Nerve blocks in pediatrics

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Key points

- Regional anaesthesia in children has many welldocumented benefits.
- Advances in ultrasound technology have enabled practitioners to perform regional blocks in children with greater accuracy.
- Central neuraxial blocks have been progressively replaced by peripheral nerve blocks.
- Large retrospective studies and data from a prospective registry suggest that regional anaesthesia is a viable and safe option for postoperative pain relief in children

The benefits of RA in children

- reduced opioid consumption;
- reduced incidence of postoperative nausea and vomiting;
- reduced postoperative pain scores;
- reduced incidence of respiratory complications
- When appropriate, peripheral nerve blocks (PNBs) should be offered as an alternative to neuraxial anaesthesia

Differences Between the Pediatric and Adult

Children do not understand the importance of lying still for a procedure.

- Children are not able to communicate or differentiate paresthesia, pain, or pressure on injection.
- Anatomical structures are smaller and are situated more closely to each other and to the adjacent vessels.
- Target nerves are more superficial to the skin.
- There is a lower concentration of plasma protein binding, especially in young children

- Regional anesthesia is usually performed in children under deep sedation or general anesthesia.

General Equipment

- Sterile skin preparation solution.
- Sponges/gauze.
- Drape.
- Marking pen and ruler for landmark identification.
- Selection of different sizes of syringes.
- A variety of needles with a selection of gauges for skin infiltration, drawing up 5 % dextrose, local anesthetics, sedation, or induction of general anesthetic.

Midazolam (IM/IV: 0.1–0.15 mg/kg up to 0.5 mg/kg, IV infusion with loading dose of 0.05–0.2 mg/kg over 2–3 min. Continuous infusion initiated at a rate of 0.06–0.12 mg/kg/h)

– Propofol (IV: 1–2 mg/kg for sedation, then 100–150 μg/kg/min infusion)

– *Short-acting opioids:*

- **Fentanyl (IV sedation: 1–2 μg/kg, then 0.5–1 μg/kg/h IV infusion).**
- **Remifentanil (IV: 2–18 years: 1 μg/kg over 30–60 s, then 0.05–0.1 μg/kg/min IV infusion). All sedation medication should be titrated to response.**

– Several commonly used local anesthetics with different concentrations, as well as 50 mL bags or ampules of normal saline for drug dilution if necessary.

– All local anesthetics should be stored separately from the intravenous drugs.

Resuscitation Equipment

- Oxygen supply, nasal prongs, and face masks.
- Different sizes of Guedel airways, face masks, laryngeal masks, and endotracheal tubes.
- Laryngoscopes (Macintosh and Miller blades) and gum elastic bougie.
- Ambu bag (bagger).
- Suction.
- Various sizes of intravenous cannulae.
- Defibrillator

Resuscitation Drugs

- **Atropine** (0.02 mg/kg)
- **Epinephrine** (0.01 mg/kg)
- **Suxamethonium** (2 mg/kg)
- **Ephedrine** (1–12 years: 0.2–0.3 mg/kg; 12–18 years: 2.5–5 mg)
- **Glycopyrrolate** (5–10 µg/kg)
- **Intralipid®20 %** (1.5 mL/kg bolus over 1 min followed by 0.25 mL/kg/min infusion; bolus dose can be repeated at 5-min intervals if there is no return of spontaneous circulation)

Monitoring

- Electrocardiogram
- Noninvasive blood pressure
- Pulse oximetry
- Capnography

Needle Tip Design

- blunt needles
- Long-beveled needles
- Tuohy needles 18G (20G catheter) or 20G (22–24G catheter)
- Special Sprotte®cannulas (Fig. 1.4) have a lateral “eye” with smooth edges to prevent shearing of the catheter. They also have an atraumatic tip.

Tohy

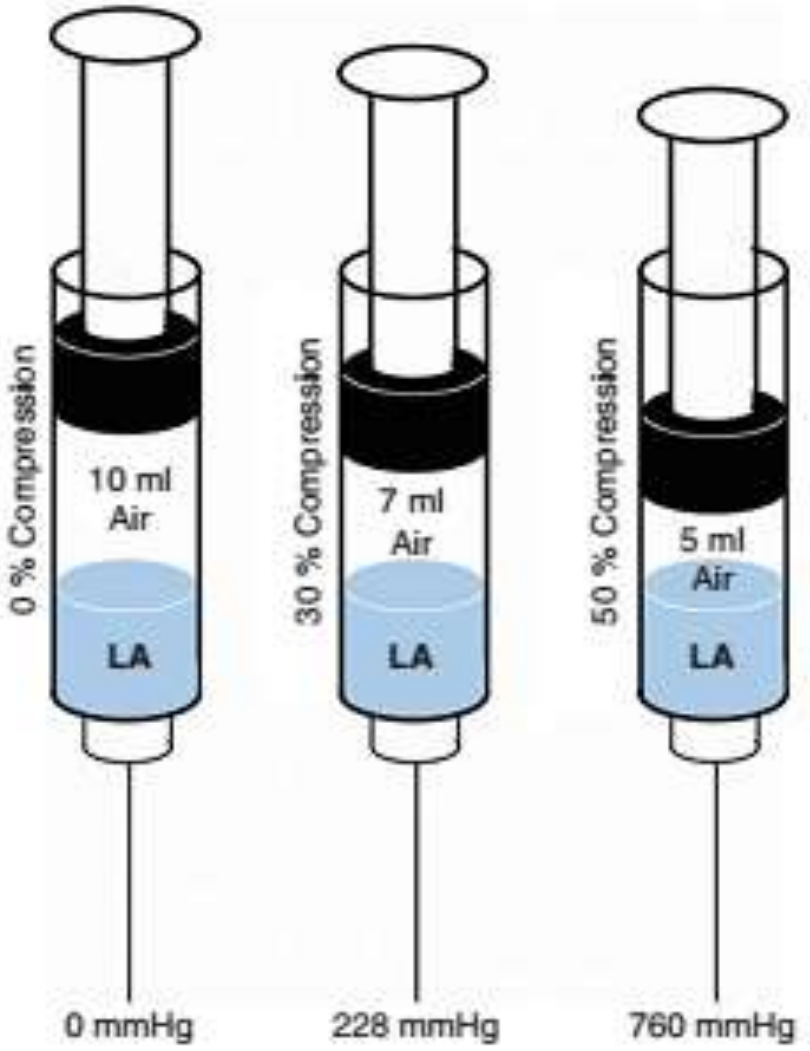
Needle Gauges

- 22G insulated needle for single-shot peripheral nerve blocks,
- For catheter insertion, 20–21G and 24G catheters with 18G and 20G Tuohy needles,

Injection Pressure Monitoring

Fig. 1.8 Commercially available single-use, in-line pressure monitor for monitoring injection pressure during peripheral nerve blockade

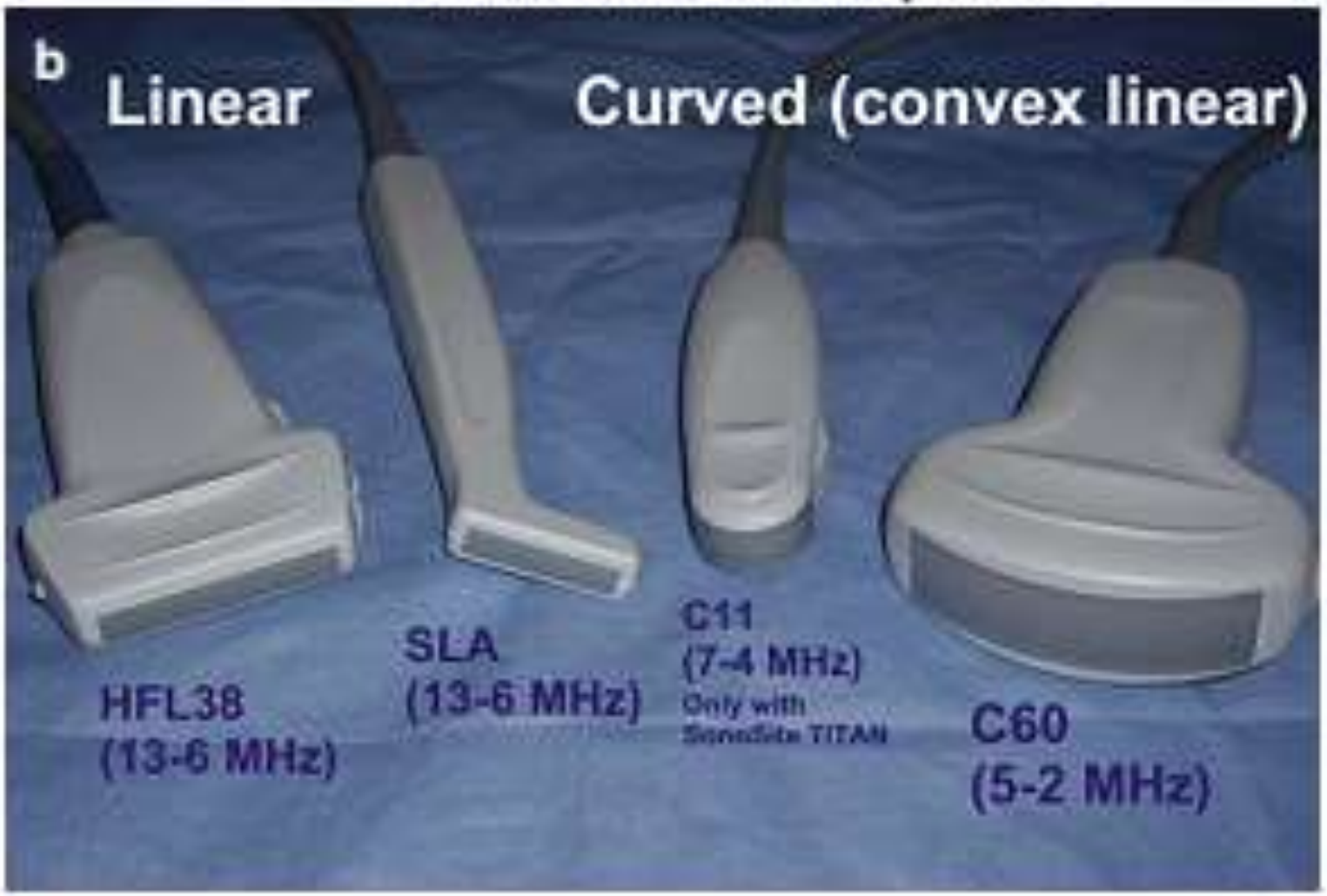
Pressure monitoring



US as a diagnostic tool

- aid in visualising anatomical structures
- Decreasing local anesthetic volume
- prevent the need for the use of a PNS and reduce the potential for tissue damage in skeletal or connective tissue disorders,such as epidermolysis bullosa and syndactyly
- increases precision and success rate, enables afaster onset of block

Ultrasound beam planes



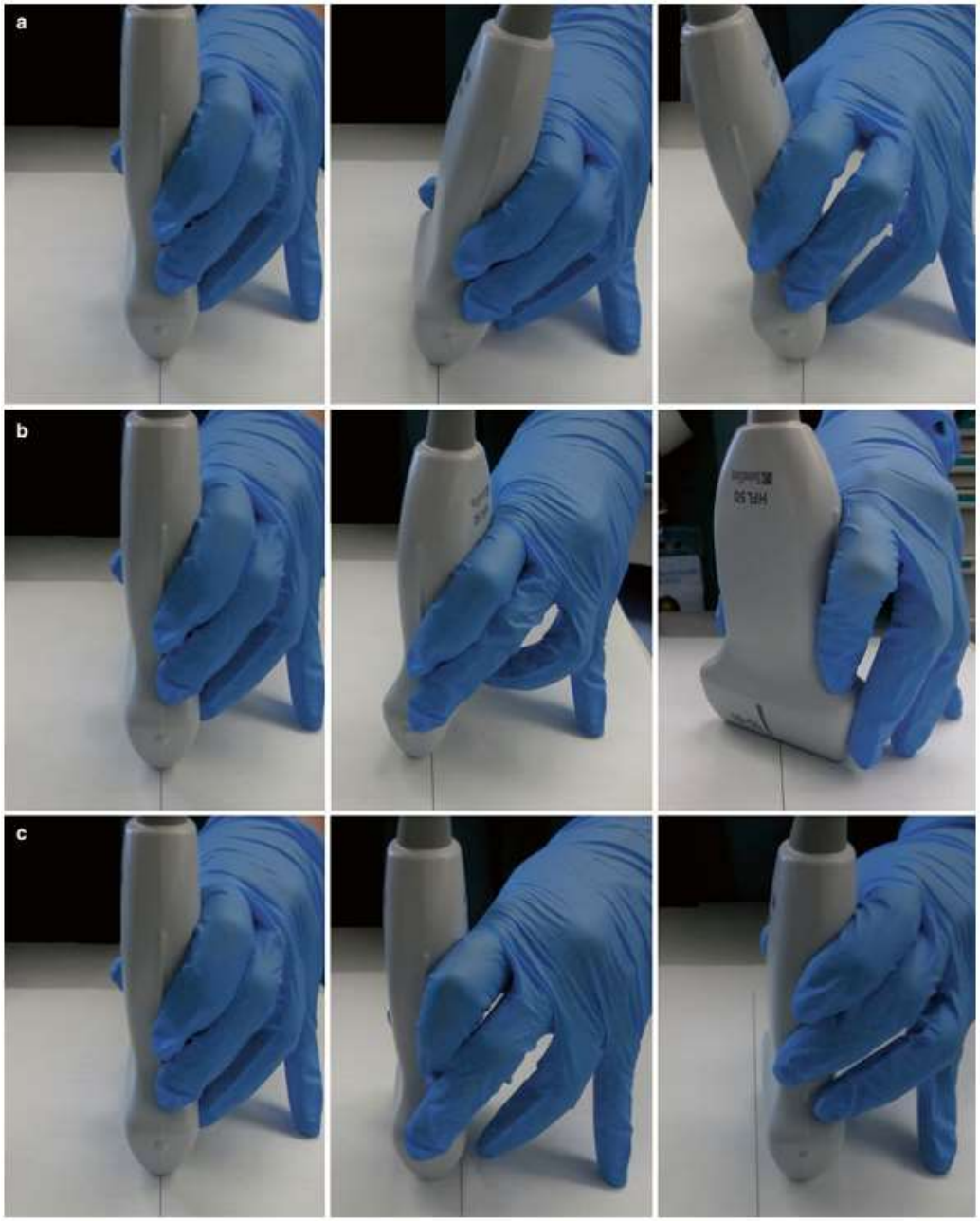
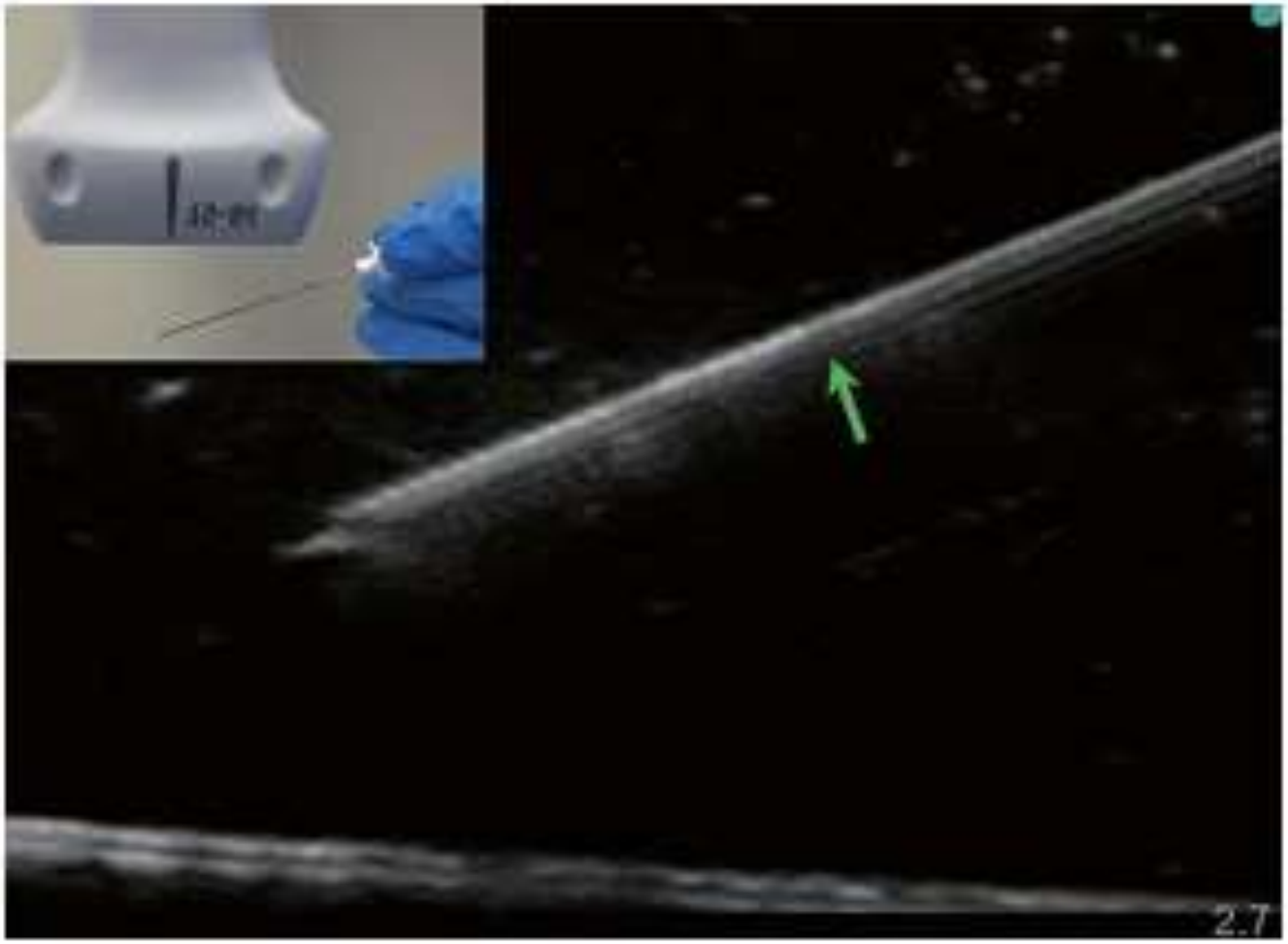


