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College Requirements for Blocks

- Informed consent should include discussion of risks including:
  - Nerve injury
  - Drug toxicity
  - Haemodynamic changes
  - Bleeding or bruising
  - Infection
  - Failure of technique
  - Specific risk eg Post dural puncture headache, pneumothorax

- Problems with informed consent in labour ward of PACU understood
- Should have qualified help when doing technique - tech or midwife
- Preparation:
  - Need full infection control
  - Skin prep must be dried to avoid contaminating equipment or drugs
  - Coagulation status must be assessed before all blocks
  - IV access prior & maintained during duration of technique
- Monitoring:
  - During insertion:
    - ECG, SPo2, RR, conscious state, frequent bp
    - Continue that level until 30mins after vitals stable
  - Person doing block must be around to assess satisfaction of block or until immediate complications have passed
  - May then delegate responsibility to other MDT members eg pain team
- Full record keeping incl prescription charting
- Equipment:
  - Catheters & giving sets must be well labelled and specifically a diff colour
  - Dedicated pumps with set protocols to avoid OD
- Post procedure r/v:
  - Local protocols to r/v for complications, effectiveness, side effects, timing of removal
  - Daily r/vs
  - MRI preferred to CT for nerve injury
  - Remove catheters if suspected infection and send for culture
- Late complications of neuraxial analgesia:
  - Postdural puncture headache
  - Epidural abscess
  - Epidural haematoma
  - Spinal cord or nerve root compression
Block Mnemonics

P - osition
P - reparation
A - natomy
L - andmarks
E - exection
S - ide effects

C onsent
A ssistant
L ines
M onitoring - ECG/SpO2/NIBP
S edation - conscious sedation, titratable midaz
O xygen
B lock trolley
E mergency drugs/Equipment
R esus

P robe
L ocal
A dditives
N erve
S timulator

A range
C lean & Aseptic technique - full sterile technique for indwelling line; single shot use sterile sheath & no touch technique technique

T ime out - 2 people, site, marking, consent
I maging
O ptimise image - depth, gain, frequency, focus
N ote relevant structures
S urround target with local

Good & Bad Of Regional Block

Advantages
- best possible pain relief
- ↓N&V by 90%
- ↓resp complications - esp if pre-existing pulmon disease
- quicker return of bowel function
- ↓blood loss
- ↓VTE risk - LMWH is just as good
- Better AV fistula maturation (upper limb)
- ↓cerebral desat in beach chair
- ↓chronic pain (epidural & PVB) in amputation & thoracotomy
- ??↓cancer recurrence
- ↓POCD - early, not at 3/12

Controversial
- ↓cardiac risk - MASTERS
- Unknown effect on functional recovery

Evidence for Use of Ultrasound
- ↓LAST
- ↓diaphragm paralysis in interscalene/supraclav
- faster to perform with less passes, and greater success rate
- quicker to perform and right level with neuraxial pre-scan

**Risks**

- **Physical:**
  - block failure - 10%
  - infection
  - bleeding
  - PDPH
  - Hypotension
  - neurological injury -
    - 1:200 temp nerve damage of which 95% would resolve in 1-2 weeks
    - 1:5000 beyond 6 months
- **Pharmacological:**
  - allergy
  - LAST:
    - Seizure 1:10,000
    - arrest 0:33,000
- **Physiological:**
  - neuro recovery
- **Recovery:**
  - care insensate limb
  - plan for transition from block to sensate limb with analgesia

**Nerve Anatomy**
Nerve Injury

- surgical cause of neuro injury much higher than regional
- risks:
  ‣ temp nerve damage (neurapraxia) = 1:100 - 200
  ‣ permanent nerve damage = 1:5,000
  ‣ varies by block e.g.:
    - supraclavicular = 0.03%
    - femoral = 0.3%
    - interscalene = 3%
- but highly variable:
  ‣ LM technique vs US
  ‣ which nerve block
  ‣ age
  ‣ pregnant
  ‣ co-morbidities
- intra-fascicular injection:
  ‣ high pressures within nerve \(\Rightarrow\) ischaemia
  ‣ signs:
    - high injection pressure
    - pain on injection
    - 0.2mA with dex on nerve stim
    - swelling of nerve on US with injection
  ‣ stop!
- other causes of nerve ischaemia:
  ‣ hypotension
  ‣ vascular occlusion
  ‣ haematoma pressure
  ‣ poor positioning
  ‣ stretching or direct injury during surgery
  ‣ position of pt limbs
- UL blocks have higher proportion of injury
  ‣ highest injury risk = interscalene
- low risk groups = obstetrics & paeds
- high risk groups = obese, elderly with comorbidities
- Management of nerve damage:
  ‣ early recognition
  ‣ ref to neurologist
  ‣ investigation: nerve conduction studies, MRI, EMG
  ‣ ask about profession & hand dominance

Treating Injury

- red flags:
  ‣ severe or progressive worsening pain
  ‣ complete absence of sensation
- Treat based on severity:
  ‣ mild signs eg partial sensation loss only: reassure + r/v in 2-3 week in clinic
  ‣ ongoing symptoms - nerve conduction studies in 14-21 days
- If unexplained painful deficit \(\approx\) post op inflammatory neuropathy \(\Rightarrow\) ref neurologist

Ways to Decrease Neurological Complications

- need to avoid penetrating the perineurium & entering the fascicle
- pain on injection:
  ‣ historical teaching
  ‣ evidence to suggest not a relevant factor
subjective reporting
- especially poor if co-morbidities eg diabetes

