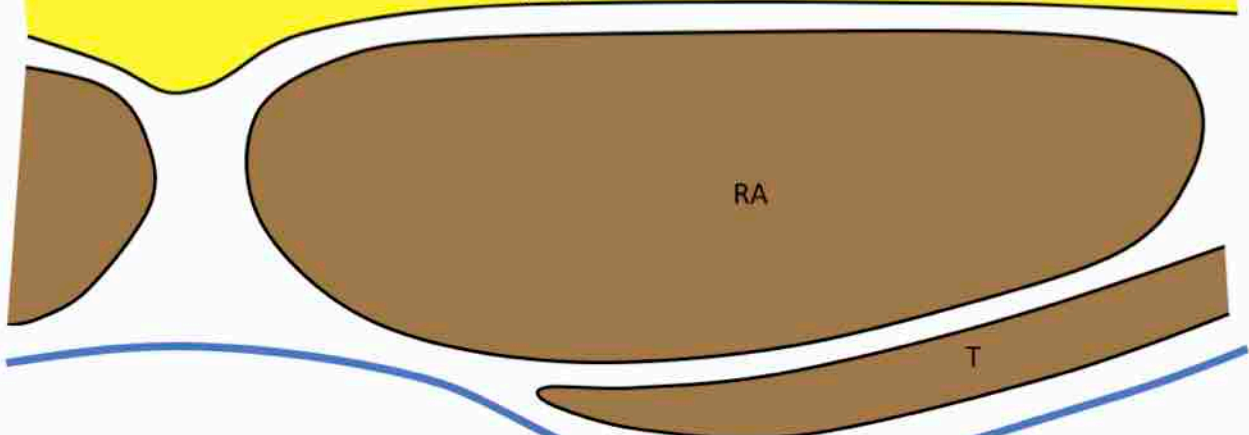
KEY MUSCLES TO IMAGE

- RECTUS ABDOMINUS
- EXTERNAL OBLIQUE (EO)
- INTERNAL OBLIQUE (IO)
- TRANSVERSUS ABDOMINIS (TA)
- LINEA SEMILUNARIS

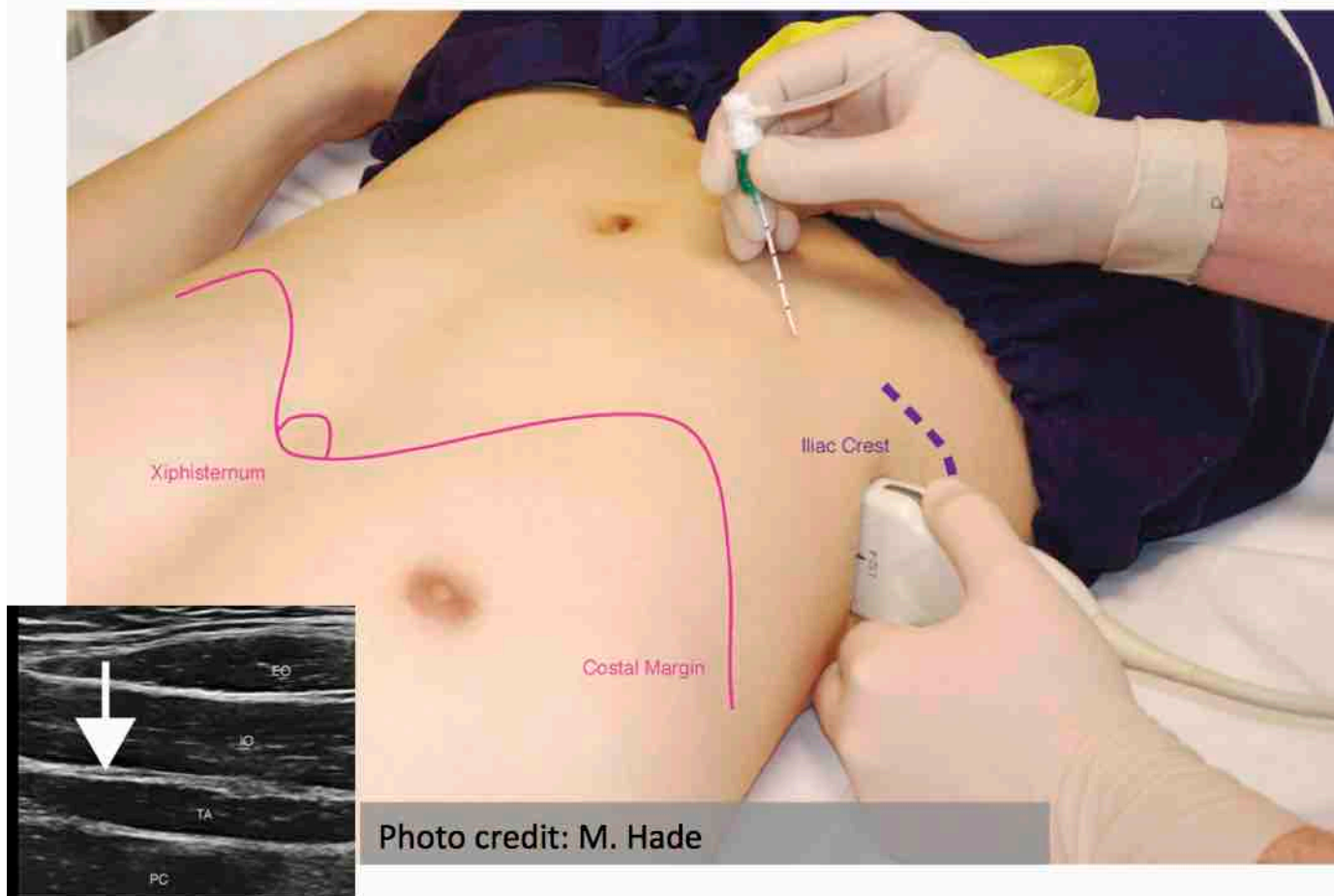
SUBCOSTAL TRANSVERSUS ABDOMINIS PLANE BLOCKS

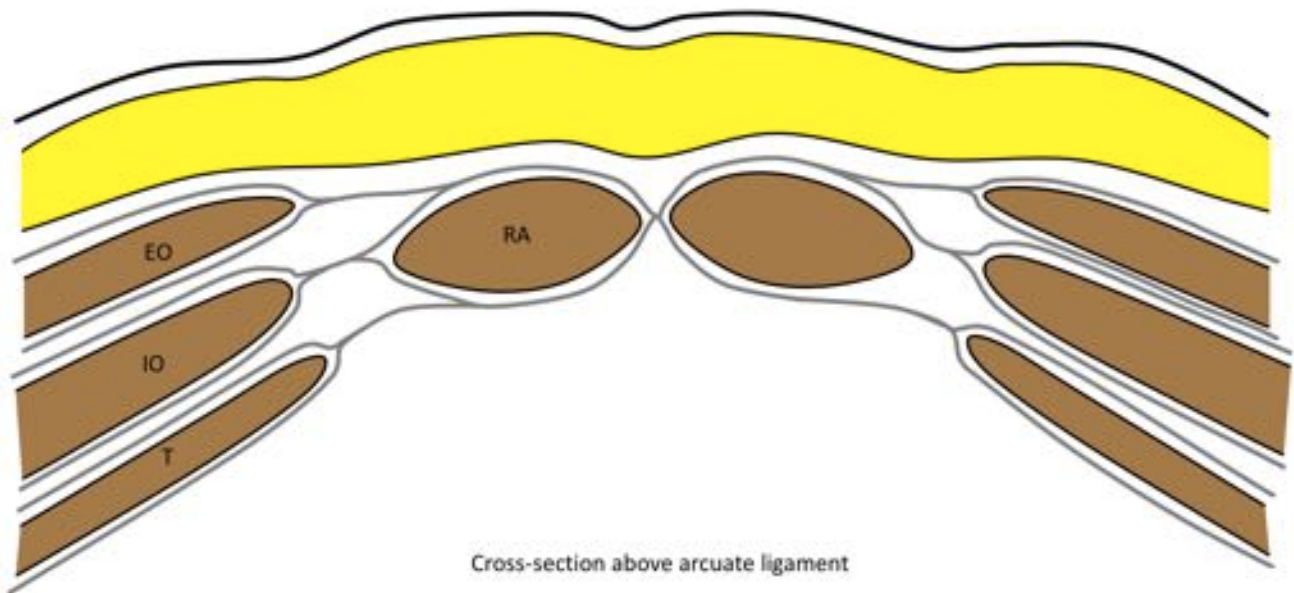


Structures imaged if scanning close to sternum; RA, rectus abdominis; T, transversus abdominis