Fig. 4.4 Tilting (**a**), rotating (**b**), and manipulating (**c**) the alignment of the ultrasound probe is necessary to visualize the tip of the needle. The *line* on the paper indicates the original axis of the probe

Needling Technique



- **The in-plane (IP) technique**, maintaining the needle path along the transducer long axis, is the **technique of choice in children**

Complications

- ***Sedated or anesthetized*** during block performance.

- Many children will not be able to report ***paresthesia*** regardless of alertness
- An inability to report and detect ***early CNS signs of toxicity***
- Need to carefully watch ***cardiac signs*** of local toxicity

Congenital and pre-existing disease

Peripheral Neuropathy

e.g*., **diabetes, multiple sclerosis, peripheral vascular disease***

CNS Disorders

e.g., multiple sclerosis, post-polio syndrome

Maintaining a standard of care during regional anesthesia practice:

Preoperative patient selection

Appropriate parental and parent consent

Using appropriate equipment and technique

Monitoring regional anesthesia practice

Accurate and meticulous anesthesia documentation

Postoperative communication and follow-up visit

Relative contraindications

- Anatomical anomalies; technical challenges: small structures
- Preexisting progressive neurological disease; comatose states; sepsis; coagulopathy
- Lengthy procedures that outlast the duration of action of the local anesthetic

Absolute contraindications

- Parental and patient refusal
- Lack of experience and skills; lack of appropriate equipment (e.g., nerve stimulator, ultrasound, proper size of needle); lack of appropriate equipment for resuscitation and monitoring (e.g., oxygen, mask, drugs, etc.)
- Infection at the site of injection; allergy to local anesthetics; coagulopathy

Allergic Reactions

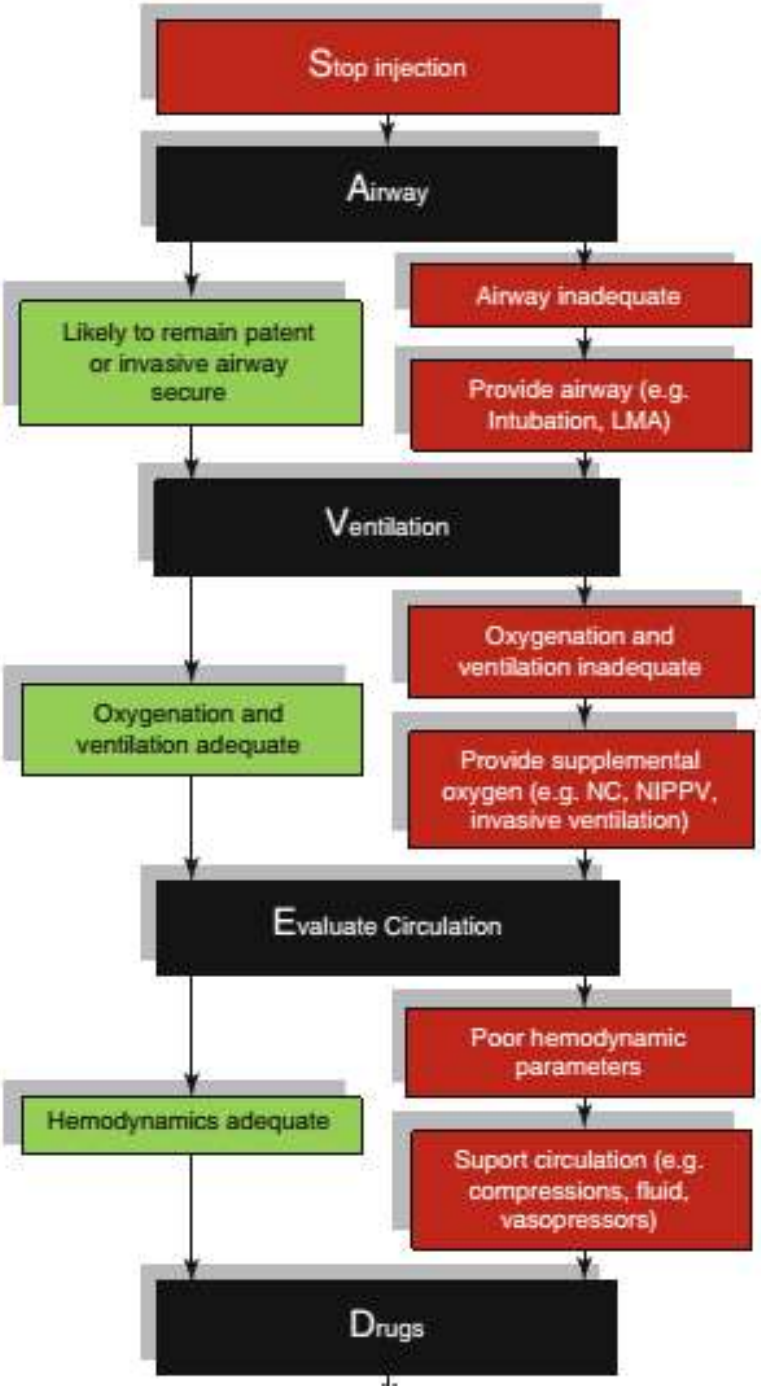
- Rare
- Mild local reactions (e.g., pruritus, erythema), Antihistamine
- Mild but become systemic (e.g., nausea, vomiting: +Corticosteroid
- True anaphylaxis (e.g., hypotension, bronchospasm) :Advanced Life Support guidelines, epinephrine (0.01 mg/kg s.c. or i.m.)

Systemic Toxic Reactions

- so exceedingly rare
- less than 0.05 %
- The first signs may in fact be dysrhythmias, hypotension, or even cardiac arrest.
- Monitoring T wave height
- Adding adrenaline (epinephrine) (2-5 mic perkg) to LA to detect accidental intravascular injection in children is *controversial.*
- Should be injected slowly, in fractioned boluses (0.1-0.2 ml per kg), with intermittent aspiration and under ECG monitoring

Baseline ECG

Marked increase in T wave height after intravascular injection of bupivacaine with epinephrine


Stop injection
Airway
Likely to remain patent or invasive airway secure
Airway inadequate
Provide airway (e.g. Intubation, LMA)
Ventilation
Oxygenation and ventilation adequate
Oxygenation and ventilation inadequate
Provide supplemental oxygen (e.g. NC, NIPPV, invasive ventilation)
Evaluate Circulation
Hemodynamics adequate
Poor hemodynamic parameters
Suport circulation (e.g. compressions, fluid, vasopressors)
Drugs

Use medications as appropriate:

- **Lipid emulsion** (administer early) Bolus of 1.5 ml *kg–1 iv over one minute Infusion of 0.25 mL*kg–1*min–1

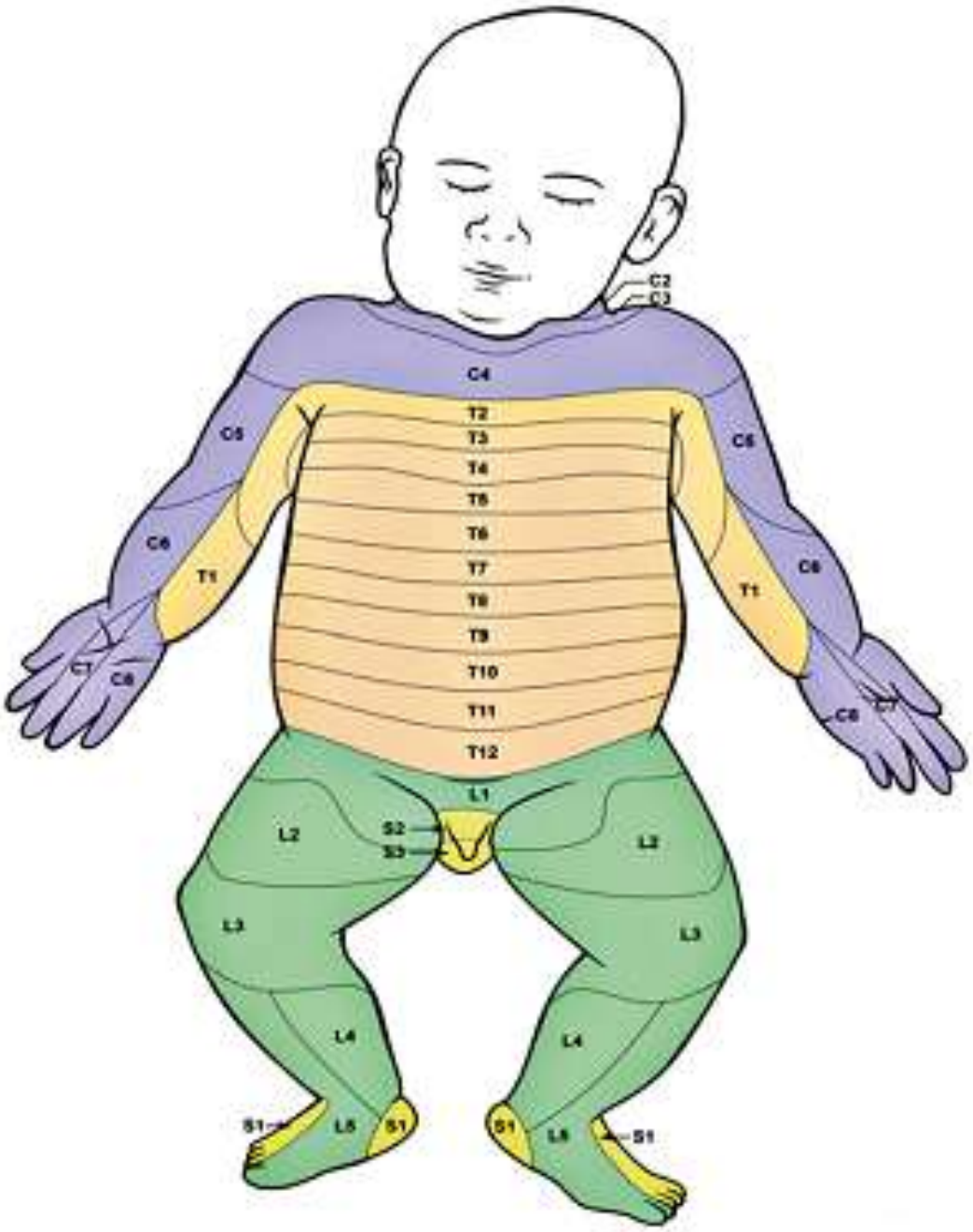
  Repeat bolus q3-5 min to a total of 3 mL*kg–1
- **Bronchospasm/Edema** → antihistamines, corticosteroids,bronchodilators
- **Hypotension** →fluid, epinephrine (10–100µg aliquots)
- **Seizures** → midazolam (0.05–0.1 mg*kg–1), propofol(0.5–1.5 mg*kg–1), barbiturates (thiopentone [1–2 mg*kg])
- **Ventricular arrythmias** → amiodarone (300 mg initially,followed by repeat 150 mg bolus 3–5 minutes later)

Acute compartment syndrome

- A sudden increased pressure within a fascial compartment after a fracture, trauma or an ischaemic vascular event.
- A compartment pressure >30 mmHg is considered critical.
- only a few case reports of ACS in paediatrics have been published, and none of them showed a convincing link between RA and delayed diagnosis of ACS

Methods/equipment for reducing the risk of nerve injuries

- **Needle type**: small gauge, short beveled
- **Patient:** awake with appropriate level of sedation
- **Nerve stimulation**: use accurate nerve stimulators and insulated nerve needles (current ≥0.2 mA)
- **Ultrasound**: direct visualization of nerves and surrounding structures by using high-resolution ultrasound equipment if available
- **Paresthesia**: injection should be stopped and needle repositioned if persistent
- **High injection pressure**: avoid rapid and high-pressure injections (pressure <20 psi)
- **Local anesthetic**: avoid high concentrations (i.e., lidocaine 2 % or bupivacaine 0.75 %)


C2
C3
C4
T2
T3
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T7
T8
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C5
C6
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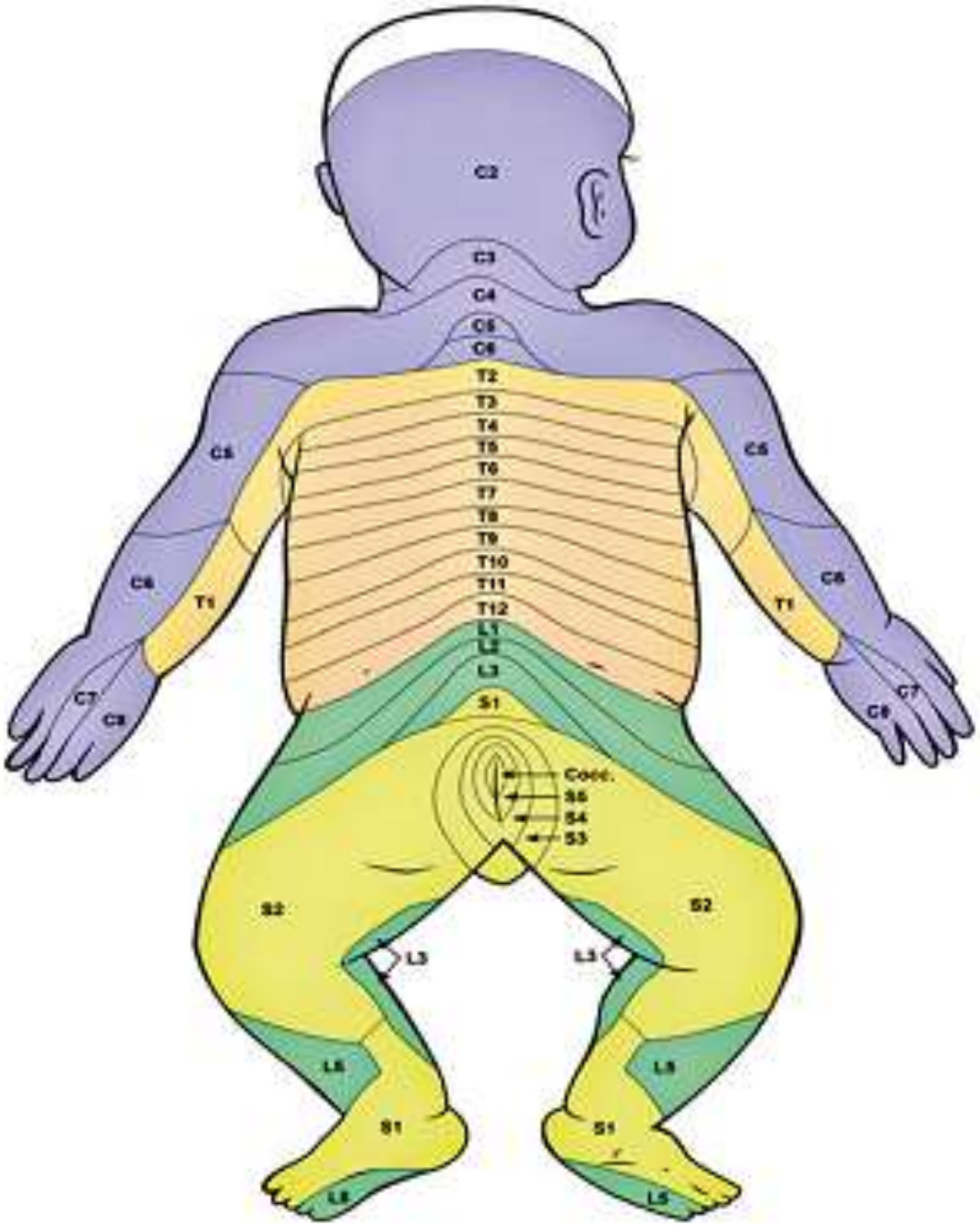
C7
C8