- nerve stimulation:
  - use to r/o intrafascicle location
  - use 5% dextrose to hydro-dilate & nerve stim current of 0.2mA

- ultrasonography (no evidence to support this helping):
  - operator dependant
  - unable to differentiate between intrafascicular or extrafascicular

- blunt needles

- injection pressure monitoring:
  - low resistance to injection $\approx$ extrafascicular location of needle tip (<20psi)
  - use inline devices or compressed air technique
  - highly sensitive but poor specificity ie low pressure = extrafascicular
    $\Rightarrow$ but may be other causes of high pressure eg blocked needle

- awake vs asleep debate:
  - no official ANZCA position on this except adequately trained practitioner
  - awake pro’s:
    - nerve needle contact painful
    - early signs of LAST
  - asleep pro’s:
    - no evidence dangerous
    - higher pt satisfaction
    - better teaching
    - see needle tip on US, seen neuraxial swelling, use nerve stim to avoid intra-neural injection
  - asleep cons:
    - task fixation
    - no pain feedback
    - epidural is easier upright

$\Rightarrow$ general guidance to avoid asleep injections if can.
$\Rightarrow$ inter scalene likely awake
$\Rightarrow$ use sedation & US :: not painful or disturbing

Natural Hx of PostOperative Neuropathy
- 95% will resolve within 4-6 weeks - most within 1st week
- 99% sensory changes resolve in 1st year
- refer for electrophysiologic testing if any symptoms other than sensory or neuropathy severe or long lasting:
  - EMG
  - nerve conduction studies
Local Anaesthetic Choice

- ropivacaine 0.75% (unless very short surgery use lignocaine)
- do not put any additives in mixture
  - off license use of Dex is emerging to prolong block 4mg Dex in 20mls for single shot
- variables:
  - onset = concentration
  - duration = total dose

<table>
<thead>
<tr>
<th>Aim</th>
<th>Lignocaine</th>
<th>Ropivacaine</th>
<th>Bupivacaine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical Anaesthesia</td>
<td>2%</td>
<td>0.75%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Surgical Analgesia</td>
<td>1%</td>
<td>0.375-0.5%</td>
<td>0.25%</td>
</tr>
<tr>
<td>Post-op analgesia</td>
<td>-</td>
<td>0.2%</td>
<td>0.125%</td>
</tr>
</tbody>
</table>

- Catheter: use 0.2% ropiv:
  - Inter scalene 2ml/hr with 2ml hourly pt bolus
  - Other blocks 5ml/hr with 5ml hourly pt bolus

Block Testing

- In essence check for sensation change in distribution of structure blocked
- Possible grading scale:

Motor
- 0 = none
- 1 = twitch
- 2 = weak against resistance
- 3 = full power

Sens to ice
- 0 = nil
- 1 = faint touch
- 2 = able but decr compared to other side
- 3 = full sens
Nerve Stimulators

Principle
- electrical current applied externally to nerve will induce membrane potential to reach threshold for depolarisation
- depolarisation \(\Rightarrow\) generation of action potential
- type of fibre effected determines response:
  - sensory \(\Rightarrow\) tingling/pain
  - motor \(\Rightarrow\) contraction of effector mm
- duration of stimulus required to cause depolarisation depends on type of nerve fibre allowing specificity:
  - \(A_\alpha =\) motor \(=\) 0.05-0.1ms
  - \(Ad =\) pain & temp \(=\) 0.15ms

Technique
- at a given current the current required to trigger mm contraction is proportional to the distance between needle tip and nerve fibre
- to create motor response:
  - use duration of 0.05-1ms
  - pulse frequency 1-2Hz
  - amplitude range 0-1mA
- hydro-dissection fluid is important:
  - saline conducts current \(\Rightarrow\) wider field of stimulation
  - 5% glucose does not conduct current ie stimulation immediately adjacent to tip only
- can start with large amplitude to gain general area of nerve
- then need to ↓amplitude to pinpoint:
  - [saline] target for ideal position is contraction with amplitude of 0.2-0.3mA
    - lower amplitude risks nerve damage
  - [glucose] 0.2mA would indicate intraneurial placement of needle tip - should reposition prior to LA

Needles
- general type of needle = monopolar
- needle insulated apart from small section on tip
- place neutral electrode to complete circuit
- needle tips:
  - short bevelled needle 45deg may ↓chance of nerve lesions

Tourniquet Pain
- blocks will variably cover tourniquet pain
- ischaemic pain is very difficult to mask completely \(\therefore\) even with best block pt unlikely to be able to fully tolerate prolonged tourniquet
- procedural sedation can help if problems \(\Rightarrow\) pt needs to be fully fasted as per regular guidelines
Upper Limb

Brachial Plexus
Motor Nerves
- musculocutaneous nerve - C5,6,7
- median nerve - C5,6,7,8,1
- axillary nerve - C5,6
- radial nerve, C5,6,7,8,1
- ulnar nerve, C8,T1
- long thoracic nerve - C5,6,7

[thumbs up = extension]

Axillary Nerve (C5,6)

Route:
- Through axillary space
- pass through quadrilateral space

Divisions
- divides into:
  › anterior:
    - winds round surgical neck humerus
    - supply ⇒
      • ant & mid deltoide
      • skin over lower half of deltoide
  › posterior:
    - supply:
      • post deltoide
      • teres minor
      • few fibres skin over lat upper arm