LATERAL TRANSVERSUS ABDOMINIS PLANE BLOCKS





INDICATIONS

- ABDOMINAL SURGERY

SUGGESTED LOCAL ANAESTHETIC DOSAGES

- 20 - 30 mL per side, concentration depends on safe dose

TRANSDUCER

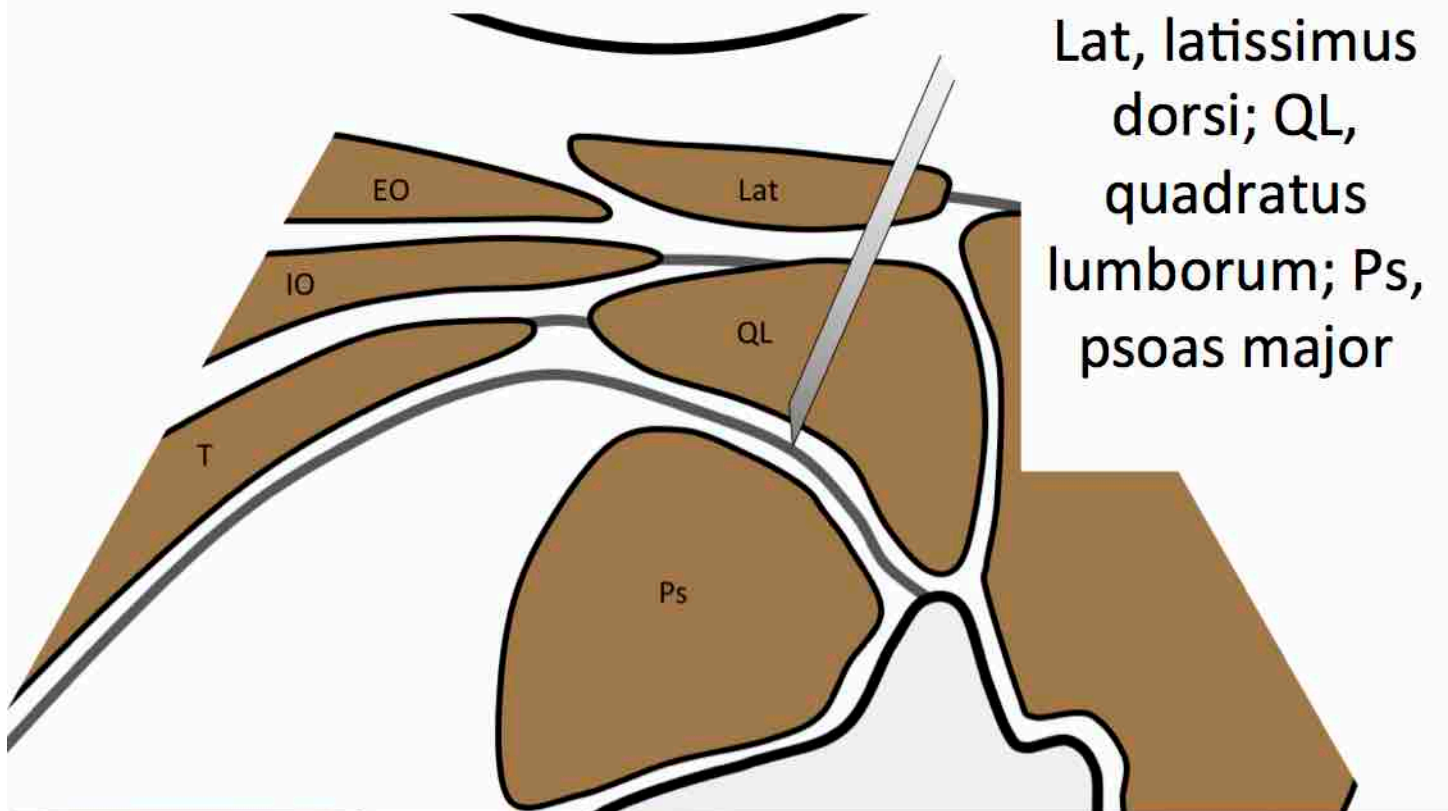
- High or intermediate frequency linear transducer.
Curvilinear transducer in some individuals

NEEDLE 100 – 150 mm

TIPS

- If block performed at completion of surgery, surgical dressings may interfere with needle trajectory

6. POSTERIOR ABDOMINAL WALL BLOCKS: QUADRATUS LUMBORUM BLOCKADE



Lat, latissimus dorsi; QL, quadratus lumborum; Ps, psoas major

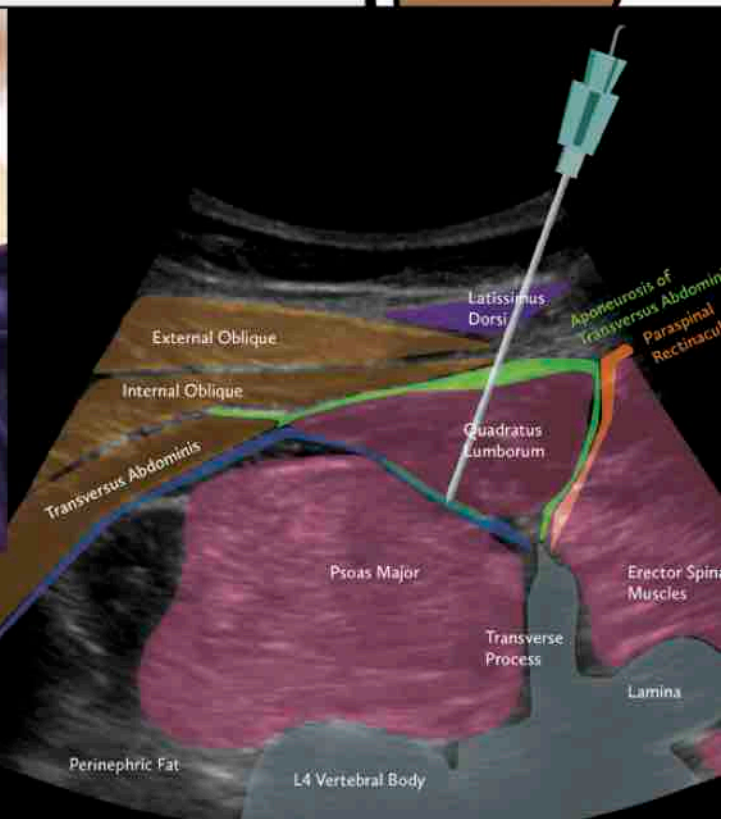
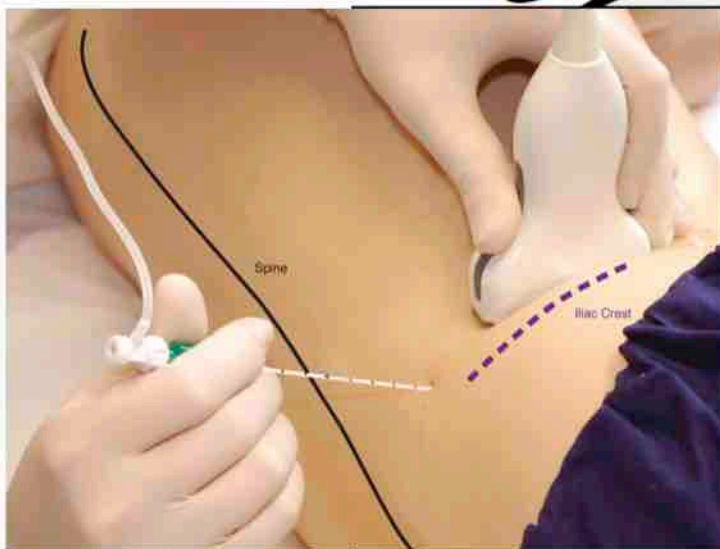


Photo credit: M. Hade

KEY STRUCTURES TO IMAGE

- LUMBAR (3 -4) TRANSVERSE PROCESSES
- LUMBAR VERTEBRAL BODY
- PSOAS MAJOR
- QUADRATUS LUMBORUM
- APONEUROSIS OF TRANSVERSUS ABDOMINUS

BACKGROUND

There has been increasing interest in injecting into the TAP plane more posteriorly. QL block is an extension of that practice. It is hypothesized that injecting posteriorly results in more extensive spread of local anaesthetic. There is a pathway through the arcuate ligament that results in spread from the QL plane into the paravertebral space. This is an emerging area of clinical research.