C2
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C5
C6
T2
T3
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T7
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T9
T10
T11
T12
L1
L2
L3
S1
C5
C6
T1
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Coc.
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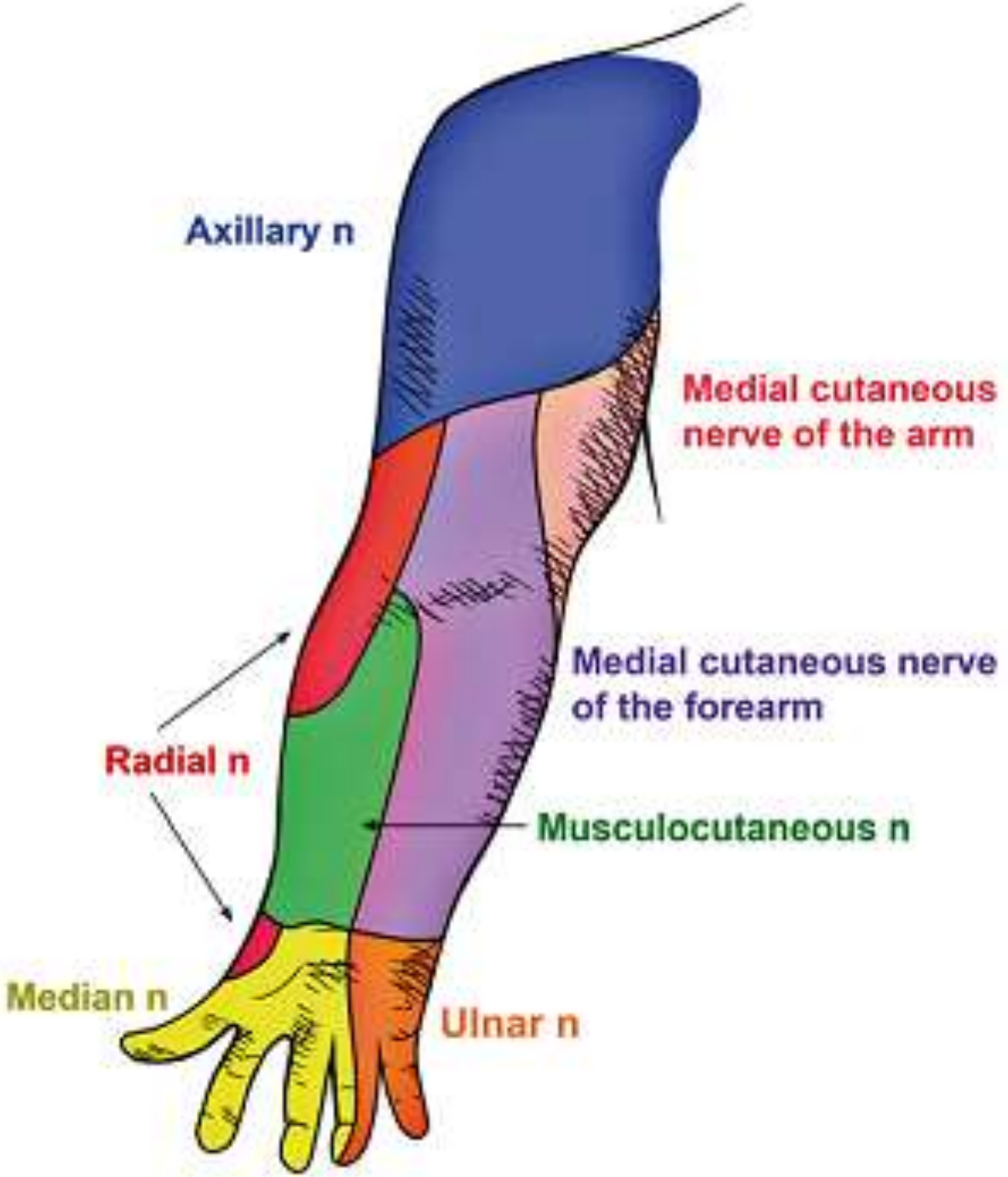
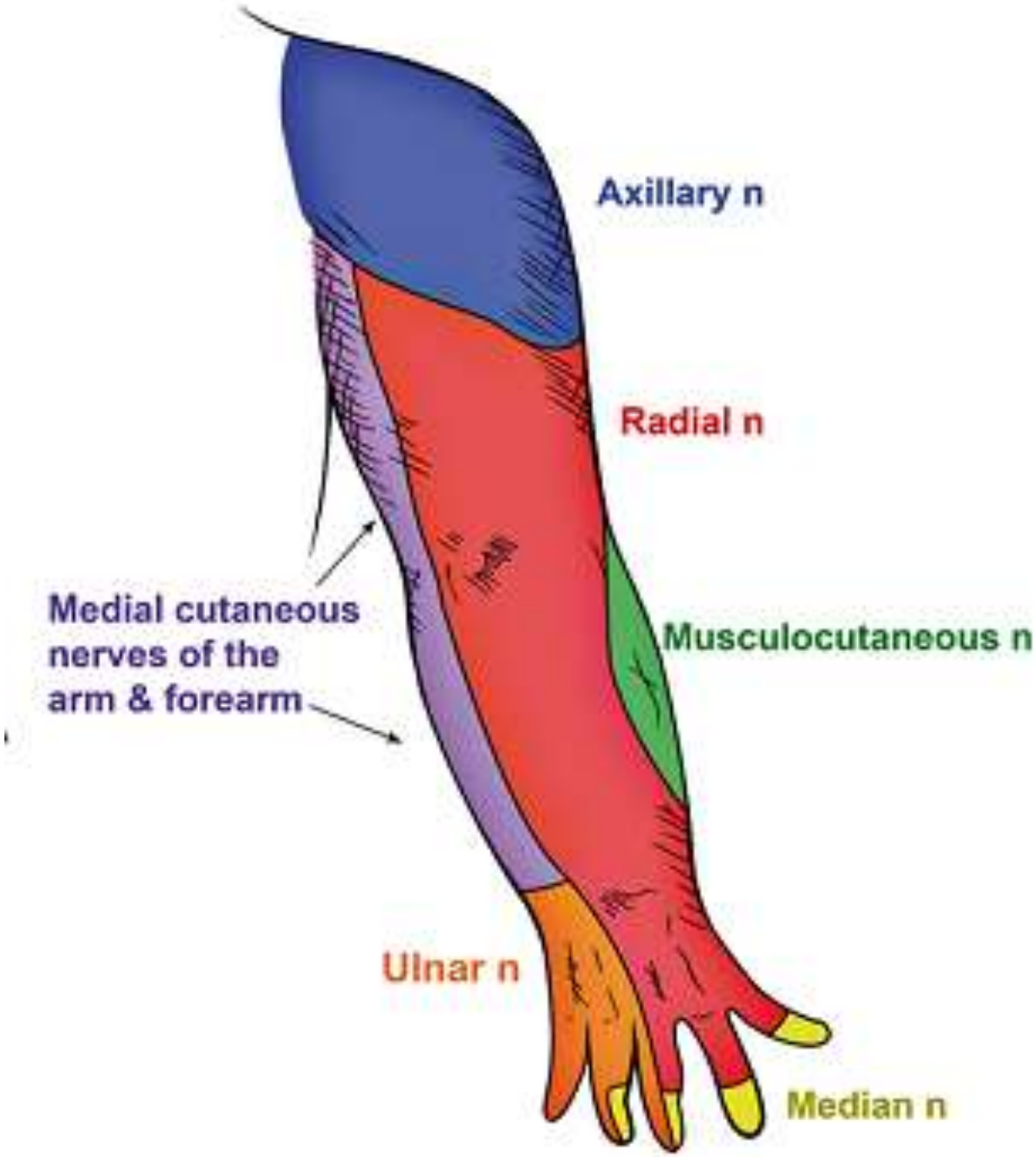
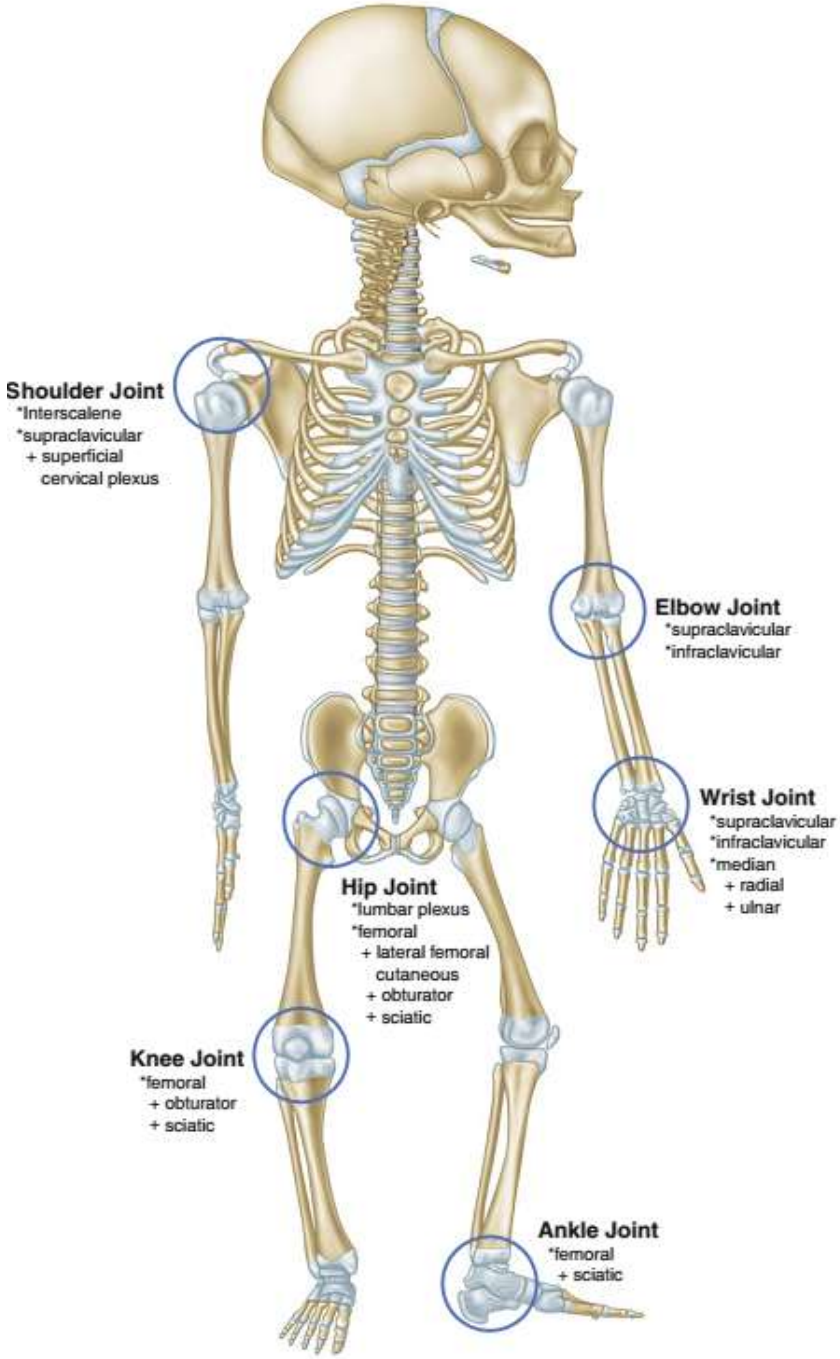
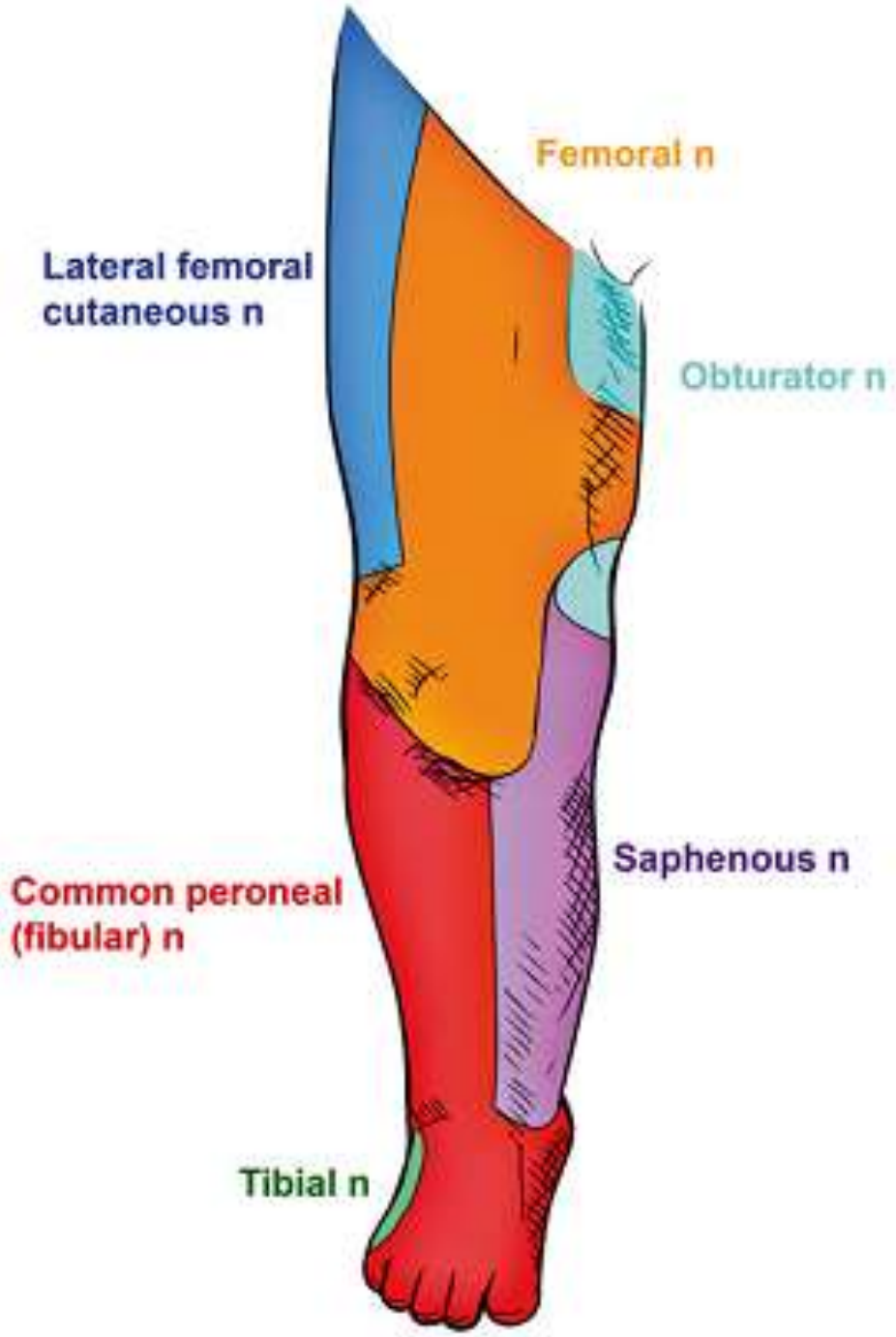
L5
S1