Supply

<table>
<thead>
<tr>
<th></th>
<th>Axillary</th>
<th>Ant division</th>
<th>Post division</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articular</td>
<td>shld</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensation</td>
<td>skin lower ½ deltoide</td>
<td>upper ¼ deltoide</td>
<td></td>
</tr>
<tr>
<td>Muscle</td>
<td>ant &amp; mid deltoide</td>
<td>post deltoide teres minor</td>
<td></td>
</tr>
</tbody>
</table>

- can miss cutaneous sensation around elbow

Clinical
- ↓ abduction of arm esp 15-90deg as well as weak flex/ext/rotation depending on starting position
- sensation military patch over lat deltoide lost

Radial Nerve (C5-T1)

Route
- lies post to axillary artery in axilla
- exits axilla through post wall via lower triangular space (below quadrilateral space)
- enters spiral groove of humerus
- descends obliquely between med & lat heads of triceps
- lower ½ arm pierces lat IM septum ⇒ enter anterior compartment
- runs in groove between brachialis & brachioradialis

Divisions
- in front lat epicondyle divides into
deep branch
superficial branch

Superficial Branch
- descends along anterolat of forearm
- deep to brachioradialis & lat to radial artery
- distal ⅓ forearm pierces deep fascia → superficial

Deep (Posterior) Branch
- entirely mm & articular
- enters post compartment through 2 heads of supinator
- descends between deep & superficial forearm extensors
- supplies all mm in extensor forearm compartment
- @ lower forearm lies on IO membrane

Supply

<table>
<thead>
<tr>
<th>Articular</th>
<th>Radial</th>
<th>Superficial B.</th>
<th>Deep B.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articular</td>
<td>elbow</td>
<td>skin post forearm</td>
<td>intercarpal joints</td>
</tr>
<tr>
<td>Sensation</td>
<td>skin post forearm</td>
<td>skin dorsum lat hand &amp; anatomical snuff box</td>
<td></td>
</tr>
<tr>
<td>Muscle</td>
<td>3 head of triceps</td>
<td>ECRB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>anconeus</td>
<td>supinator</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lat brachialis</td>
<td>all forearm extensors</td>
<td></td>
</tr>
<tr>
<td></td>
<td>brachioradialis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ECRL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Clinical
- Axilla injury:
  - motor: loss of ext of elbow, wrist & fingers
  - sens - as above
- mid arm:
  - motor: weak supination & loss of ext hand/fingers
  - sens: loss sensation post forearm & hand as above
- below elbow:
  - motor: weakness in wrist & hand extension only (ECRL working)
  - sens: none
Musculocutaneous Nerve (C5,6,7)

Route
- lateral to axillary artery in axilla
- pierces coracobrachialis to run underneath biceps brachi on top of brachialis
- @elbow pierces deep fascia to become lat cutaneous nerve of forearm

Divisions
- lateral cutaneous nerve of forearm

Supply

<table>
<thead>
<tr>
<th></th>
<th>M/C Nerve</th>
<th>Lat Cutaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articular</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensation</td>
<td></td>
<td>lat forearm</td>
</tr>
<tr>
<td>Muscle</td>
<td>both heads biceps brachi</td>
<td>⅔ brachialis coracobrachialis</td>
</tr>
</tbody>
</table>

Clinical
- isolated injury ⇒ weakness of elbow flex & supination
Median Nerve (C5-T1)

**Route**
- through axilla
- under cover of biceps
- starts lat to brachial artery ⇒ crosses it lower arm to medial
- @ cubital fossa:
  - gives off ant interosseous nerve (deep median)
  - lies deep to bicipital aponeurosis
  - enters forearm through 2 heads of pronator teres
- passes under fibrous arch formed by FDS
- continues in forearm underneath FDS
- @ forearm - gives off palmar cutaneous branch
- @ wrist:
  - lies between FDS & FCR
  - enters hand under flexor retinaculum

**Divisions**
- ant interosseous nerve (deep branch):
  - descends on ant aspect of IO membrane
- palmar cutaneous branch:
  - does not pass through flex retinaculum

**Supply**

<table>
<thead>
<tr>
<th></th>
<th>Median</th>
<th>Ant. IO Nerve (deep)</th>
<th>Palmar cutaneous B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articular</td>
<td>ant elbow</td>
<td>- radiocarpal</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- intercarpal</td>
<td></td>
</tr>
<tr>
<td>Sensation</td>
<td>- lat ½ palmar hand</td>
<td></td>
<td>- lat palmar skin</td>
</tr>
<tr>
<td></td>
<td>- lat 3 ½ digits dorsal &amp; palmar side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muscle</td>
<td>- pronator teres</td>
<td></td>
<td>- FPL</td>
</tr>
<tr>
<td></td>
<td>- FCR, FDS</td>
<td></td>
<td>- lat ½ FDP</td>
</tr>
<tr>
<td></td>
<td>- palmaris longus</td>
<td></td>
<td>- pronator quadratus</td>
</tr>
<tr>
<td></td>
<td>- intrinsics of hand:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- L - umbricals (lat 2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- O - opponens pollicis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- A - abductor pollicis brevis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- F - flexor pollicis brevis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Clinical**
- damage above elbow:
  - motor:
    - loss pronation of forearm
    - ape hand deformity ⇒ unable to abduct thumb or flex 1-3 digits
  - sensory loss - total loss in hand under normal distribution
- damage at forearm:
  - ant interosseous syndrome from too tight cast:
    - loss pronation forearm
    - loss flexion 1-3 digits
    - no sensory deficit
- carpal tunnel:
  - weakness in abduction & opposition of thumb
  - absence of ape hand - AbPL intact
  - sensory: numbness in digits & nail beds but normal palmar sensation
**Ulnar Nerve (C8,T1)**