INDICATIONS

- ABDOMINAL SURGERY, RESCUE BLOCKS, NEPHRECTOMY, LAPAROSCOPY, HERNIA REPAIR

SUGGESTED LOCAL ANAESTHETIC DOSAGES

- 30 mL volume, concentration depends on safe dose

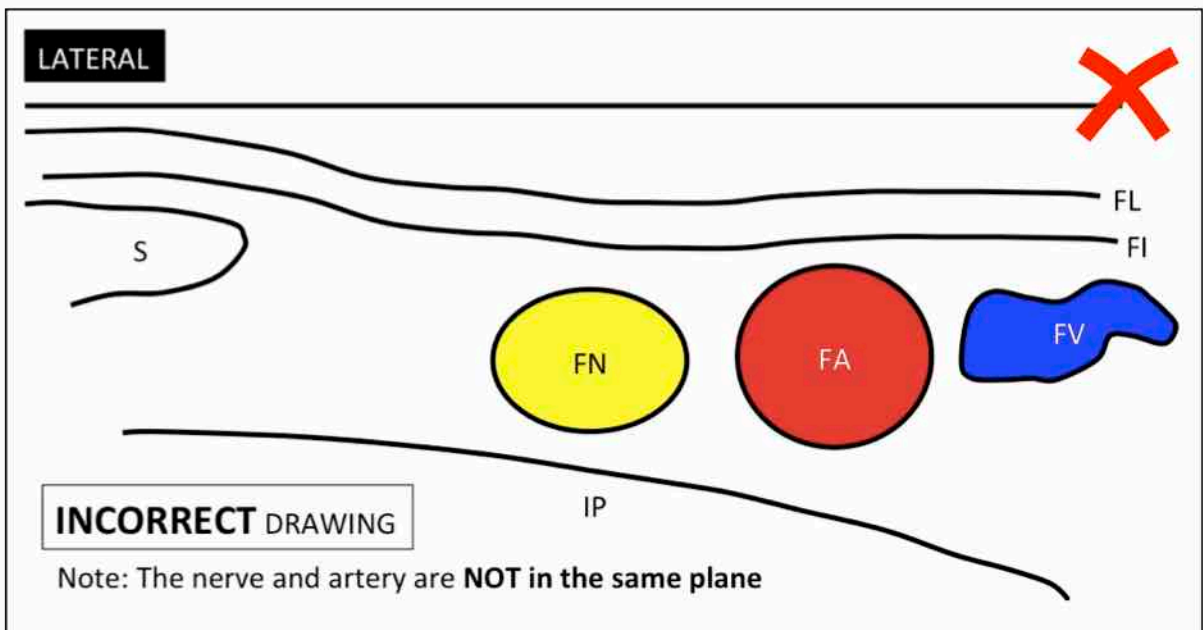
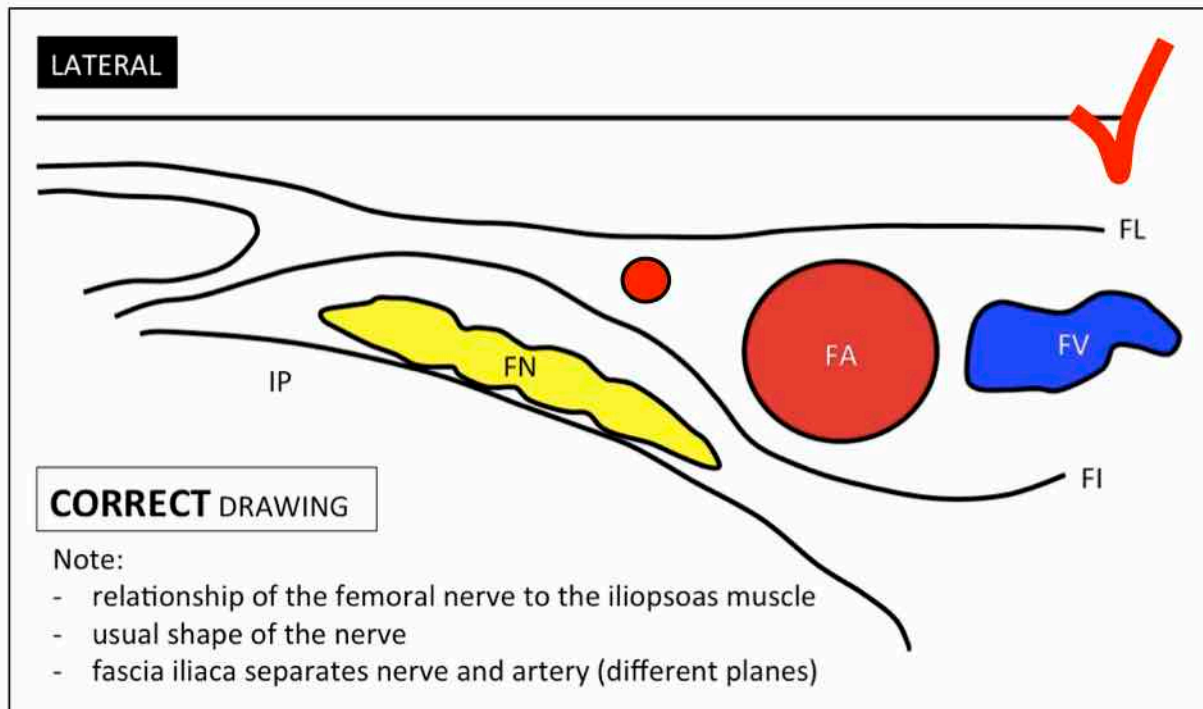
TRANSDUCER

- Intermediate frequency linear but more likely curvilinear transducer

NEEDLE 100 – 150 mm

7. FEMORAL

Toolbox: online modules 6; RAP lecture 4; hands-on module 2

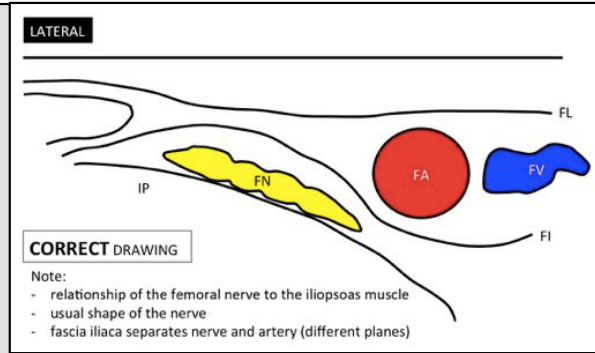


The fascia iliaca (FI) separates the femoral artery (FA) from the femoral nerve (FN). Note the close relationship between the femoral nerve and the iliopsoas (IP). Also seen are the femoral vein (FV) and sartorius (S) and fascia lata (FL).