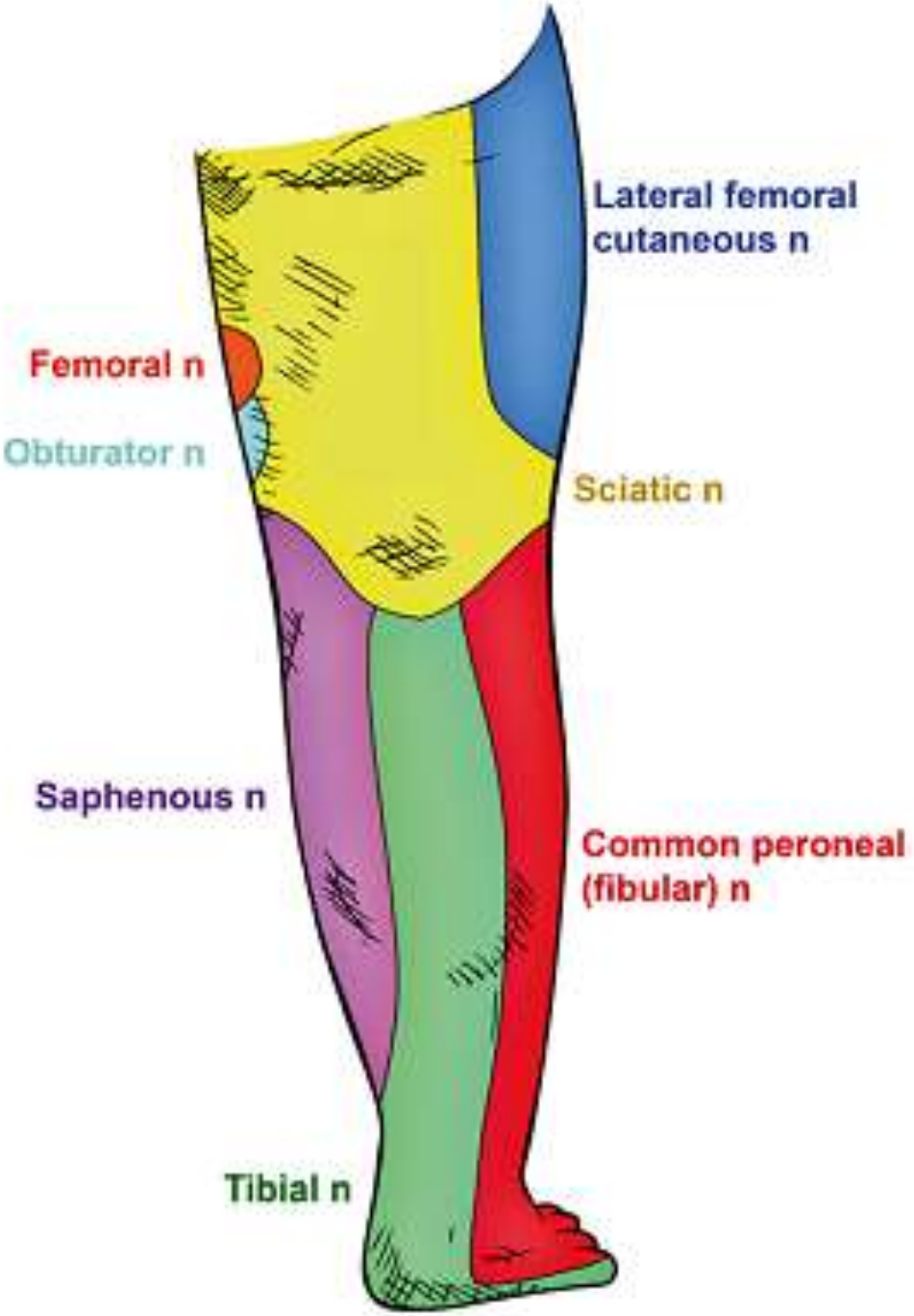

Axillary n
Medial cutaneous nerve of the arm
Medial cutaneous nerve of the forearm
Radial n
Musculocutaneous n
Median n
Ulnar n


Axillary n
Radial n
Medial cutaneous nerves of the arm & forearm
Musculocutaneous n
Ulnar n
Median n



ıtion of the major joints


Femoral n
Lateral femoral cutaneous n
Obturator n
Saphenous n
Common peroneal (fibular) n
Tibial n


Lateral femoral cutaneous n
Femoral n
Obturator n
Sciatic n
Saphenous n
Common peroneal (fibular) n
Tibial n

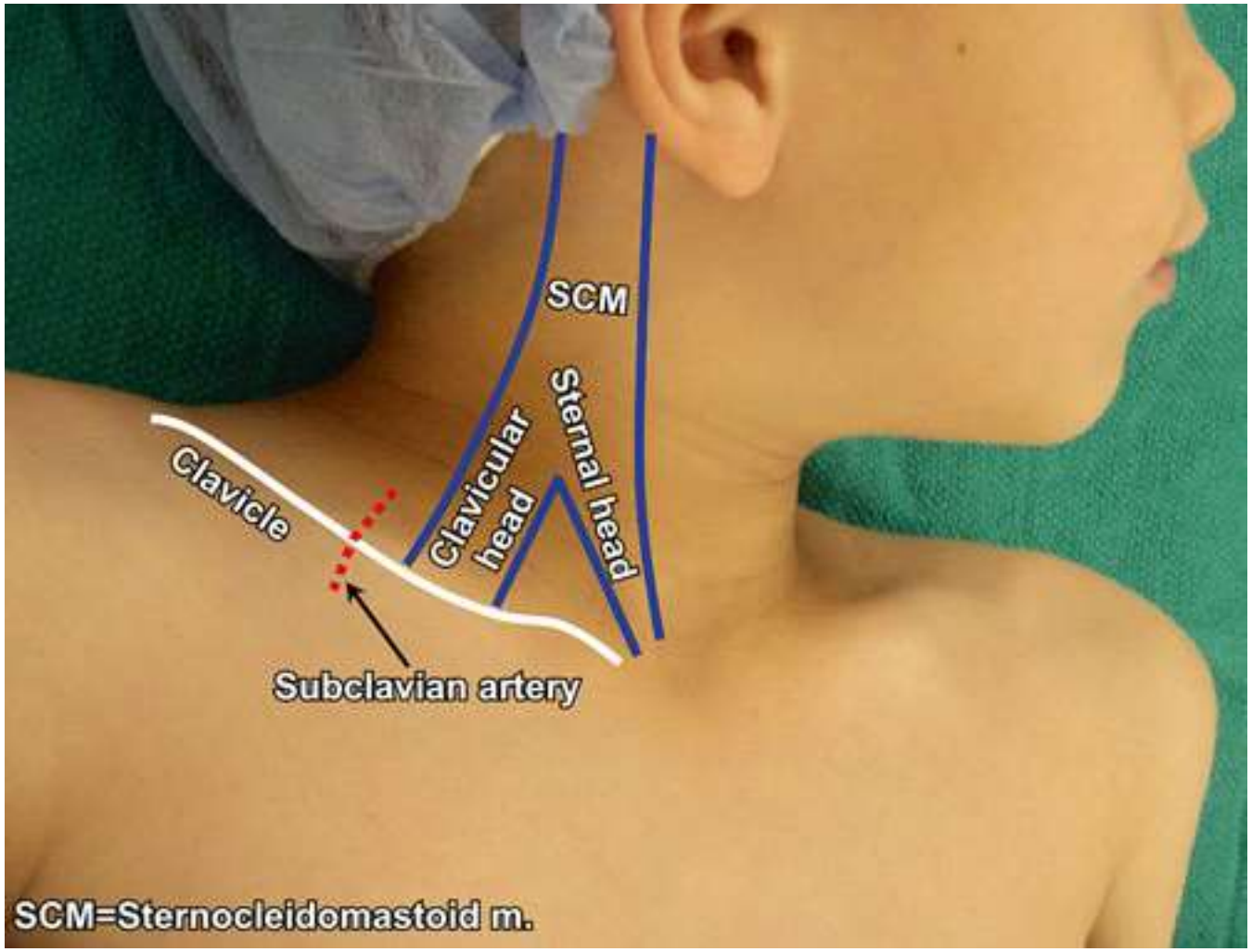
Upper Extremity Blocks

- The most common approaches to the brachial plexus in children include the **supraclavicular, infraclavicular, and axillary** approaches.

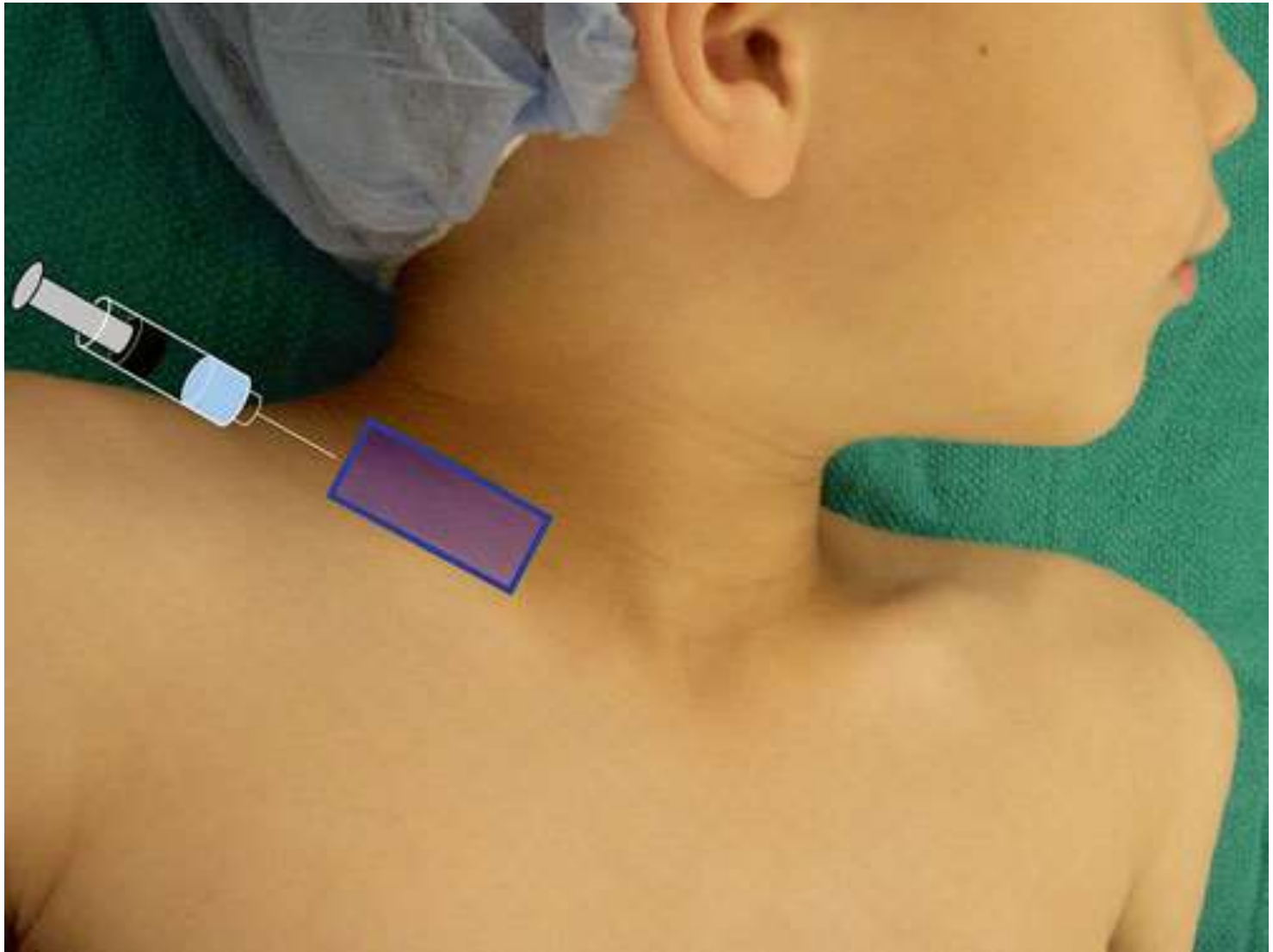
Supraclavicular approach

- **Indications**
- • Hand, forearm, and elbow surgery
- **Local Anesthetic Application**
- 0.15–0.2 mL/kg.
- 0.25 % bupivacaine, 0.5 % bupivacaine,
- 0.2 % ropivacaine, or 2 % lidocaine