**Route**
- descends lying medial to axillary artery in axilla
- continues medial to brachial artery
- @ lower arm:
  - passes back piercing IM septum
  - enters post compartment
- runs through elbow in ulna groove between med epicondyle & olecranon
- enters flexor compartment of forearm between 2 heads FCU
- Runs down lying on top FDP & under FCU
- 5cm prox to wrist splits into:
  - dorsal cutaneous branch
  - palmar branch of ulnar nerve
- palmar branch in hand splits into terminal

**Divisions**
- dorsal cutaneous branch:
  - passes backwards deep to FCU
  - becomes superficial through deep fascia
  - divides into 3 dorsal dig nerves on dorsum wrist/hand
- palmar branch:
  - enters hand superficial to flexor retinaculum in Guynons canal
  - in hand divides into terminal branches (deep & superficial Bs)
  - lies lat to pisiform

<table>
<thead>
<tr>
<th>Articular</th>
<th>Ulnar</th>
<th>Dorsal cutaneous</th>
<th>Superficial B.</th>
<th>Deep B.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensation</td>
<td>elbow</td>
<td>- dorsal skin med ½ digits</td>
<td>- nail beds &amp; palmar skin med ½ digits</td>
<td>wrist</td>
</tr>
<tr>
<td>Muscle</td>
<td>FCU, med ½ FDP</td>
<td>- Palmaris brevis</td>
<td>- AbDM, FDM, ODM, med 2 lumbricals, AdP, all interossei</td>
<td></td>
</tr>
</tbody>
</table>

**Clinical**
- Damage at elbow:
  - loss flexion 4th & 5th digits
  - claw hand deformity 4th & 5th digits at rest:
    - hyperextension of MCP joints
    - flex at IP joints
  - sens loss all aspects of ulnar nerve at hand
- Damage at wrist:
  - loss flexion 4th & 5th digit
  - claw hand as above ⇒ more prominent as ulnar half of FDP not affected ⇒ ↑ed flex at IP joints
  - sensory: no loss of sensation on dorsum of hand in ulnar distribution
- Test ulnar function:
  - interossei resistance
  - AdP - nerve twitch
  - sensation checking in hand
Suprascapular Nerve
- Comes off early in brachial plexus (roots/trunks) ⇒ innervation of shoulder
- needs interscalene to get reliable coverage

Intercostal Brachial Nerve
- not from brachial plexus ⇒ sensation into axilla
- is not relevant in tourniquet pain ie clinically irrelevant

CUTANEOUS NERVES OF UPPER LIMB

Regional Upper Limb Blocks
Comparison

<table>
<thead>
<tr>
<th>Approach</th>
<th>Indications</th>
<th>Benefits</th>
<th>Disadvantages</th>
<th>Risks/side effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interscalene</td>
<td>Upper arm/Shoulder</td>
<td>Superficial, catheter</td>
<td>Misses ulna</td>
<td>Phrenic, spinal cord, horns</td>
</tr>
<tr>
<td>Supraclavicular</td>
<td>Arm + hand</td>
<td>Single shot, tourniquet</td>
<td>No catheter</td>
<td>PTX, phrenic</td>
</tr>
<tr>
<td>Infraclavicular</td>
<td>Arm + hand</td>
<td>Catheter, tourniquet</td>
<td>Deep</td>
<td>PTX</td>
</tr>
<tr>
<td>Axillary</td>
<td>Below elbow</td>
<td>Safe</td>
<td>No tourniquet, multiple passes</td>
<td>LAST</td>
</tr>
</tbody>
</table>

Interscalene

**Indications**
- Good for shld, humerus & elbow
- Risk of missing lower roots: might still be able to move hand

---

Fig. 42.4 Ultrasound image of the C5, C6, and C7 roots lying in the plane between the two scalene muscles.
**SonoAnatomy**
- **nerve roots** visualised lateral to carotid & IJ between scalene mms
- C5 superficial ⟹ T1.
- Often only see C5,6,7
- Below 7 may be a muscle bridge which prevents spread of LA down to T1

**Method**
- Sitting up, head ring, pillow under shld to be blocked
- walk up from supraclavicular
- Block low enough to just see thyroid
- use in plane for single shot (out of plane for catheter
- 20mls of 0.75% ropiv
- nerve twitch ⟹ C5 deltoid, C6 biceps

**Side Effects**
- phrenic nerve block - in 100% ⟹ subjective SOB
- Horners syndrome
- rLN block ⟹ hoarse voice

**Complications**
- vessel puncture
- PTX
- intrathecal or epidural injection
- needle damage risk to nerves which found inside middle scalene :
  ‣ dorsal scapular nerve
  ‣ long thoracic nerve