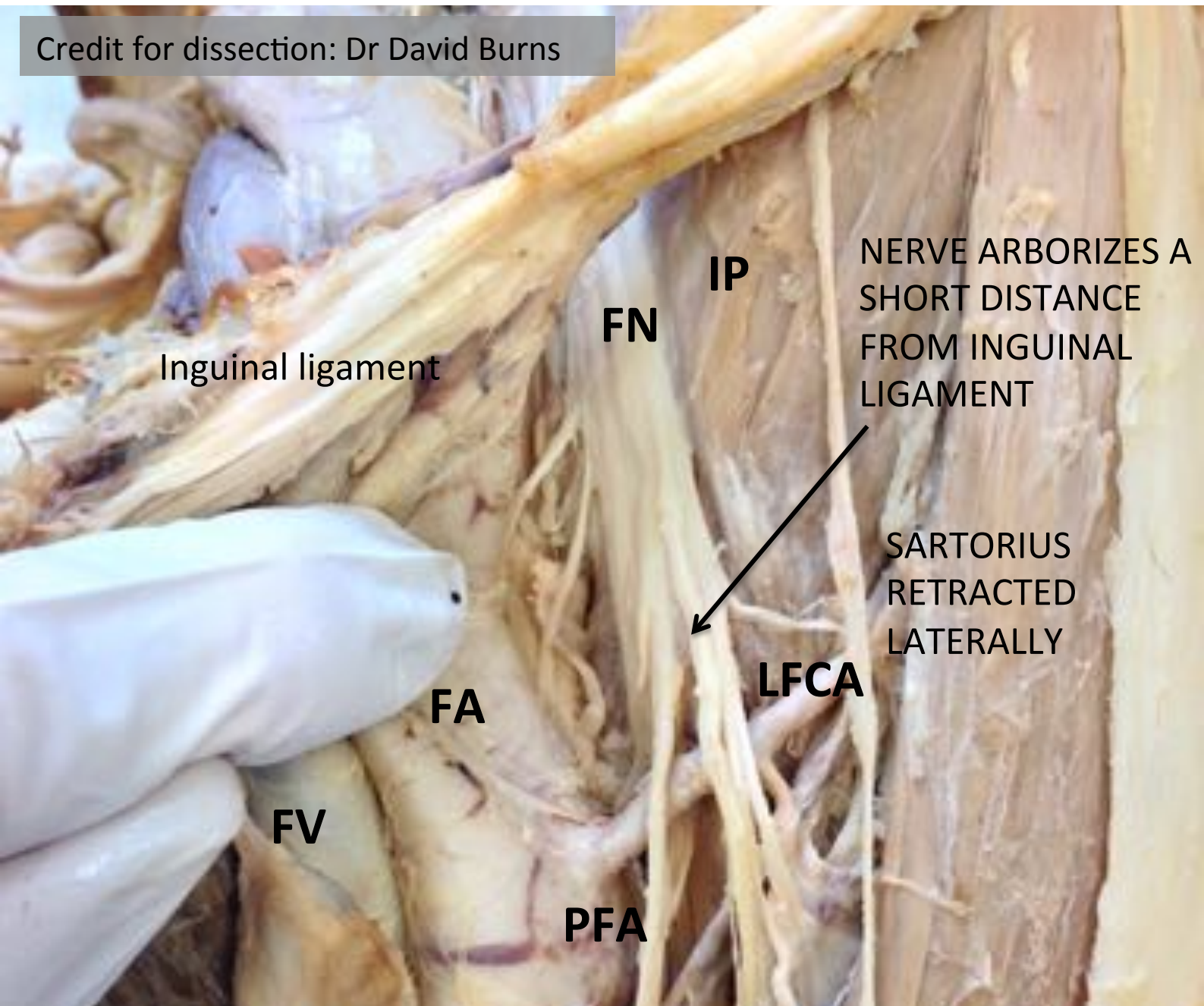
KEY STRUCTURES TO IMAGE

- ILIOPSOAS MUSCLE (IP)
- FASCIA ILIACA
- FASCIA LATA
- LATERAL CIRCUMFLEX FEMORAL ARTERY (LCFA)
- FEMORAL ARTERY (FA)/VEIN (FV)
- FEMORAL NERVE (FN)

TIP: IF PROFUNDA FEMORIS ARTERY (PFA) IMAGED THEN MOVE TRANSDUCER PROXIMAL TILL THERE IS ONE ARTERY



Credit for dissection: Dr David Burns



INDICATIONS

- Total knee arthroplasty
- Medial compartment arthroplasty
- ORIF femur (as high as neck of femur)
- Continuous passive movement following manipulation under anaesthesia
- Other moderate to highly invasive procedures of knee, anterior thigh, femur

Suggestion: Adductor canal block is appropriate for ACL repair and total knee arthroplasty

CONTRAINDICATIONS

- Avoid using concentrated long-acting local anaesthetic if early ambulation or discharge is planned

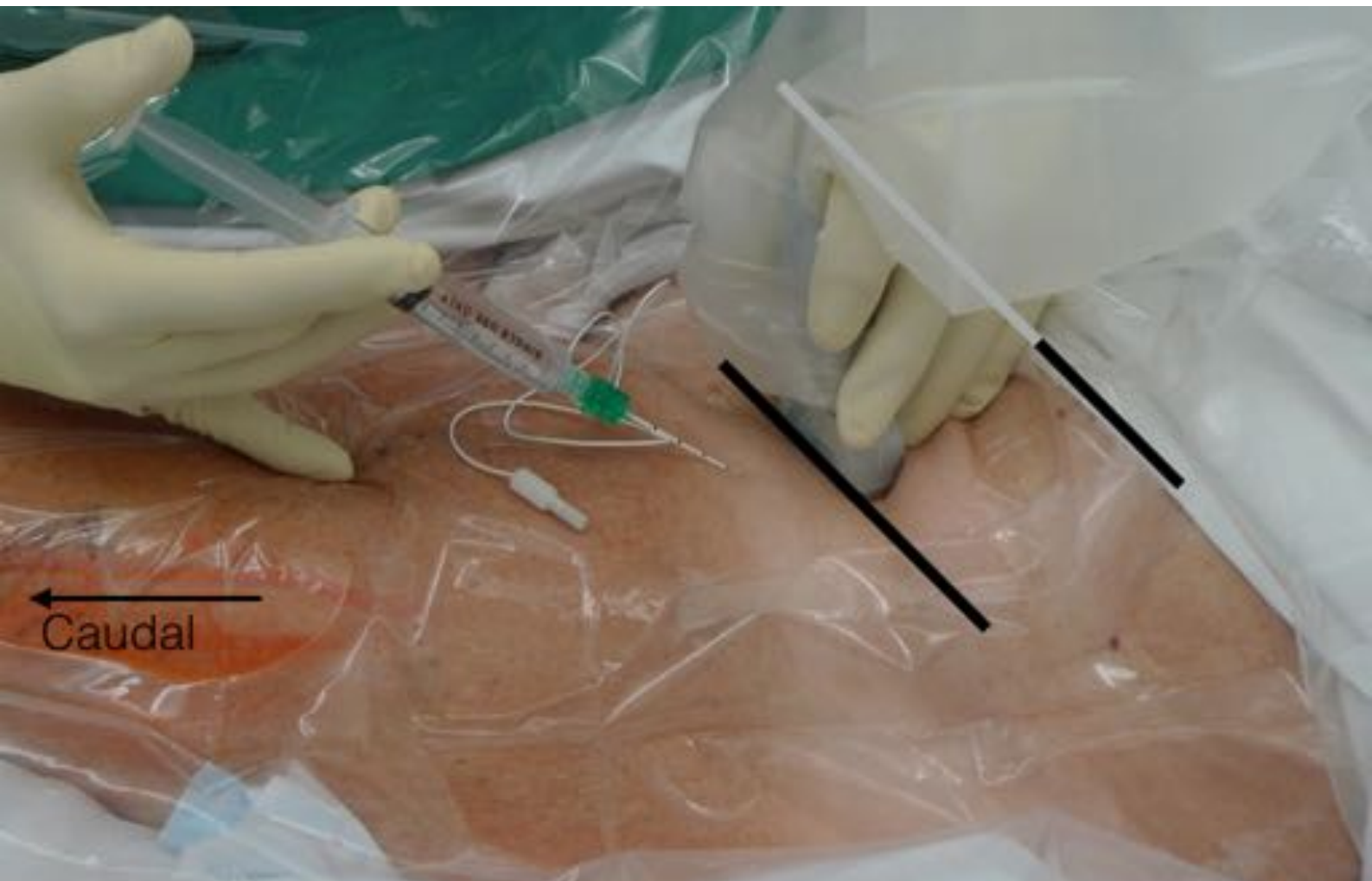
SUGGESTED LOCAL ANAESTHETIC DOSAGES

- Femoral block is commonly used for postoperative analgesia:
- 10-20 mL 0.2 % ropivacaine (*refer to departmental total knee joint replacement guidelines*); followed by continuous infusion.