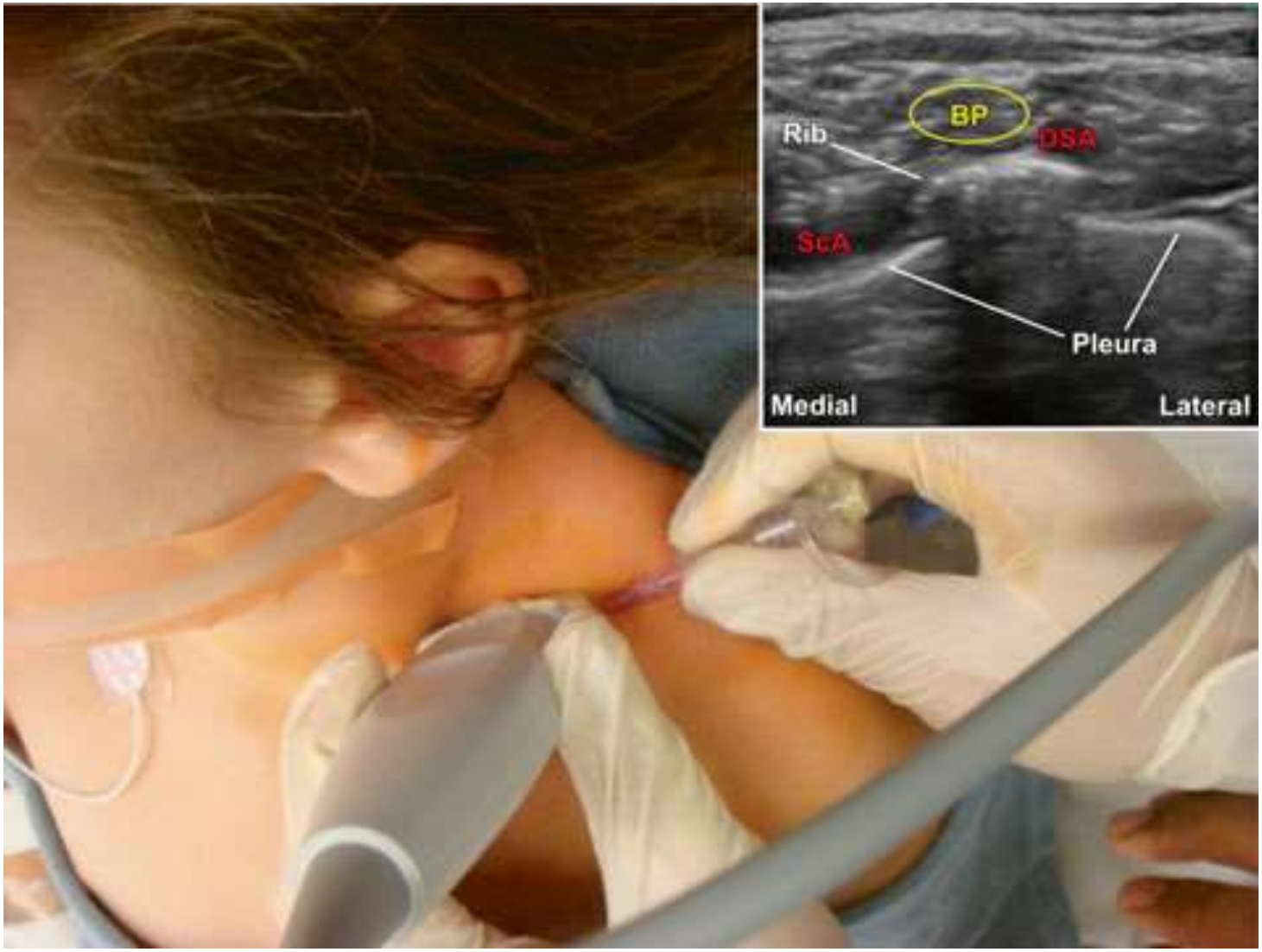
Supraclavicular approach



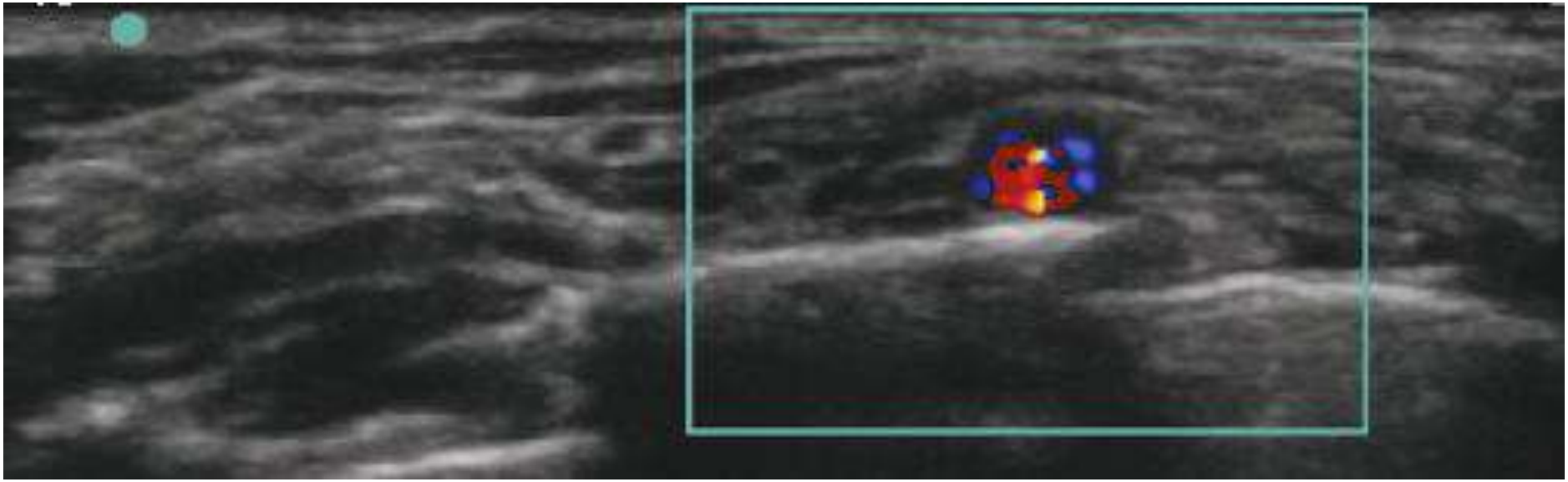
Supraclavicular approach



Supraclavicular Brachial Plexus Block



Supraclavicular block



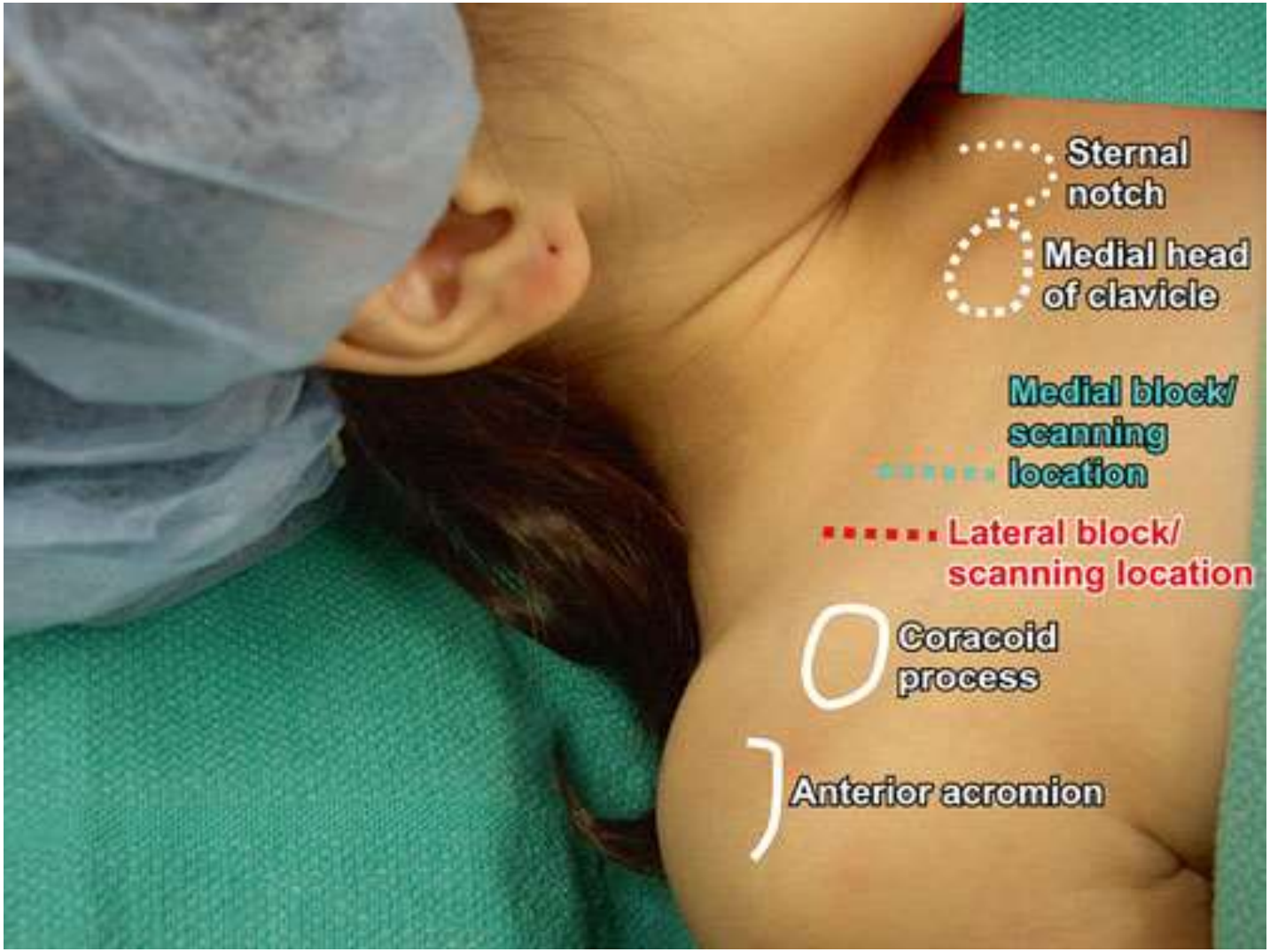
- A 5-year-old female patient, 20.4 kg, presented for closed reduction percutaneous pinning of the left elbow.
- An ultrasound-guided supraclavicular nerve block was administered with a 20G needle ; 3.5 mL 0.25 % bupivacaine with epinephrine 1:200,000 was given for postoperative analgesia.
- Block duration was 6–12 h, and surgery lasted for 2 h and 8 min. Pain reporting following surgery was 0/10 (FLACC scale) at PACU admission and 0/10 (FLACC scale) at PACU discharge.

Infraclavicular approach

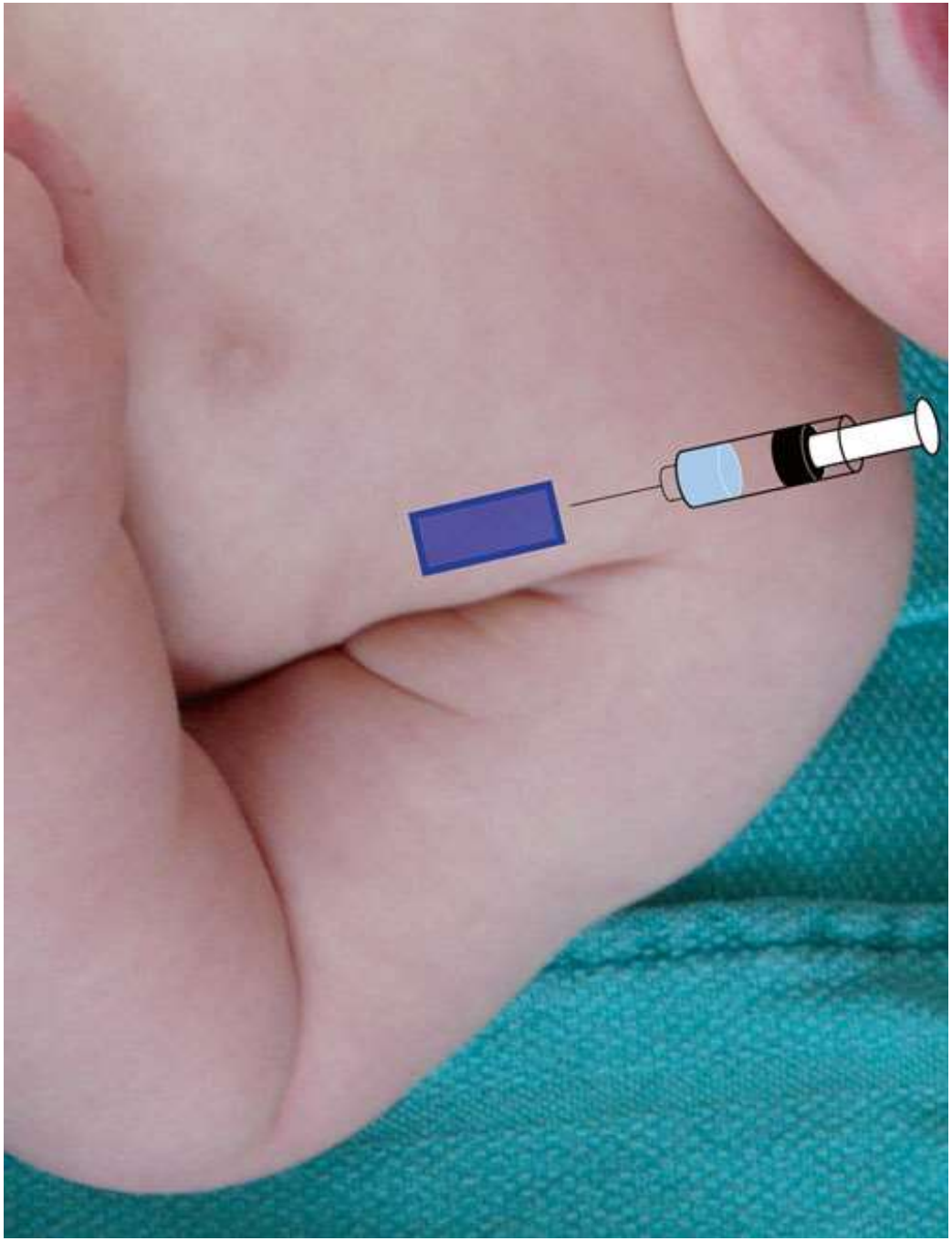
- **Indications**

  Surgery of the upper arm including the proximal humerus, elbow, forearm, and hand.
- 0.5 mL/kg of 0.2–0.5 % ropivacaine or 0.25–0.5 % bupivacaine

Infraclavicular approach



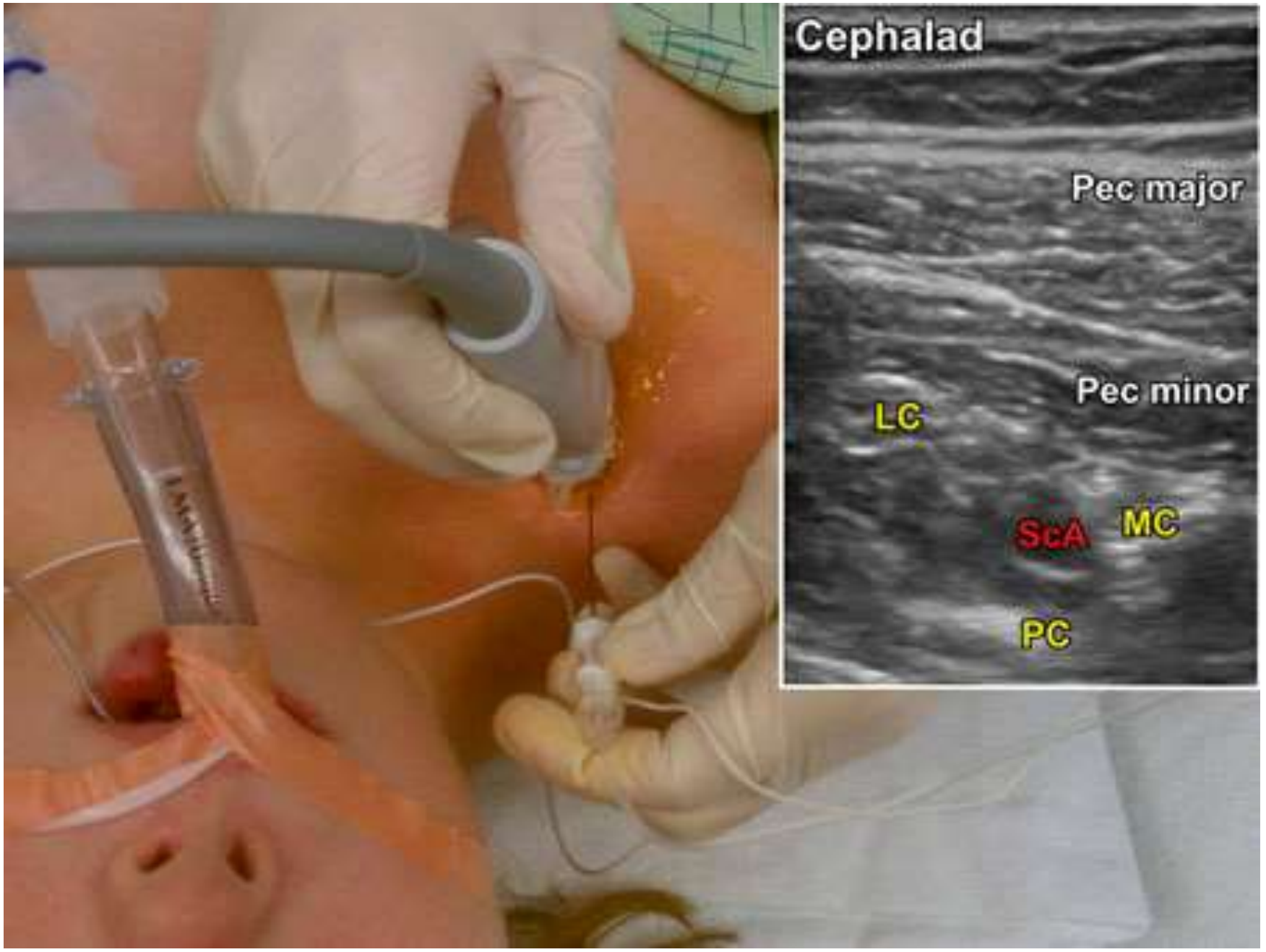
Infraclavicular approach



Clinical Pearls

- Place the linear probe medial to the coracoid process and inferior to the clavicle.
- After recognizing the axillary artery, look for the cords using an IP approach, with the tip of the needle aimed towards the posterior cord.
- Avoid using a medially positioned ultrasound probe (pleura)