**Supraclavicular Block**

**Indications**
- best for total arm block ie elbow, forearm, wrist or hand (arm spinal)
- only poss with ultrasound
SonoAnatomy
- [trunks & divisions on US]
- Probe flat coronal straight down into bed
  - plexus falling over 1st rib
  - Start lat and move medial
  - 1st pulsation is subclavian artery
  - Plexus lateral to artery
- Rotate probe to get artery round
- Hypoechoic bundle of grapes
- Tilt to get rib underneath target rather than pleura so to prevent overshoot of needle
- Lat to medial in plane
  - Needle tip in corner pocket of artery and 1st rib
- Second injection within plexus
- Needle tip control important
- Want to see spread of fluid amongst divisions - is not one big nerve
- 25-30mls 0.75% ropiv (smaller in elderly)

Side Effects
- Horner's syndrome - only if very high volume placed
- phrenic nerve block

Complications
- PTX
- phrenic nerve paralysis ~50% block
- artery puncture
- intravascular injection
Infraclavicular Block

Indications
- anaesthesia arm, forearm, wrist or hand surgery

Sono Anatomy
[see brachial plexus cords on US: med, lat, post]
- place probe beneath midpoint of clavicle in sagittal plane
- need subclavian artery in cross section
- in plane approach ensuring spread of LA posterior & lateral to artery
- place 20-30mls 0.75% ropiv
- twitches:
  - lat cord = elbow flexion - but too lateral!
  - post cord = wrist or finger extension (good)
  - pectoralis twitch = too superficial

Side Effects
- Horners
- (very unlikely to get phrenic nerve block)

Complications
- PTX
- artery puncture
- intravascular injection

Needle from above (head end).
Probe in position marked
Axillary Block

Indications
- Forearm, wrist or hand surgery

Sono-Anatomy
- Lighthouse: artery high in axilla perpendicular to humerus
- Arm abducted to 90% and ext rotated
- Look for: vein - too much pressure
- Can track nerves up from elbow if struggle to identify in axilla
- In plane or OOP
- Block deeper nerves first to prevent distortion superficially
- Don't forget musculocutaneous nerve which lies laterally underneath biceps and on top of coracobrachialis
- All nerves lie on anterior of fascial plane
  - 2 m's are on same side
  - Median nerve - starts lateral with artery but crosses it to medial in distal arm
  - Ulnar nerve:
    - Starts between art & vein
    - Bottom of axilla it moves to other side of vein
  - Radial nerve:
    - Between 3-6oclock ie post to artery
    - Drops down to humorous mid arm
  - M/c nerve
    - Most hyperechoic nerve in body
- 20ml total 0.75% ropiv

Side Effects
- nil

Complications
- artery puncture - compress for 5mins if so
- intravascular
- will not cover tourniquet pain:
  - axillary vein
Forearm Blocks

- Follow nerves up from location at wrist:
  - Elbow:
    - Median:
      - arm abducted, elbow slightly flexed, & supinated.
      - nerve medial & slightly deeper than brachial artery
    - Radial:
      - same position as for median block
      - block prox to flexor crease
      - nerve lateral to biceps tendon lying between brachialis & brachioradialis
  - Ulnar:
    - position should int rotated, abducted, elbow slightly flexed
    - block 2 cm prox to elbow
    - trace prox from ulnar groove. 2-3 cm see nerve running into triceps
  - Wrist:
    - Median:
      - dead central of wrist between palmaris longus & FCR
    - Ulnar:
      - medial to artery (between artery & FCU)
    - Radial:
      - divides prox to wrist: purely sensory at this stage

Biers Block

Indications
- anaesthesia for superficial arm surgery or fracture reduction
- max 30 mins surgery

Technique
- measure bp
- insert cannula into both arms (operating side should be distal back of hand)
- double tourniquet to upper arm
- exsanguinate limb with compression bandage or elevate if fractured
- inflate cuff 100 mmHg above art pressure
- inject prilocaine 7 mg/kg into cannula distal to tourniquet:
  - Metabolism in liver
  - Risk of metHb creation
- arm will feel warm & mottled
- surgery start in mins
- tourniquet must stay up for at least 15 mins
Abdomen Anatomy
- as TAP blocks

Regional Blocks Abdomen

Transversus Abdominis Plane Block
- 25% patients don't have nerve in this plane
- Single shot should last ~12hrs
- Limited evidence
- No advantage over intrathecal morphine
**Indications:**
- Analgesia for surgery on ant abdomen

**Anatomy**
- Ant abdo innervated by anterior rami of T7-L1
- Nerves run in TAP between IO & TA:
  - Thoracic nerves T7-T11: sensation to abdominal wall
  - T12
  - Ilioinguinal and iliohypogastric (both L1)
- Halfway through their course from post → lat → ant abdomen they give out lat cutaneous branches
  - These pierce IO & EO → lat abdo wall
  - Must place block more lat/post to this branching

**Sono-Anatomy**
- Probe halfway between iliac crest & costal margin as picture above
- IP technique with probe mid axillary line & needle ant to it
- Move into TAP making sure feel movement through EO & IO
- Inject 25mls 0.375% ropiv into each side (volume is more impt than conc to achieve spread)

**Complications**
- Failure - high failure rate, poor coverage, only covers skin
- Bowel puncture
- Intrahepatic/intrasplenic injection

---

**Inguinal Field Block**

**Indications**
- Inguinal hernia, orchidopexy, hydrocele surgery

**Anatomy**
- Ilioinguinal & iliohypogastric nerves:
  - Branches of lumbar plexus from L1 ant rami
  - Run along TAP then pierce IO → EO to provide sensation to lower abdo & upper thigh
- LM block =
  - Perpendicular needle 2cm medial to ASIS
  - Inject 8mls after 1st pop = IO - EO plane
  - Inject 8mls after 2nd pop = TA - IO plane
- S/C infiltration:
  - Fan wise superficial to aponeurosis → block cutaneous supply from lower intercostals & subcostals
  - Inject
    - Medial end of incision
    - Fan wise from pubic tubercle (to block contralaterals)
- Surgeon: 5mls into inguinal canal → genitofemoral nerve