TRANSDUCER

- Intermediate frequency linear transducer is suitable in most circumstances.

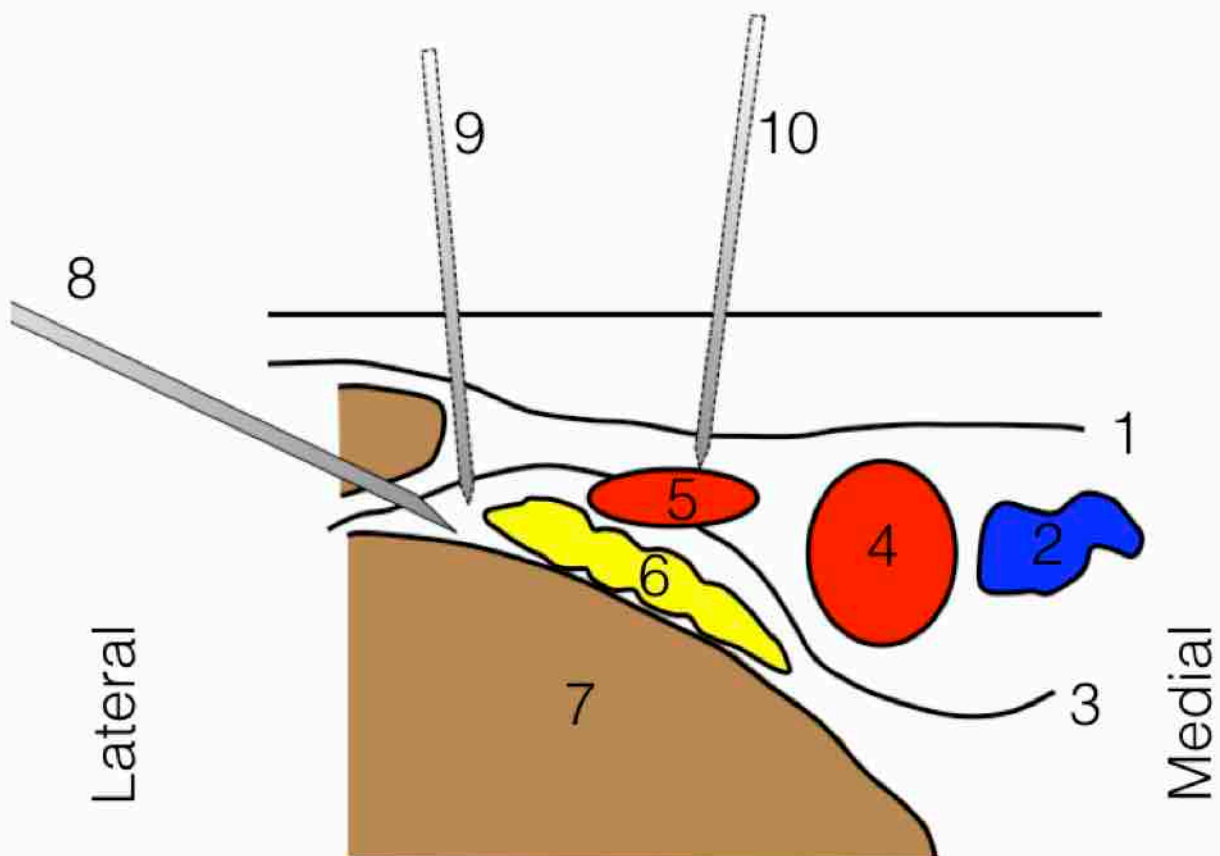
NEEDLE 50 – 100 mm (depends on approach and trajectory)



Black line = Femoral skin crease; black-grey line = inguinal ligament

Examples of trajectories and relative risk of vascular injury.

1. Fascia lata; 2. Femoral vein; 3. Fascia iliaca; 4. Femoral artery; 5. Circumflex artery (femoral); 6. Femoral nerve; 7. Iliopsoas muscle; 8. Lateral to medial in-plane approach; 9. Out-of-plane approach; 10. Out-of-plane approach too medial.

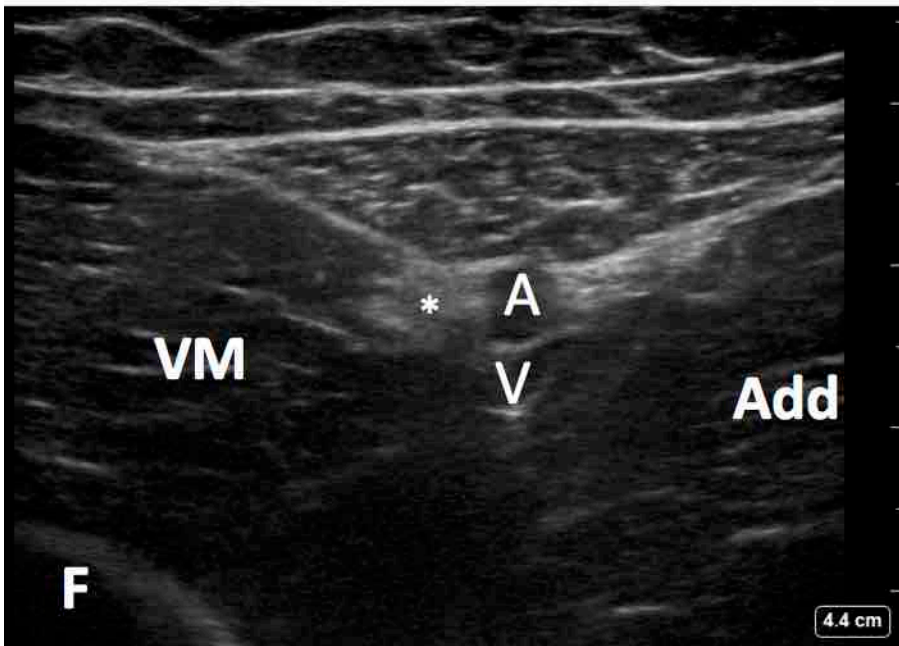
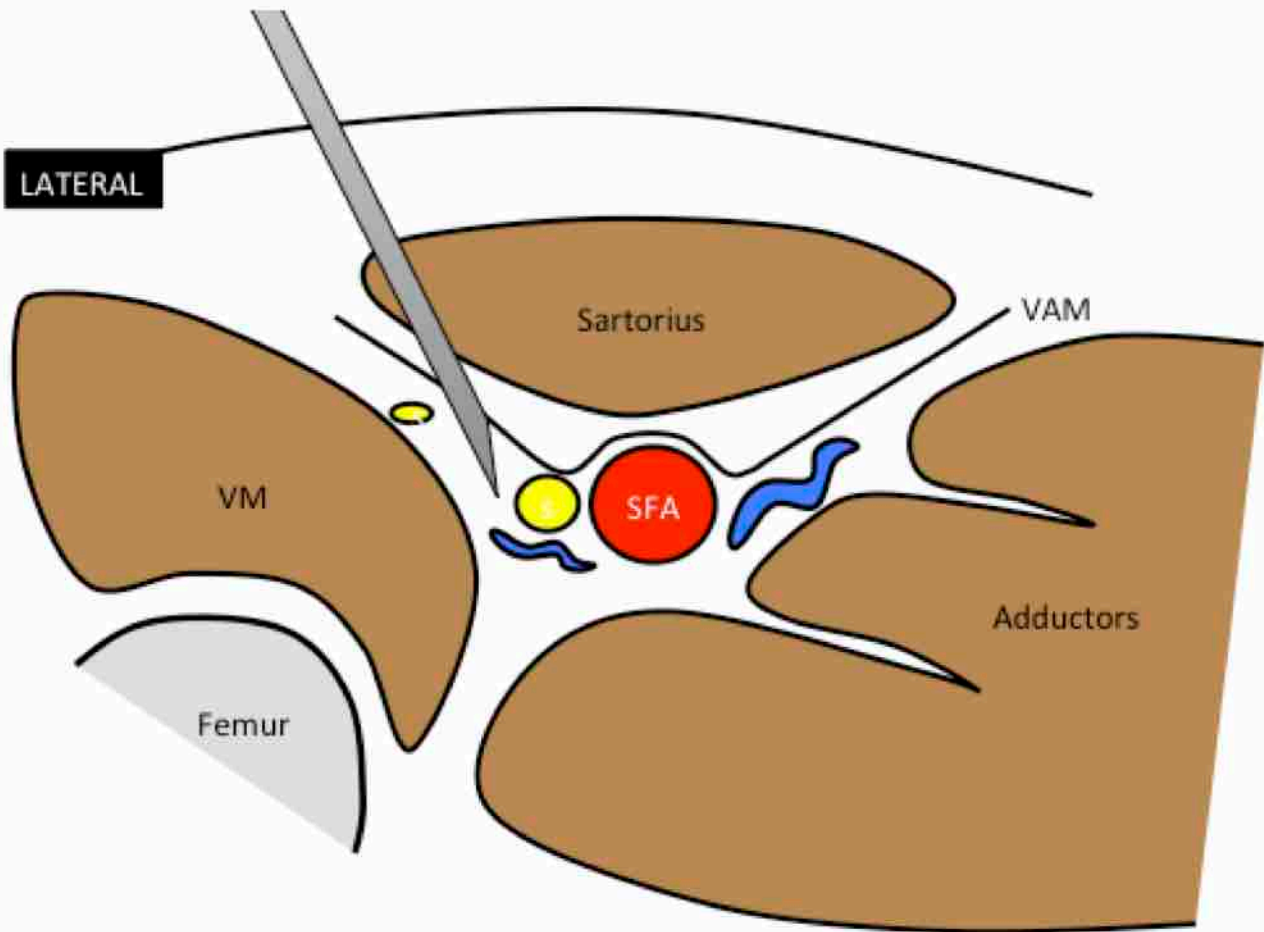