Infraclavicular Block



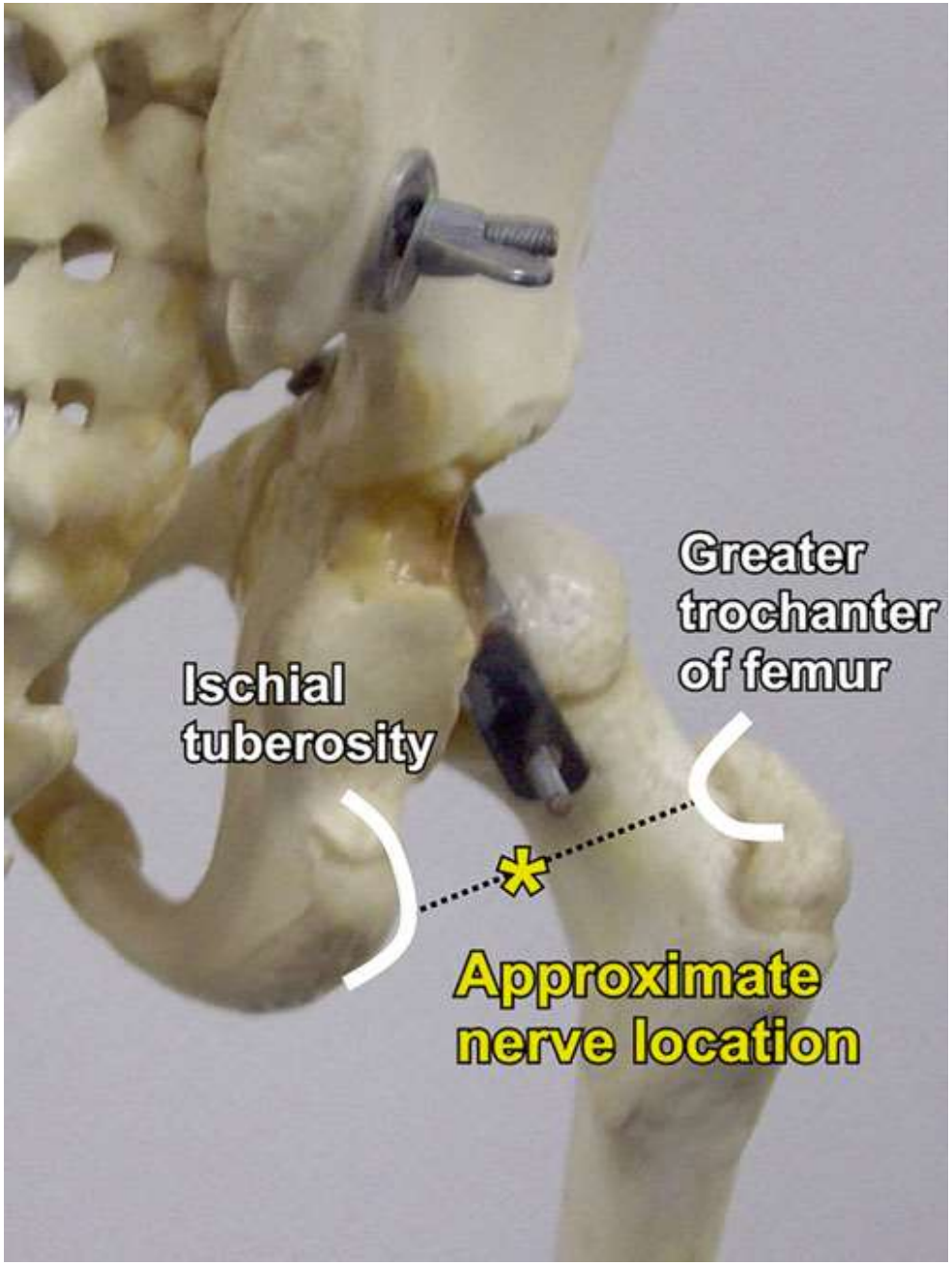
- An 8-year-old female patient, 50.3 kg,
- open reduction and fixation of the right small finger
- a 22G needle and 10 mL 0.25 % bupivacaine with 1:200,000 epinephrine

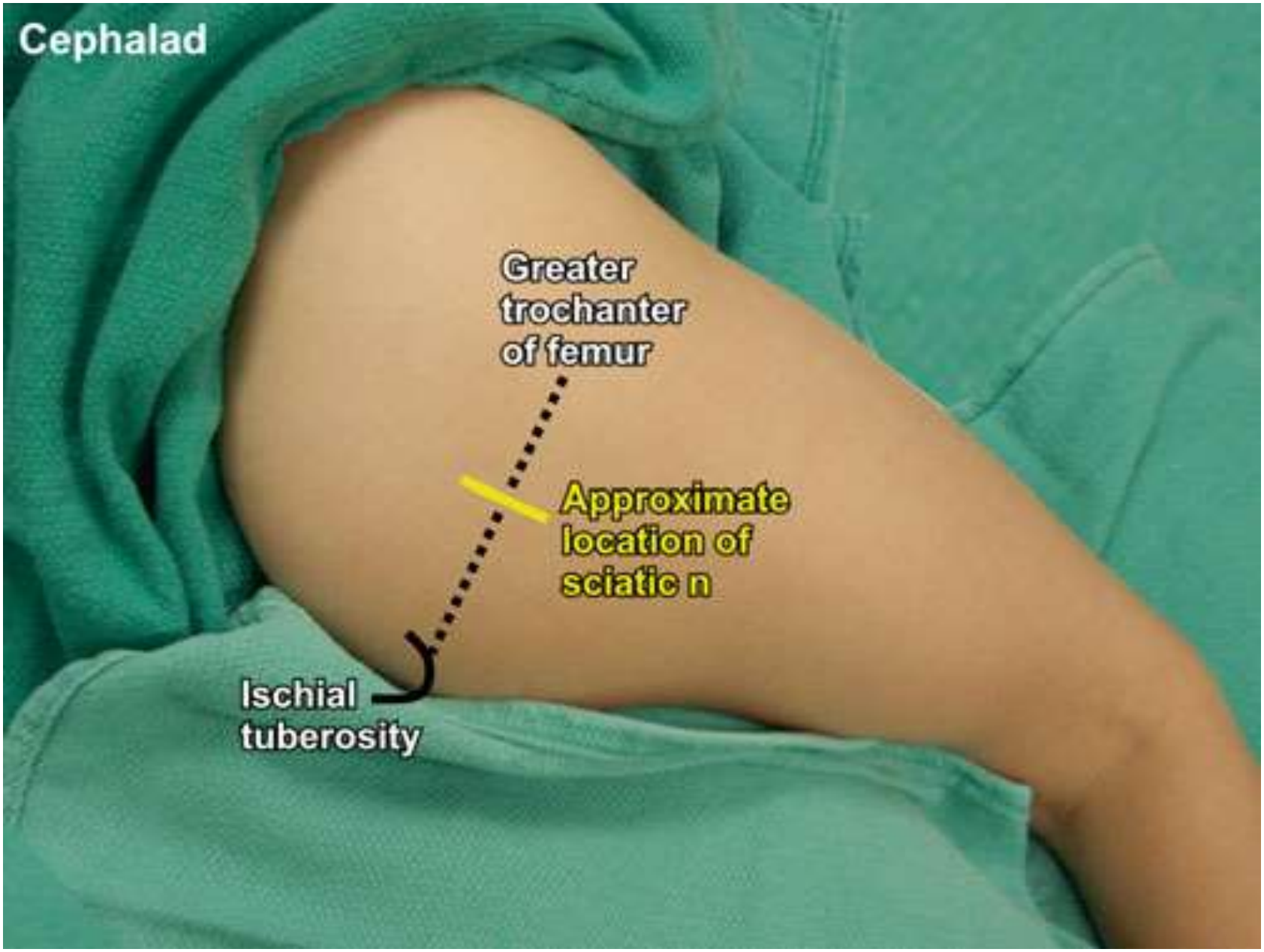
Block duration was 6–12 h;

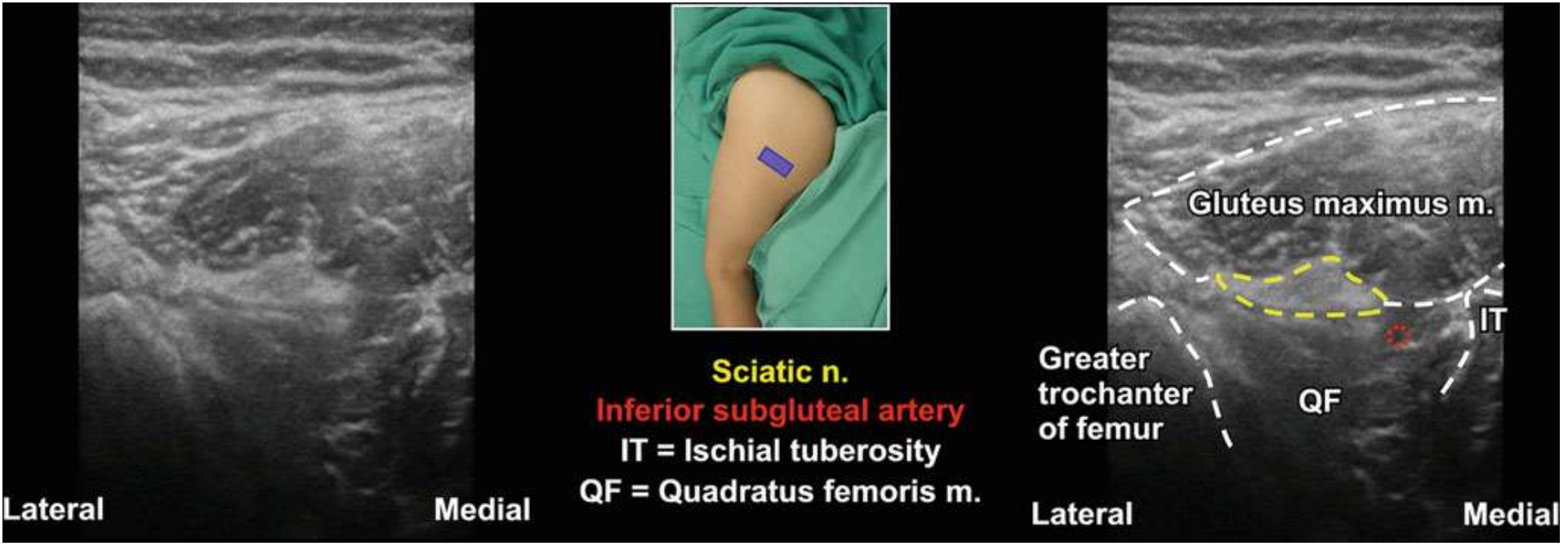
Infragluteal/Subgluteal Sciatic Nerve Block Approach

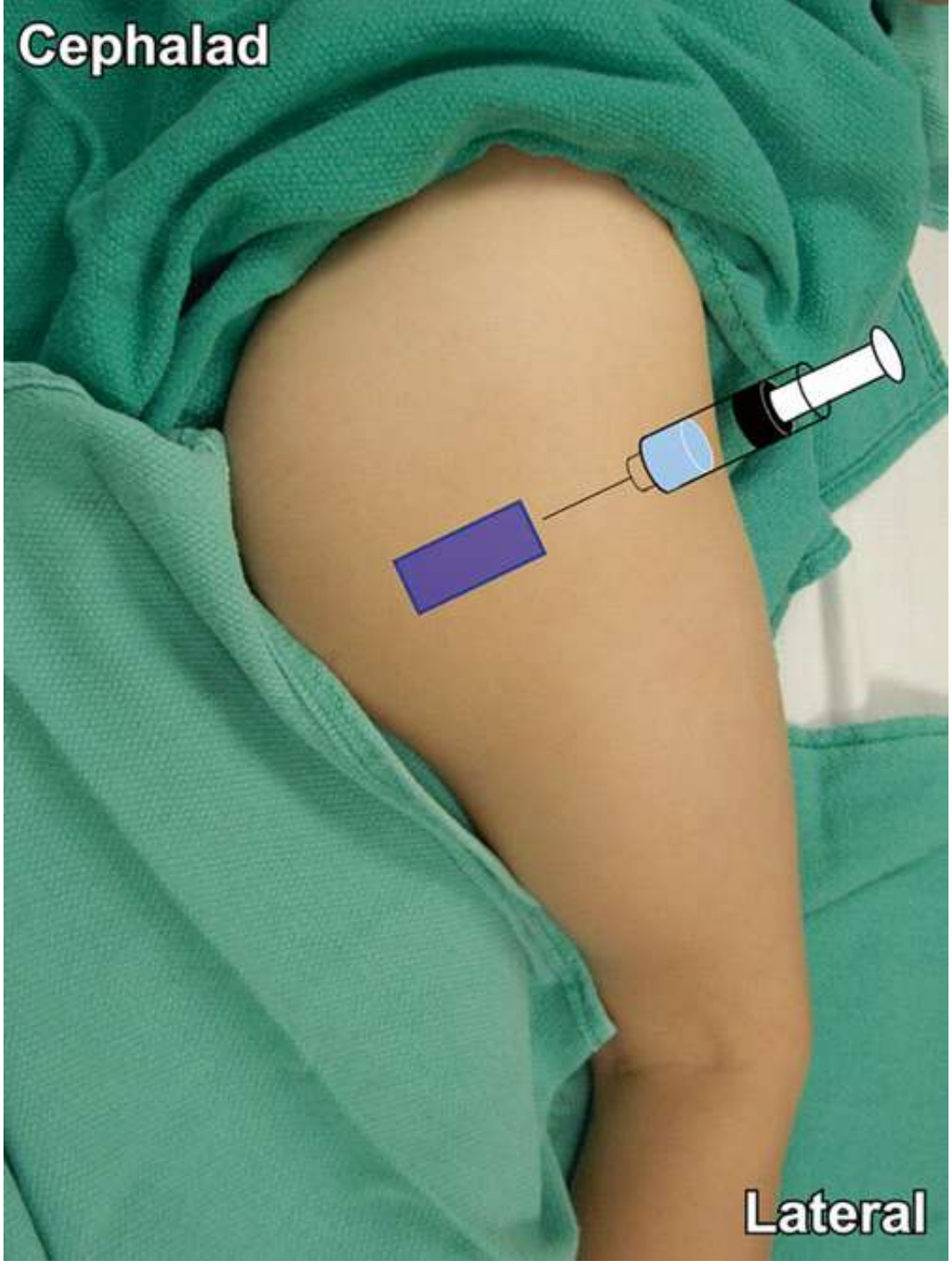
- **Indications**
- • Sciatic nerve before bifurcation:
- – Knee surgery (with supplemental blockade of the femoral nerve)
- – Removal of leg implants
- • Sciatic nerve after bifurcation (may require supplemental blockade of the saphenous nerve):
- – Surgery on the lower limb
- – Foot and ankle surgery

- (1) 1 % lidocaine,
- (2) 0.5 % bupivacaine,
- (3) a mixture of equal volumes of 0.5 % bupivacaine and 1 % lidocaine,
- 0.5 mL/kg in patients <20 kg and 10 mL plus 0.25mL/kg 20 kg, up to 25 mL maximum injected volumes.