**Sono Anatomy**
- Probe between ASIS & umbilicus & scan caudally
- Insert IP with needle medial to probe
- Use US to identify planes
- Inject in TAP plane

**Complications**
- Femoral nerve block
- Bowel puncture
- Intravascular injection
Rectus Sheath Block
- need to inject post border of muscle but within rectus sheath
- limited benefit
Lower Limb

Lumbar Plexus

**Nerves**
1 (twice) Get Laid On Fridays
2 from 1, 2 from 2, 2 from 3
2 GO medial of psoas (genitofemo & obturator) ⇒ rest go lateral
- Iliohpogastric (L1)
- ilio-inguinal (L1)
- Genitofemoral (L1,2)
- Lateral cutaneous nerve of thigh (L2,3)
- Obturator Nerve (L2-4)
- femoral nerve (L2-4)
**Femoral Nerve**

**Route**
- post division of ant primary rami
- runs through pelvis on top of iliacus
- emerges under inguinal ligament lateral to artery
- passes into femoral triangle where divides

**Division**
- anterior division:
  ‣ divides further into cutaneous branches (medial & intermediate cutaneous nerves of thigh)
- post division:
  ‣ divides further:
    - to supply muscles & joints
    - saphenous:
      • comes off post femoral 3cm below inguinal ligament
      • passes into adductor canal
      • pierces roof of canal to become cutaneous between sartorius & gracilis
      • descends medial side of leg

**Supply**

<table>
<thead>
<tr>
<th></th>
<th>Femoral</th>
<th>Ant F.</th>
<th>Post F.</th>
<th>Saphenous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articular</td>
<td></td>
<td></td>
<td>- knee (anterior)</td>
<td></td>
</tr>
<tr>
<td>Sensation</td>
<td></td>
<td>- med &amp; intermediate cutaneous of thigh</td>
<td>- hip</td>
<td>- skin front &amp; medial side of knee, leg, foot</td>
</tr>
<tr>
<td>Muscle</td>
<td>- iliacus</td>
<td>- sartorius</td>
<td>- quads</td>
<td></td>
</tr>
</tbody>
</table>

**Obturator Nerve**

**Route**
- from ant divisions L2,3,4
- passes down inside psoas major & emerges medial to it
- crosses sacro-iliac joint & obturator internus
- enters pelvis via opening in obturator membrane = obturator canal

**Divisions**
- divides into:
  ‣ anterior
    - with femoral nerve makes subsartorial plexus
  ‣ posterior
Supply

<table>
<thead>
<tr>
<th></th>
<th>Obturator</th>
<th>Post D.</th>
<th>Ant D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articular</td>
<td></td>
<td>- post knee incl cruciates</td>
<td>- Hip</td>
</tr>
<tr>
<td>Sensation</td>
<td></td>
<td></td>
<td>- Some skin</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>high medial</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>thigh</td>
</tr>
<tr>
<td>Muscle</td>
<td></td>
<td>- Ad Magnus</td>
<td>- Ad Longus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Obturator externus</td>
<td>- Ad brevis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Gracilis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Pectineus</td>
</tr>
</tbody>
</table>

Lumbosacral Plexus

Nerves
- Sciatic:
  - Common peroneal (L4-S2)
  - Tibial Nerve (L4-S3)
- Others:
  - Sup gluteal (L4-S1)
  - Inf gluteal L5, S1)
  - Pudendal (S2-S4)
  - Posterior cutaneous nerve of thigh (S1-3)
Sciatic Nerve

- from ventral rami
- = largest nerve in body
- emerges through greater sciatic notch under piriformis
- passes down under biceps femoris & between other hamstrings to superior corner of popliteal fossa where it divides: (although may divide higher up in thigh)
  ‣ tibial nerve
  ‣ common peroneal nerve

<table>
<thead>
<tr>
<th></th>
<th>Sciatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articular</td>
<td>hip, knee</td>
</tr>
<tr>
<td>Sensation</td>
<td></td>
</tr>
</tbody>
</table>
| Muscle   | • All hamstrings  
           | • Adductor Magnus |

Clinical

- damage to sciatic →
  ‣ loss all active movement below knee
  ‣ foot drop
  ‣ loss most of sensation (except saphenous distribution)

**Tibial Nerve (L4-S3)**

- = larger of 2 sciatic divisions

**Route**

- from sup to inf corners of popliteal fossa
- @knee gives off sural nerve (CPN also contributes to it)
- pass under fibrous arch of soleus
- @ankle lies between medial malleolus & achilles tendon (post to malleolus)
- passes under flexor retinaculum
- ends by dividing into:
  ‣ med plantar nerve
  ‣ lateral plantar nerve