TIPS

- In the prescan use colour Doppler to identify the circumflex vessels
- Identify lateral border of the nerve, deep to fascial ilaca and aim lateral to this border (regardless of in-plane or out-of-plane technique)

8. ADDUCTOR CANAL BLOCK

Toolbox: online modules 6; RAP lecture 4; hands-on module 2



Sartorius (S), vastus medius (VM), femur (F), adductor muscles (Add) and superficial femoral artery (A) and vein (V), region of saphenous nerve *, its position changes proximal to distal.

Sonogram obtained approximately midway along thigh, either in adductor canal or distal femoral triangle



Photo credit: Dr Rowan Thomas

KEY STRUCTURES TO IMAGE

- SARTORIUS
- SUPERFICIAL FEMORAL VESSELS
- VASTUS MEDIUS
- SAPHENOUS NERVE

INDICATIONS

- Major foot surgery *foot/ ankle surgery to cover medial foot to 1st metatarsal*
- Total knee arthroplasty
- Tibial surgery

CONTRAINDICATIONS

SUGGESTED LOCAL ANAESTHETIC DOSAGES

- 15-30 mL 0.375-0.5 % ropivacaine (postop analgesia)

TRANSDUCER

intermediate frequency linear or curvilinear transducer

NEEDLE 100 mm

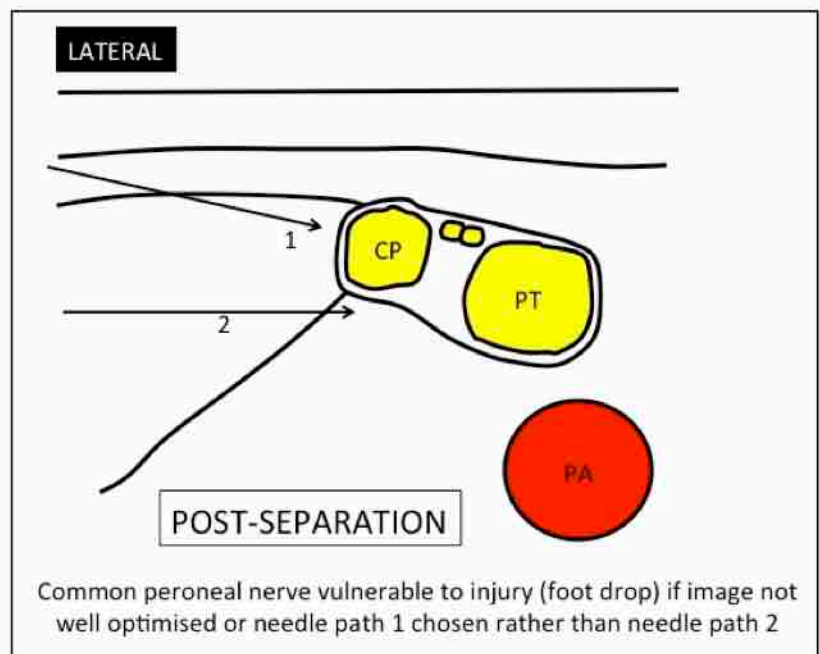
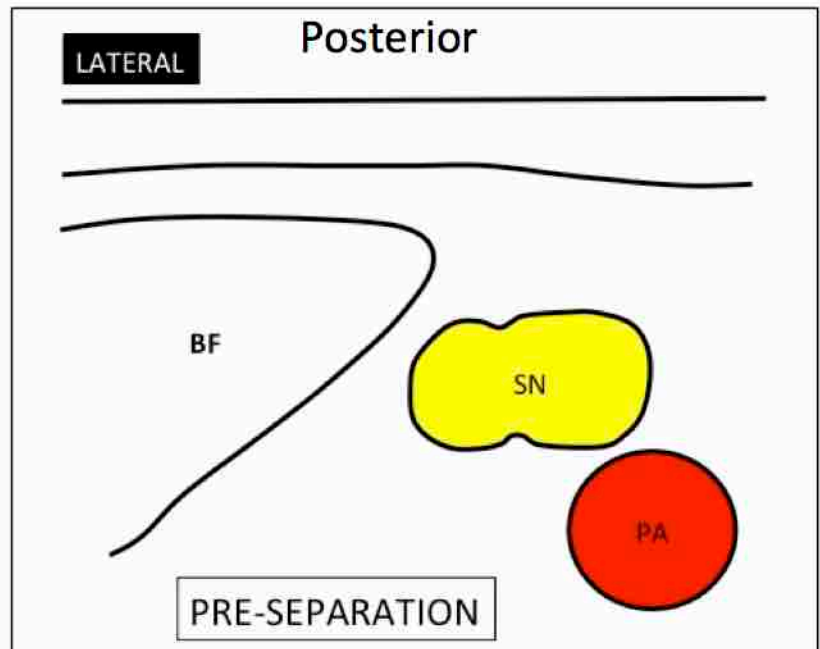
TIPS

- Spread of local anaesthetic may highlight the saphenous nerve, which until then may be difficult to delineate

9. POPLITEAL SCIATIC

Toolbox: online modules 7; RAP lecture 4; hands-on module 2

An important reason for identifying separation of the sciatic nerve (SN) into its common peroneal nerve (CPN) and tibial nerve (TN) components is for **protection of the CPN** which may lie in the path of the needle trajectory. Both components lie within a common connective tissue layer. The sciatic nerve lies between the medial side of the biceps femoris (BF) and the popliteal artery (PA). The popliteal vein (not drawn) lies close to the PA.



KEY STRUCTURES TO IMAGE

- BICEPS FEMORIS
- POPLITEAL VESSELS
- COMMON PERONEAL NERVE (CP)
- TIBIAL NERVE

INDICATIONS

- Major foot surgery#
- Total knee arthroplasty
- Tibial surgery*

**Avoid if acute tibial fracture (high risk of compartment syndrome)
or valgus deformity total knee arthroplasty (risk of common peroneal injury)
#Suggest adding saphenous nerve block for
foot/ ankle surgery to cover medial foot to 1st metatarsal*

CONTRAINDICATIONS valgus deformity (if patient for total knee joint replacement, neuropathy)

SUGGESTED LOCAL ANAESTHETIC DOSAGES

- 20-30 mL 0.2-0.5 % ropivacaine (postop analgesia)
- 20-30 mL 0.75% ropivacaine (major ankle surgery, non-weight bearing patients), lignocaine 2% suitable for surgical anaesthesia

TRANSDUCER

intermediate frequency linear or curvilinear transducer

NEEDLE 100 mm

TIPS

Notes: 1. To minimise foot drop, consider injecting majority of volume around the tibial nerve and/or inject ropivacaine 0.2% only, close to the CPN. 2. Obtaining surgical anaesthesia of foot with PNB alone requires significant dose of local anaesthetic, typically use this block for analgesia.