Greater
trochanter
of femur
Ischial
tuberosity
*
Approximate
nerve location


Cephalad
Greater trochanter of femur
Approximate location of sciatic n
Ischial tuberosity


Lateral
Medial
Sciatic n.
Inferior subgluteal artery
IT = Ischial tuberosity
QF = Quadratus femoris m.
Gluteus maximus m.
IT
Greater trochanter of femur
QF
Lateral
Medial

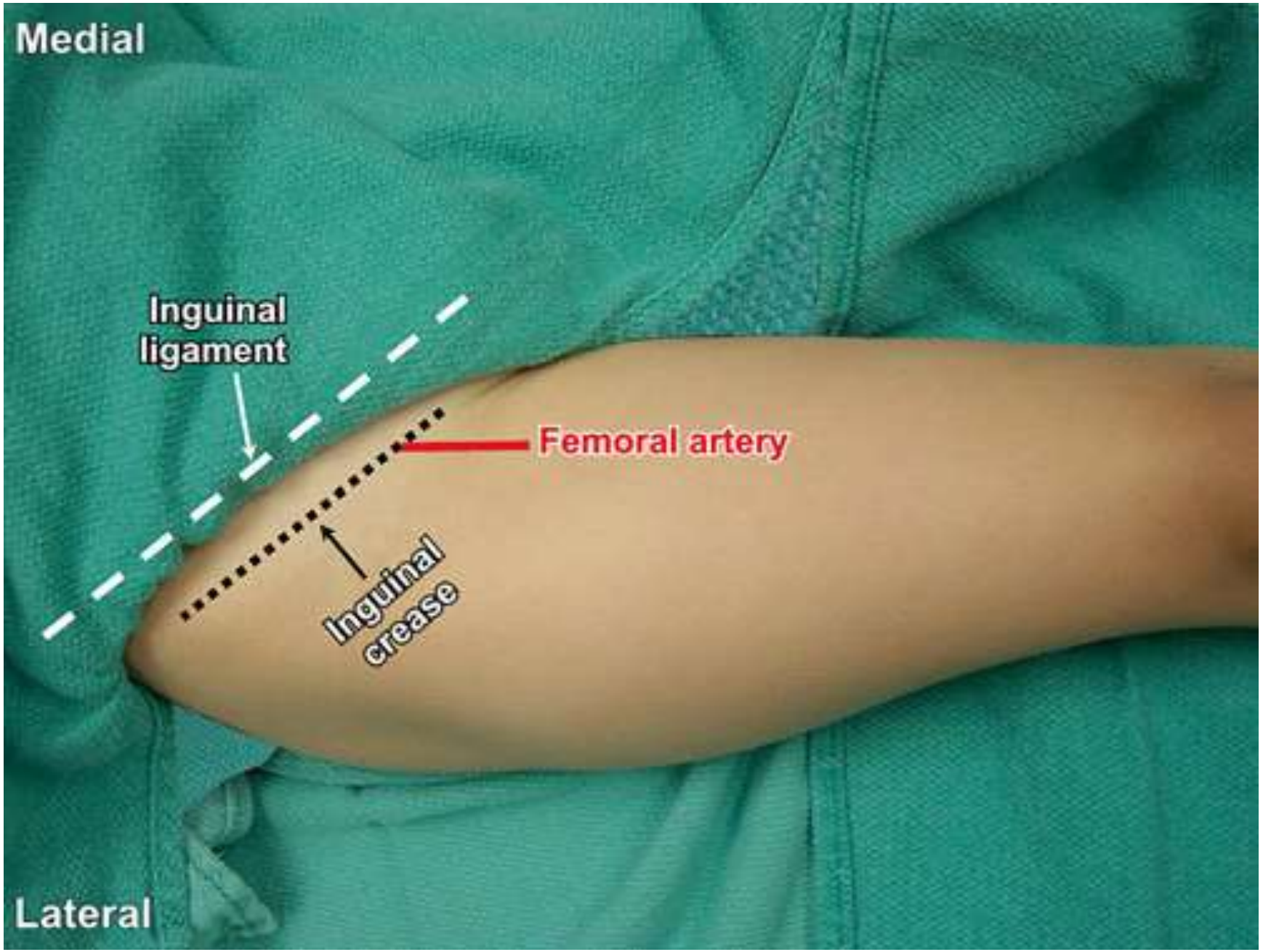

Cephalad
Lateral

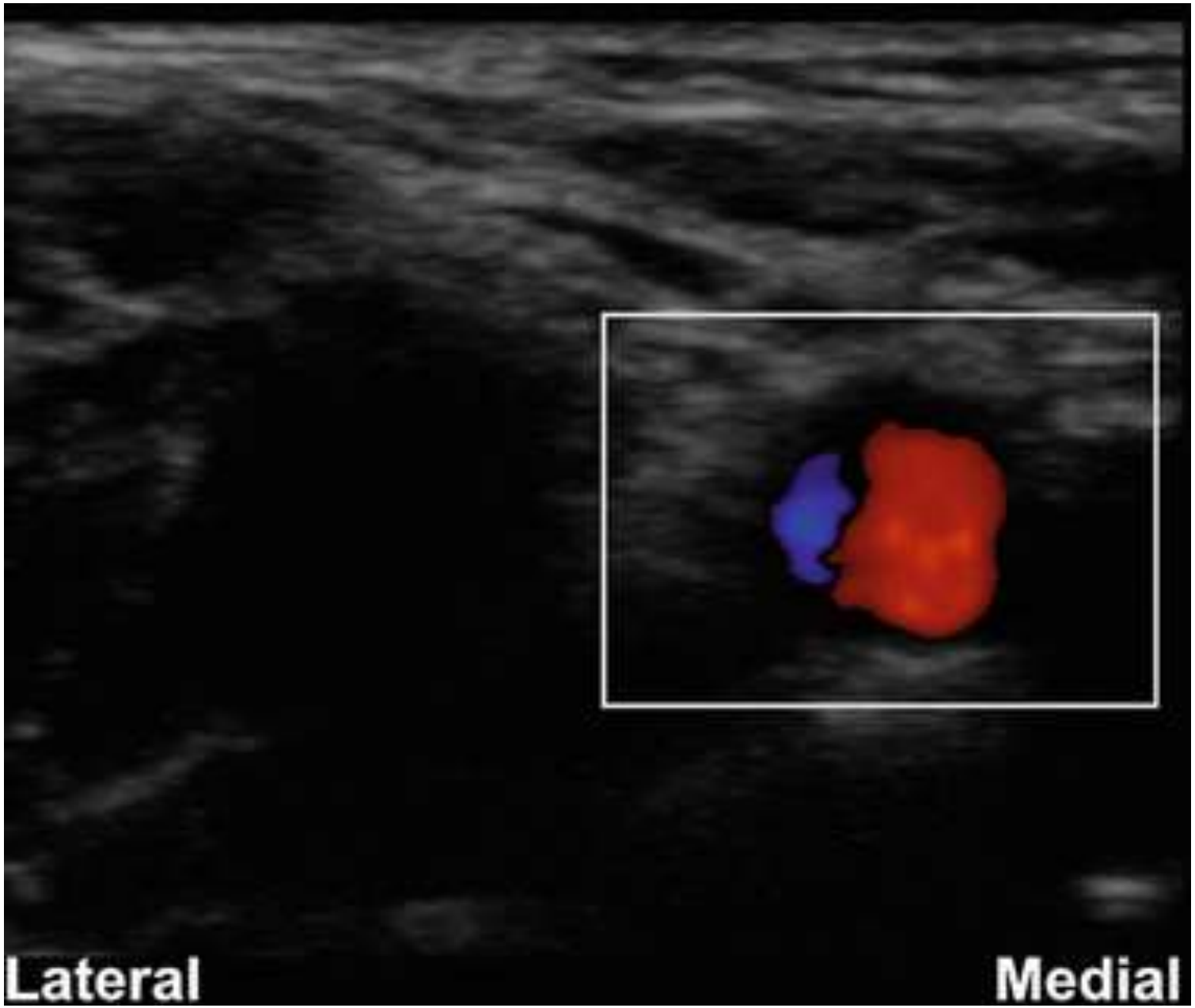

Gluteus major
Biceps femoris
SN

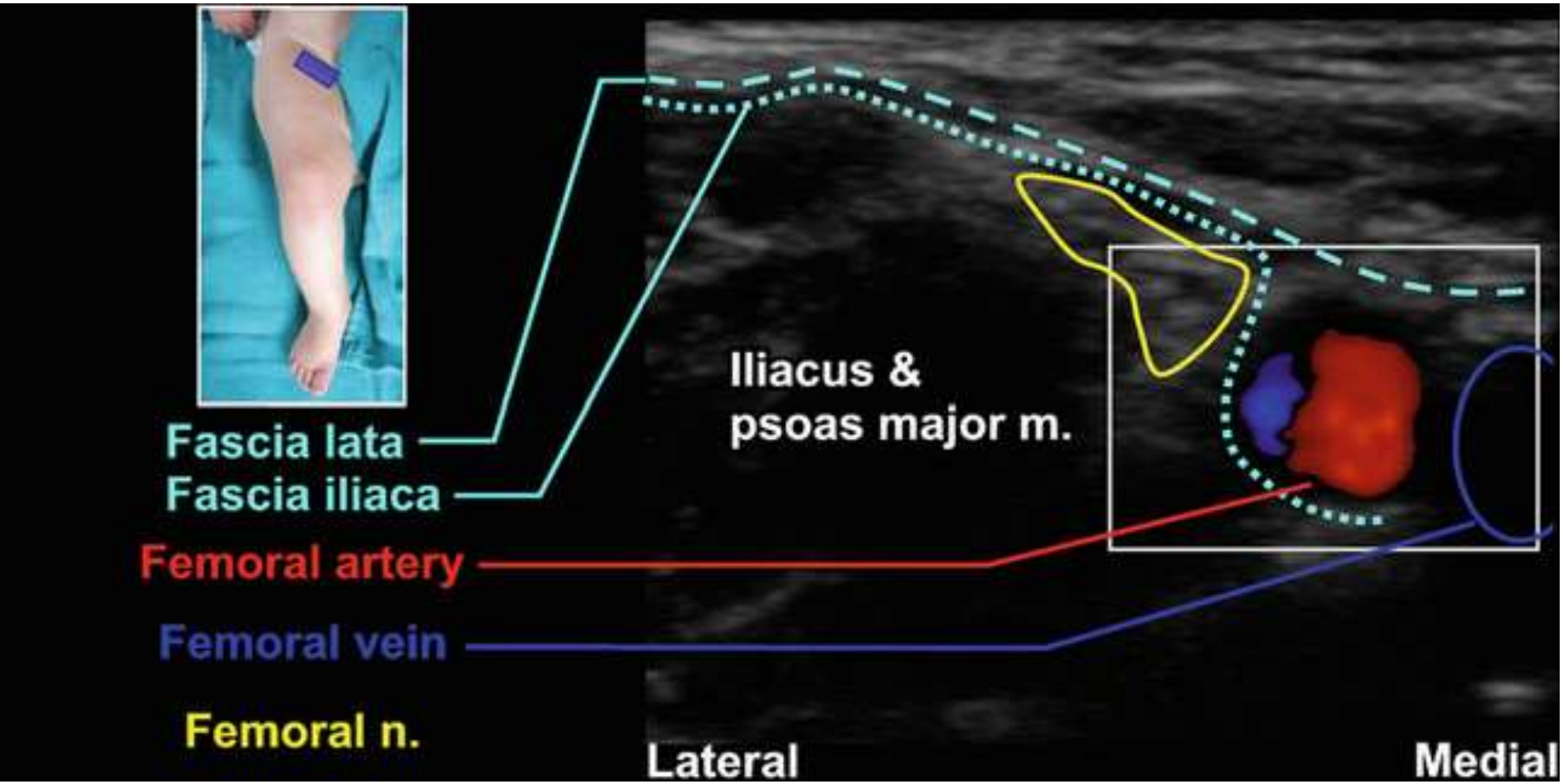
- A 10-year-old girl, 40 kg
- Open reduction and internal fixation of the ankle
- A 22G, 80 mm needle and a 13–6 MHz linear high-frequency probe
- 10 mL 0.25 % bupivacaine
- the block lasted for 8 h

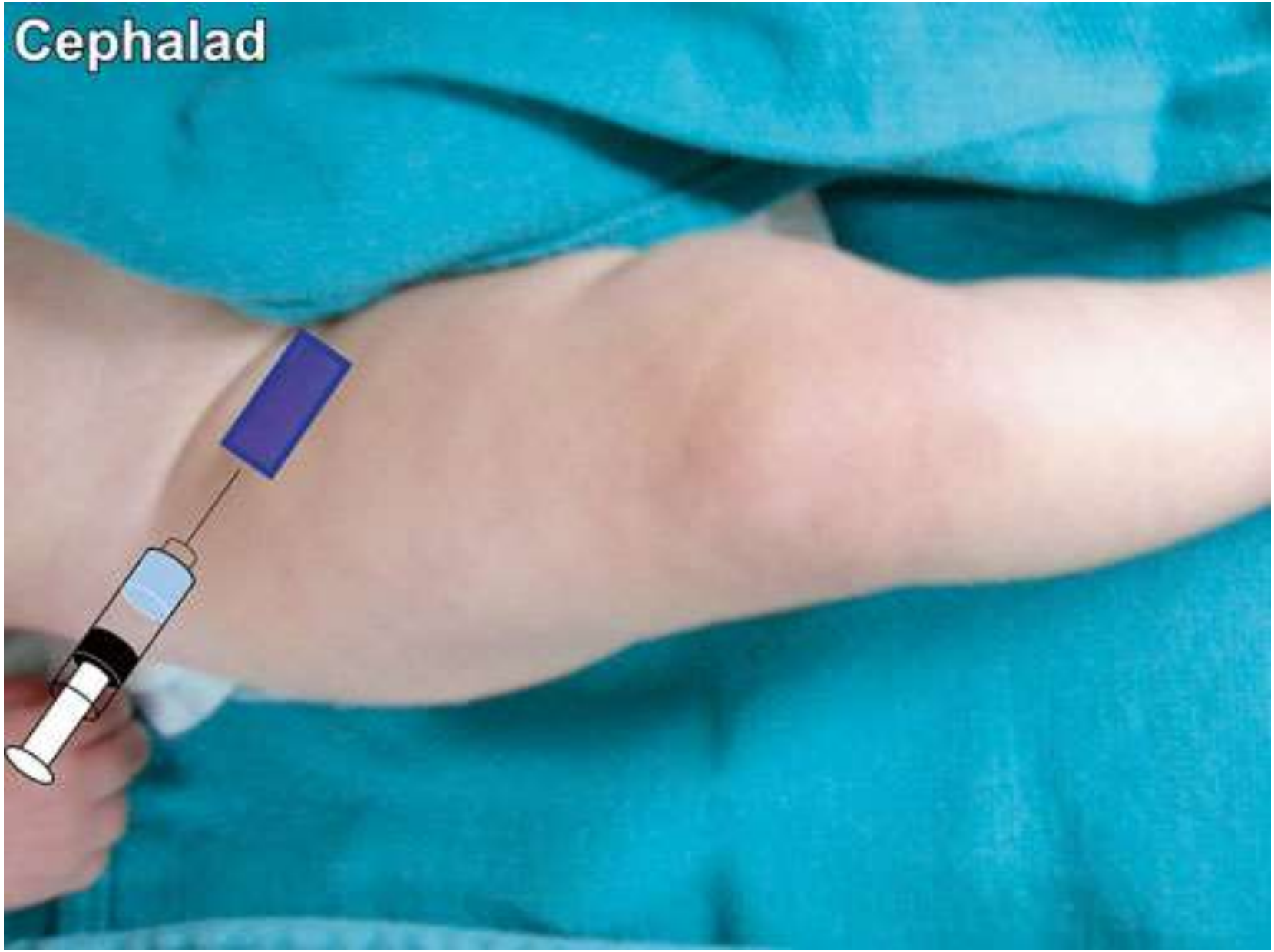
Femoral Nerve Block

- **Indications**
- Femoral nerve block provides surgical anesthesia and, primarily, postoperative analgesia in the anterior thigh and knee. Combined with a sciatic nerve block, complete anesthesia below the mid-thigh can be achieved.