**Divisions**

- sural nerve:
  ‣ passes down leg post to lat malleolus

**Supply**

<table>
<thead>
<tr>
<th></th>
<th>Tibial</th>
<th>Sural</th>
<th>Med &amp; lat plantars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articular</td>
<td>- Ankle</td>
<td>- Post-Lat side distal ½ leg</td>
<td>- Ant ⅔ sole of foot</td>
</tr>
<tr>
<td></td>
<td>- knee</td>
<td>- lat border of foot</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Sup tib/fib</td>
<td>- 5th toe except distal phalanx</td>
<td></td>
</tr>
<tr>
<td>Sensation</td>
<td></td>
<td>- Intrinsic mm’s of foot</td>
<td></td>
</tr>
<tr>
<td>Muscle</td>
<td>- Both heads gastro</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- soleus</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- plantaris</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- popliteus</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- tip post, FDL, FHL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Common Peroneal Nerve (L4-S2)

Route
- down upper lateral border of popliteal fossa
- runs behind tendon of biceps femoris
- gives off supply to sural nerve (also from tibial nerve)
- winds round head fibula
- here divides into:
  - deep branch
  - superficial branch

Divisions
- Deep branch:
  - runs under EDL
  - descends on ant aspect of IOM
  - passes under ankle extensor retinaculum
  - in foot divides into:
    - med branch
    - lateral branch
- Superficial branch:
  - runs down under peroneus longus
  - ⅔ down leg divides into:
    - med branch
    - lat branch

Supply

<table>
<thead>
<tr>
<th>Common Peroneal</th>
<th>Deep CPN</th>
<th>Superficial CPN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Articular</strong></td>
<td>- Knee</td>
<td>- Inf tib fib</td>
</tr>
<tr>
<td></td>
<td>- sup tib fib</td>
<td>- ankle</td>
</tr>
<tr>
<td><strong>Sensation</strong></td>
<td></td>
<td>ant/lat aspect of leg</td>
</tr>
<tr>
<td><strong>Muscle</strong></td>
<td></td>
<td>- EDL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Tib Ant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- EHL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- peroneus tertius</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deep Medial</th>
<th>Deep Lateral</th>
<th>Sup Medial</th>
<th>Sup Lateral</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Articular</strong></td>
<td>- Small joints of foot</td>
<td>- Med side of dorsum of foot</td>
<td></td>
</tr>
<tr>
<td><strong>Sensation</strong></td>
<td>- Skin between 1st &amp; 2nd toe</td>
<td>- Hallux</td>
<td></td>
</tr>
<tr>
<td><strong>Muscle</strong></td>
<td>- EDB</td>
<td>- 2nd &amp; 3rd toes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- skin between 3rd-4th &amp; 4th-5th toes</td>
<td></td>
</tr>
</tbody>
</table>
Cutaneous Supply to Lower Limb
Lower Limb Blocks

Lumbar Plexus Block

Indications
- surgery hip, knee or femoral shaft surgery
- if for lower leg need to combine with sciatic block

Anatomy
- nerves of plexus lie within body of psoas muscle
- side lying, curled, side to be blocked upper
- Tuffiers line then move ~4cm parallel lateral (⅓ towards line with PSIS’s)
- insert needle perpendicular to skin
- insert until contact transverse process ~4-7cm in
- redirect slightly cephalad or caudal
- correct position reached ~6-9cm with quadriceps contraction ⇒ dancing patella

Sono-Anatomy
- curvi-linear probe
- identify L4 transverse process by coming up from sacrum in para-sagital plane
- rotate probe to transverse and attempt to identify position to just miss transverse process with needle
- use with nerve stimulation - looking for twitches with 0.5-1mA with saline

- 0.75% ropiv 20-30ml

Side Effects
- epidural spread

Complications
- intrathecal injection
- LAST
- intra-adbo organ damage
- intravascular injection

Tips
- nerve stim 0.2mA ≈ intraneural .: risk of nerve damage on injection & spread of LA up to epidural spaces
Fascia Iliaca Block

**Indications**
- #NoF
- Hip surgery

**Anatomy**
- junction middle & lateral thirds of the femoral crease (lateral to fem nerve)
- 2 pops needed:
  ‣ 1st pop = fascia lata
  ‣ 2nd pop = fascia iliaca

**Sono-Anatomy**
- use to ensure in correct plane
- need tip in between sartorius (above) & iliacus (below)
- place 20-30mls 0.75% ropiv

**Side Effects**
- nil

**Complications**
- nil

Femoral Nerve Block

**Indications**
- analgesia for femoral shaft & knee
- combine with sciatic to produce analgesia below knee

**Sono-Anatomy**
- go proximal to fem artery giving off profunda
- deposit LA deep & medial to fem nerve
- 3 in 1 block=
  ‣ apply pressure 2-3cm distal to site of injection in order to get prox spread of LA
• hope to block obturator & lat cutaneous of thigh
  → very unreliable

**Side Effects**
- nil

**Complications**
- arterial puncture
- intravascular injection

### Lateral Cutaneous Nerve of Thigh

**Sono-Anatomy**
- nerve runs under inguinal ligament just medial to ASIS
- runs over sartorius mm
- slide probe from medial to lateral at level of femoral block to identify lateral margin of sartorius
- located between fascia lata & fascia iliaca
- 5-10mls sufficient
Sciatic Nerve Block
- multiple approaches:

<table>
<thead>
<tr>
<th>Approach</th>
<th>Benefits</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subgluteal</td>
<td>Proximal in nerve, posterior cutaneous nerve</td>
<td>Deep</td>
</tr>
<tr>
<td>Anterior</td>
<td>Supine position</td>
<td>Really deep!</td>
</tr>
<tr>
<td>Popliteal</td>
<td>Superficial, catheter</td>
<td>Distal in nerve, lower leg only</td>
</tr>
</tbody>
</table>