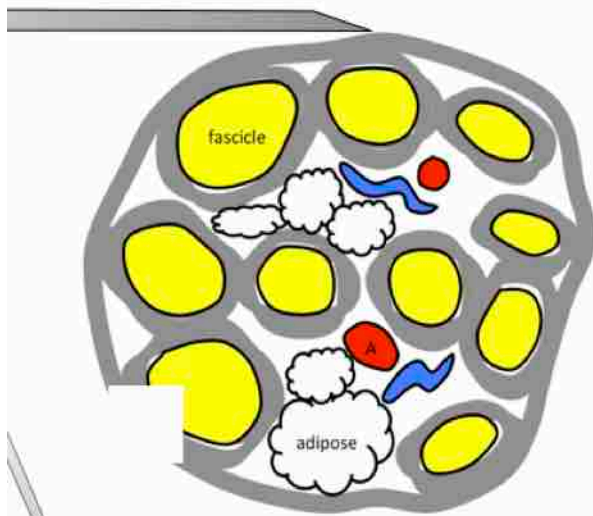
Photo credit: Dr Rowan Thomas

SAFETY

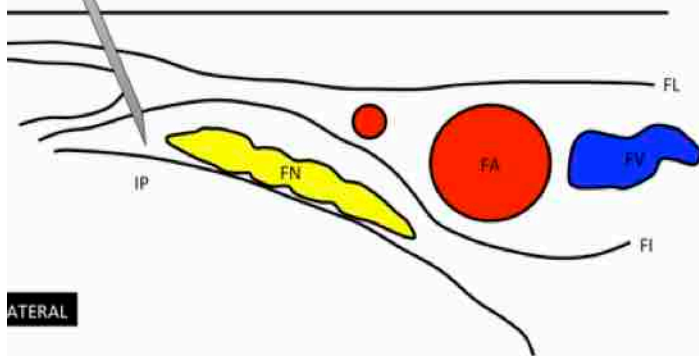
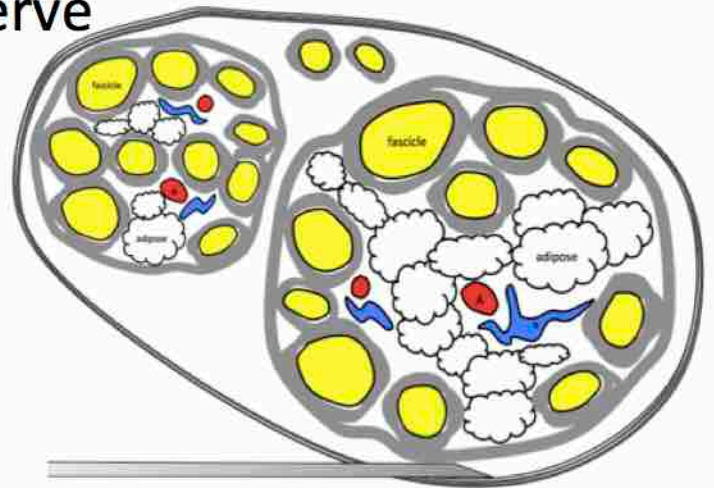
SENSIBLE NEEDLE TRAJECTORIES

Use a non-traumatic trajectory, where practical, have a tangential approach aiming at side of

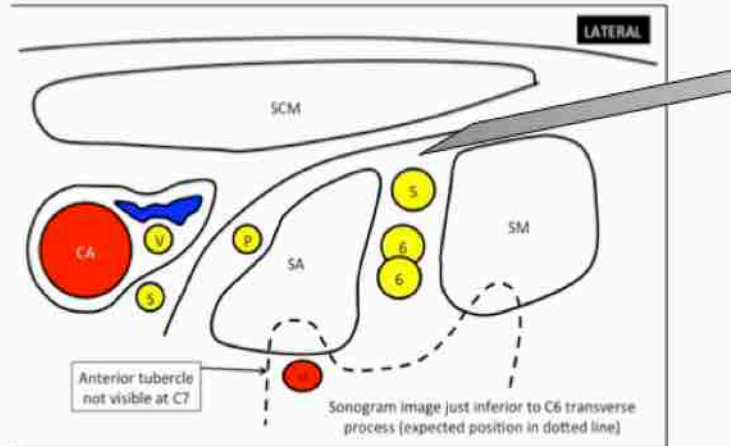
nerve



B



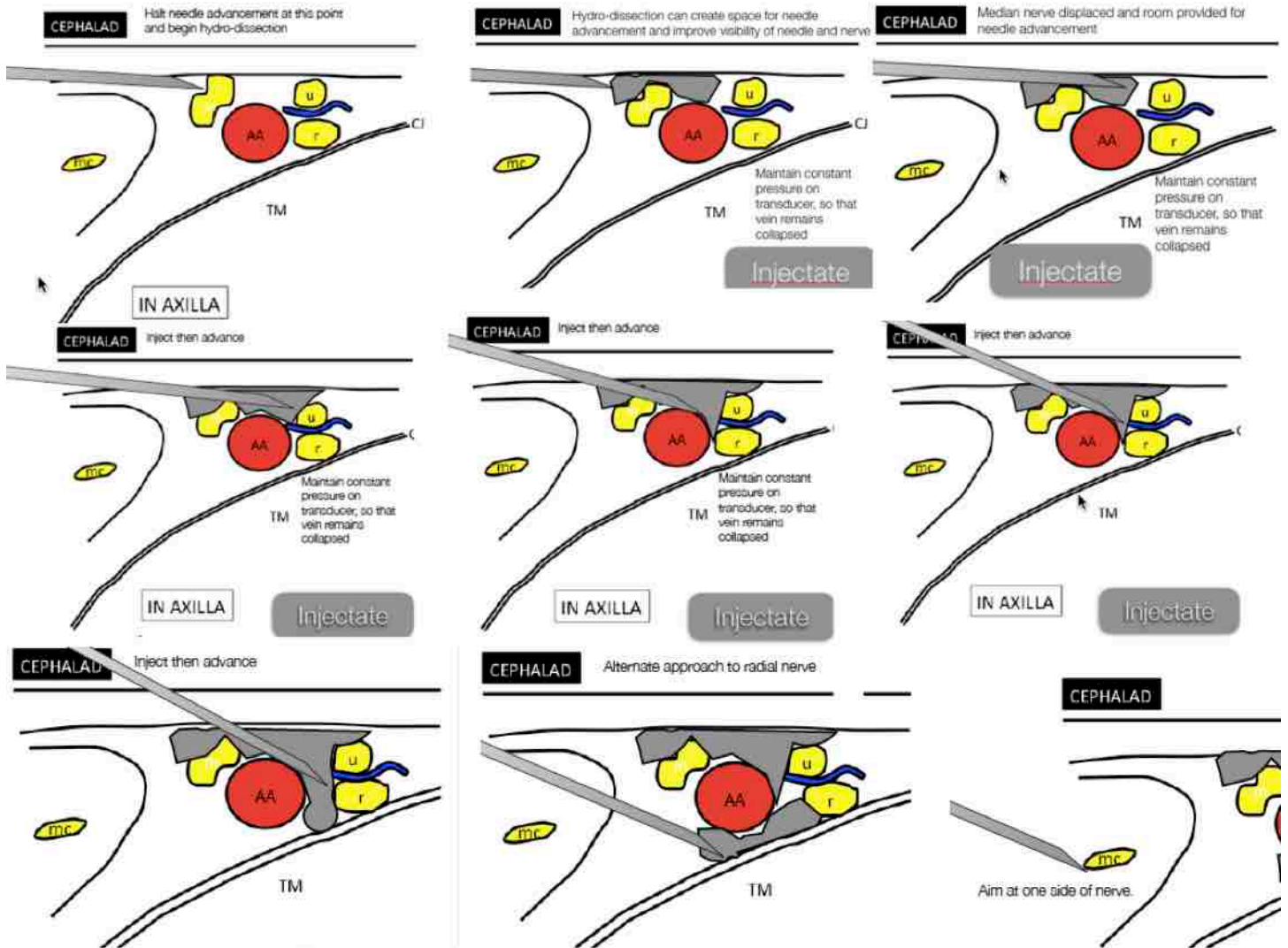
ATERAL



AVOID TRAUMA TO NERVE

HYDRO-DISSECTION

Creates space around and displaces nerves and assists with needle trajectory, highlights outer border (epineurium) of nerve



NOTES ON LOCAL ANAESTHETIC DOSAGES

Consider the purpose of the block:

Ropivacaine 0.2 – 0.5% for **postoperative analgesia**. Ropivacaine 0.5% (approximate) can be made up by mixing equal volumes of ropivacaine 0.75 and ropivacaine 0.2%.