Medial
Inguinal ligament
Femoral artery
Inguinal crease
Lateral


Lateral
Medial


Fascia lata
Fascia iliaca
Iliacus &
psoas major m.
Femoral artery
Femoral vein
Femoral n.
Lateral
Medial


Cephalad

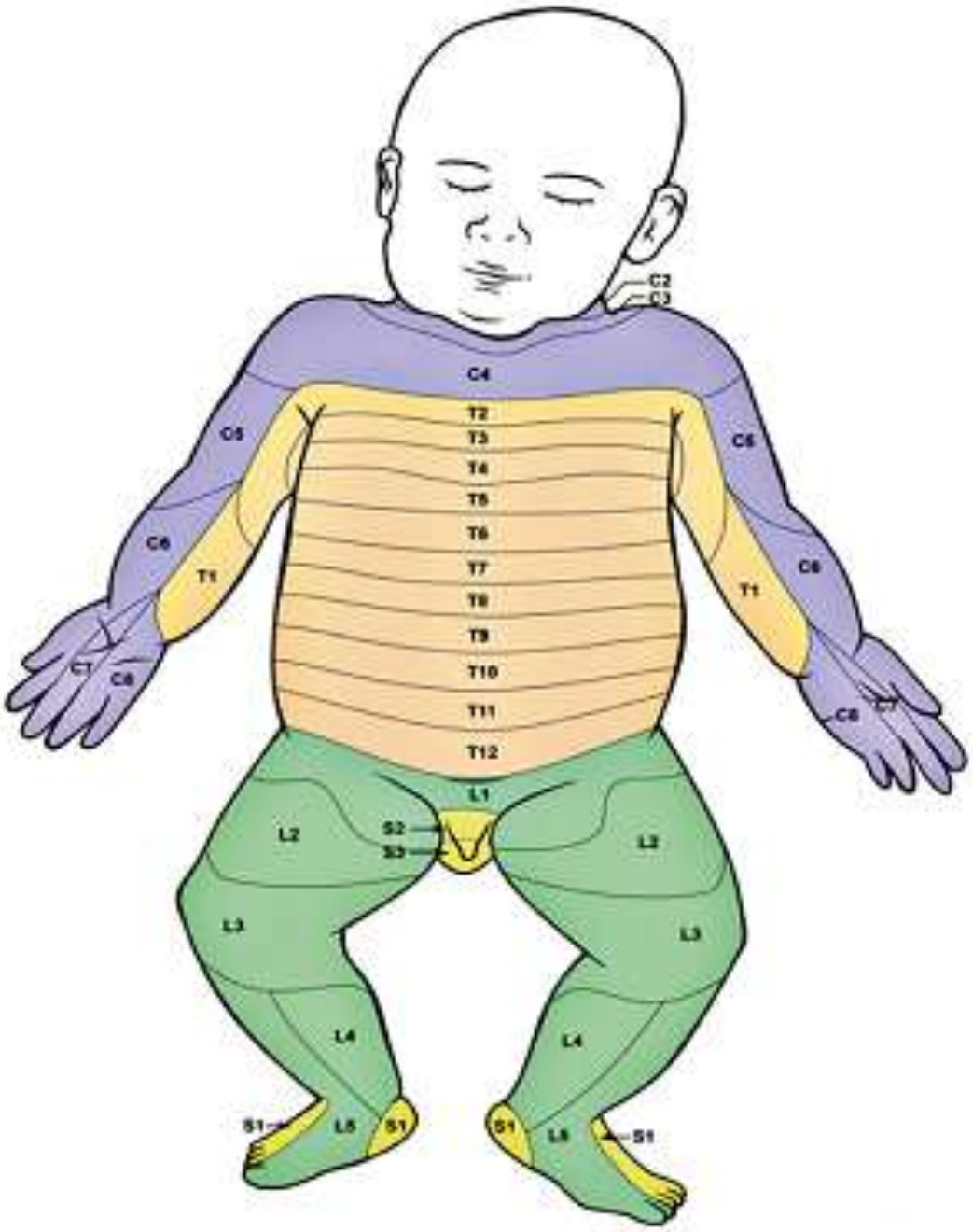
- Inject 0.2–0.5 mL/kg of 0.25 % bupivacaine or 0.2 % ropivacaine without exceeding the recommended toxic dose of local anesthetic (2 mg/kg for bupivacaine and 3–4 mg/kg for ropivacaine without epinephrine).


Cephalad
Lateral
Fascia lata
Fascia iliaca
Medial
FN
FA
FV
Iliopsoas
Femur

- An 8-year-old male, 34.2 kg,
- left knee anterior cruciate ligament reconstruction
- (10 mL 0.25 % bupivacaine)

TAP block

- The sensory innervation of the abdominal wall is derived from anterior divisions of the thoracolumbar nerves (T6–L1).


C2
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T11
T12
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C5
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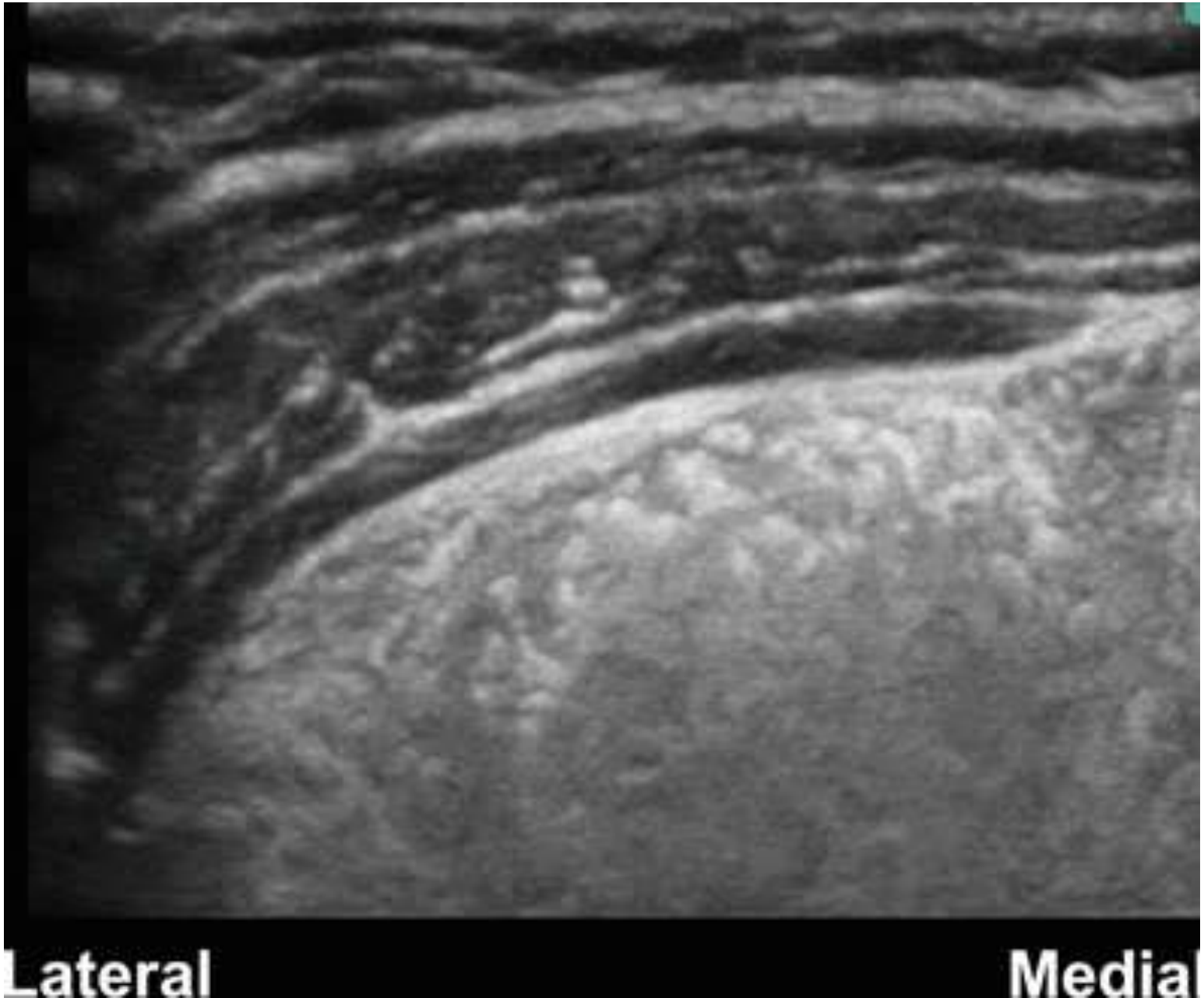
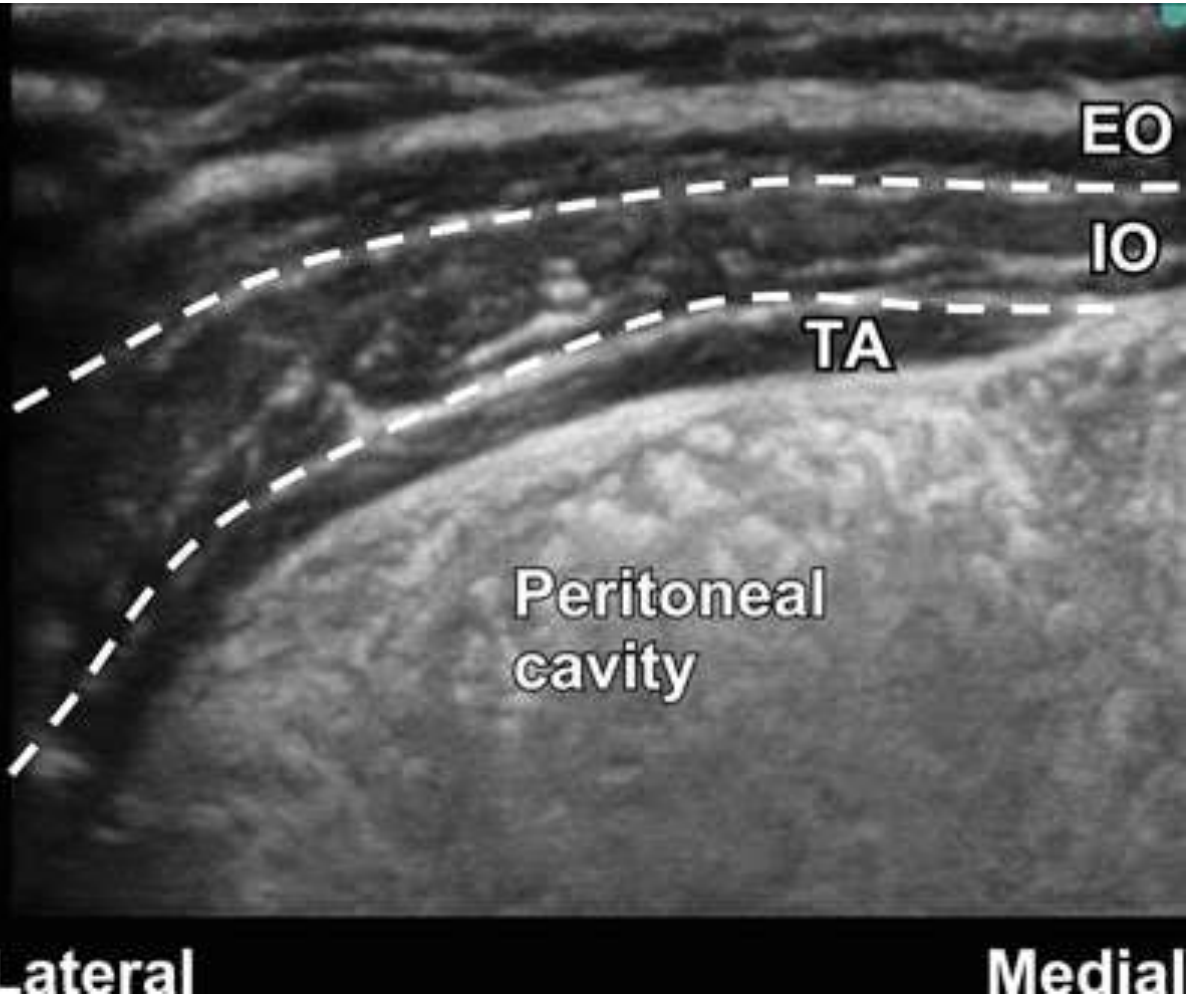
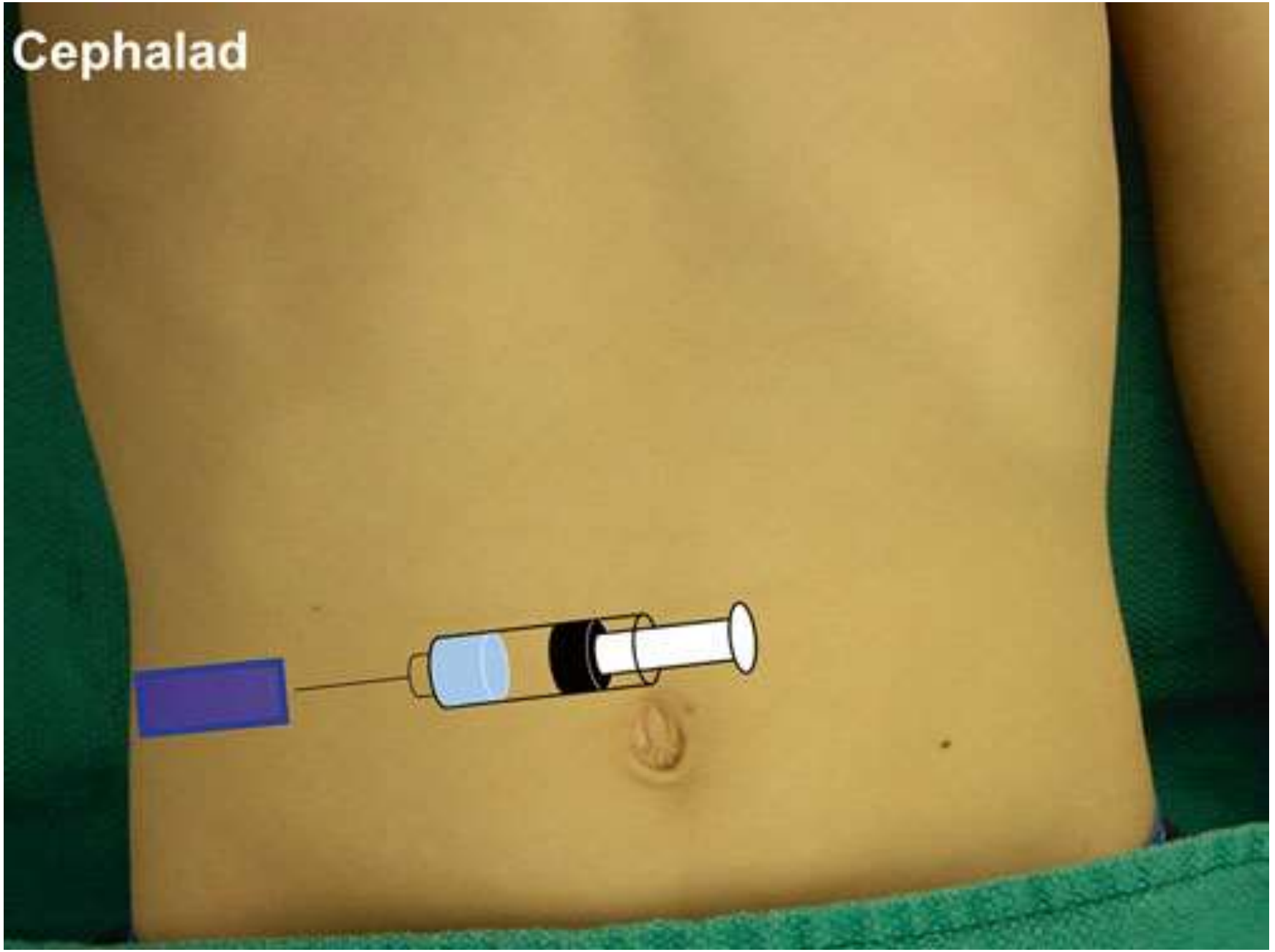
C8
T1


Lateral
Medial

EO = External abdominal oblique m.
IO = Internal abdominal oblique m.
TA = Transversus abdominis m.




Cephalad

A male toddler, 35 months old and weighing 13.5 kg, presented
for laparoscopic gastrostomy tube insertion. The
patient had a history of cystic fi brosis

- A male toddler, 35 months 13.5 kg, for laparoscopic gastrostomy tube
- a history of cystic fibrosis
- a 27G needle with an in-plane approach
- 8 ml 0.25 % bupivacaine
- with 1:200,000 epinephrine.
- Duration of surgery was 1 h, and block duration was 6 h.