Ropivacaine 0.6 - 0.75 % for **intraoperative anaesthesia and postoperative analgesia**.

3. Some units use ropivacaine 0.5% for intraoperative anaesthesia.

4. Lignocaine 2% + Adrenaline for **intraoperative anaesthesia alone**

Continuous peripheral nerve blockade: infusions rates (ropivacaine 0.2%) commonly used are 4 – 10 mL/h

Avoid producing dense peripheral blocks for no specific purpose

Communicate with your patient the likely duration of sensory/motor blockade

Plan for transition analgesia

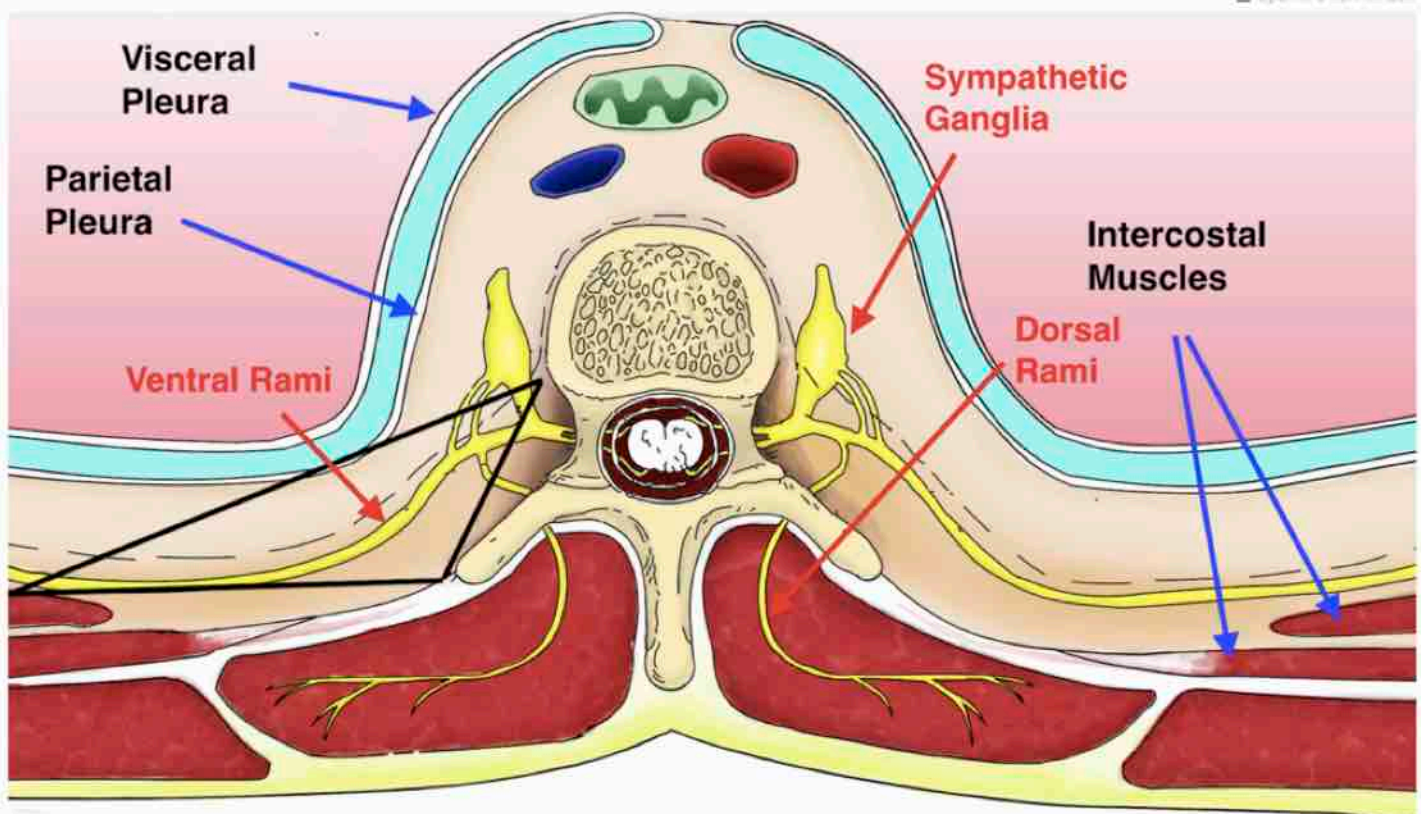
Consider when the patient is likely to weight bear (reduce doses for day cases or early next-day mobilisation)

ADVANCED BLOCK: PARAVERTEBRAL

Mandatory requirements

Toolbox: Online modules 14, Sonoanatomy for Thoracic Paravertebral Block; Hands-on Module 10, Sonoanatomy for Paravertebral Blocks.

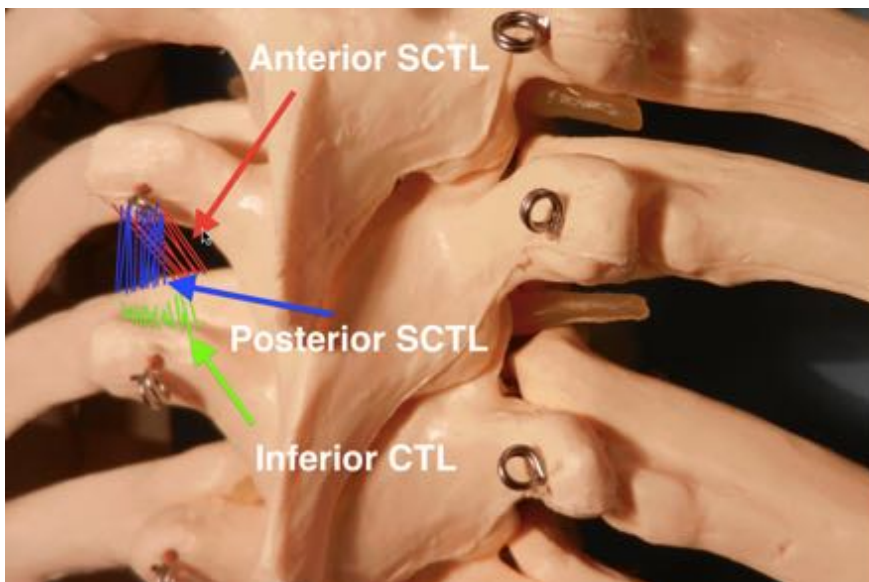
Lecture by Boris Ihnatsenka, MD, located in G:\Surgery\Anaesthetics\Operational\ANAES DEPT – Registrar Tutorial Programs\Regional Anaesthesia



**PARAVERTEBRAL BLOCKADE REQUIRES
ADVANCED SKILLS IN REGIONAL
ANAESTHESIA. PRACTICE IN CAPTURING
RELEVANT SONOGRAMS IS MANDATORY**

KEY STRUCTURES TO IMAGE

- BONES: RIBS, TRANSVERSE PROCESS, LAMINA
- PLEURA
- COSTOTRANSVERSE LIGAMENT



INDICATIONS

- Video-assisted thoracoscopy, thoracotomy, mastectomy, liver resection, unilateral rib fractures

SUGGESTED LOCAL ANAESTHETIC DOSAGES

- 5 - 7 mL per level, concentration depends on safe dose

TRANSDUCER

- Intermediate frequency linear transducer. Curvilinear transducer improves field of view and tissue penetration.

NEEDLE 100 mm

TIPS

- Positioning and ergonomic considerations are critical to the success of paravertebral blockade. Consider workshopping this in advance