Subgluteal Approach

Anatomy
- Labat approach:
  - recovery position as above
  - mark PSIS, Greater trochanter & sacral hiatus
  - draw lines as above: 3rd line perpendicular from midpoint between PSIS & GT
  - where crosses GT-SH line = needle insertion site - depth 5-10cm
Sono-Anatomy
(need pt in full lateral)
- curvilinear probe - in or out of plane, placed over site
- lateral, mid point between ischial tuberosity & greater trochanter
- target nerve between glut max & quadratus femoris
  - size of nerve means need LA placed medial & lateral to nerve
- useful to use twitches (1mA) to localise needle tip:
  - best for tibial = plantar flexion of foot
  - best for common peroneal = eversion of foot
- 15-30ml of LA

Anterior Sciatic Block

Positioning
- avoid need for lateral or recovery position
- slight abduction & ext rotation ⇒ allow access to anterior medial aspect of proximal thigh with

Sono-Anatomy
- very deep block
- not suited to catheter insertion
- curvilinear probe in at level of lesser trochanter in horizontal plane
- identify femoral artery +/- profunda (deep & medial to FA)
- sciatic nerve seen flattened oval between Adductor magnus and hamstrings at approx 6-8cm
- if difficult to see ask pt to DF/PF ankle which can show up nerve
- use OOP with very steep needle angle
- hydrodissection will help identify depth level of needle tip as approaches sciatic nerve
- inject 20mls on top of nerve
Popliteal Sciatic Block

Indications
- ankle & foot surgery

Sono-Anatomy
- patient supine with externally rotated hips & slightly flexed knee
- scan transversely through popliteal fossa distal to proximal looking for divisions of sciatic coming together

- inject in or OOP just distal to branching 5-10cm above popliteal fossa
- note in some sciatic is 2 distinct nerves the length of the leg
- possible to mistake tendons for nerves - get patient to DF/PF foot to show up tendons
Saphenous Nerve/Adductor Canal Block

**Indications**
- commonly done with popliteal to gain complete lower limb/foot coverage

**Sono-Anatomy**
- scan medial side of mid thigh looking for adductor canal & superficial femoral artery
- if can't find artery follow it down from inguinal crease
- then deposit LA either side of artery
Ankle Blocks

Anatomy
- 5 nerves innervate foot - need to block all individually

Technique

<table>
<thead>
<tr>
<th>Supply</th>
<th>LM Block</th>
<th>Sono-Anatomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>saphenous</td>
<td>Medial ankle &amp; foot</td>
<td>- 5mls from med malleolus anterioy</td>
</tr>
<tr>
<td>Sural</td>
<td>Lat foot &amp; 5th toe</td>
<td>- 5mls from lat malleolus inferiorly to TA</td>
</tr>
<tr>
<td>Tibial</td>
<td>Sole of foot</td>
<td>- 5mls post to tib artery behind med malleolus just above bone</td>
</tr>
<tr>
<td>Sup peroneal</td>
<td>Dorsum of foot</td>
<td>- 10ml fanning laterally across dorsum of foot 2-3cm distal to intermalleolar line</td>
</tr>
<tr>
<td>Deep peroneal</td>
<td>Web space 1st &amp; 2nd toes</td>
<td>- 5ml just lat to dorsalis pedis artery just above bone</td>
</tr>
</tbody>
</table>

Side Effects
- nil

Complication
- arterial puncture
- bruising
Trunk Blocks

Anatomy of Nerve Supply to Thorax & Abdomen
- mm & skin of chest & abdo supplied by spinal nerves from T2-T12
- contribution from L1 in inguinal region
- mixed spinal nerves emerge from intervertebral foramen into paravertebral space
- in PVB space they divide:
  ‣ dorsal rami $\Rightarrow$ dorsum of trunk
    - deep muscles
    - skin
  ‣ ventral rami $\Rightarrow$
    - intercostal nerves $\Rightarrow$ neurovascular plane between intercostals $\Rightarrow$ ant cutaneous nerve
    - lat cutaneous branch given off before costal angle $\Rightarrow$ pierces intercostals to become more superficial in midaxillary line

Superficial Cervical Plexus Block

Indications
- analgesia for carotid surgery or central lines

Anatomy
- primary rami of C2-C4 found behind post border of SCM
- they fan outwards and branch into 4 nerves (which need blocking):
  ‣ lesser occipital
  ‣ greater auricular
  ‣ cutaneous cervical
  ‣ supraclavicular
- LM technique:
  ‣ head turned away
  ‣ identify post border of SCM (by asking pt to turn head towards side against resistance
  ‣ injection point = midpoint of SCM (at level of cricoid cartilage (C6)
  ‣ pierce 1st fascial layer and infiltrate along & underneath SCM
3cm caudad & cephalad from injection point

**Sono-Anatomy**
- transverse scan up neck looking at post border of SCM
- identify emergence of nerves
- use IP approach to inject deep under lat border of SCM
- ensure not injecting into carotid, IJ & EJ

**Side Effects**
- Horner's
- phrenic nerve block
- vagus nerve block

**Complications**
- vessel puncture $\Rightarrow$ haematoma
- intravascular injection

---

**Intercostal Block**

![Intercostal block diagram](image)

**Indications**
- analgesia for fractured rib
- ICD insertion
- open cholecystectomy

**Anatomy**
- nerves run:
  - underneath each rib in neurovascular bundle
  - inbetween internal & innermost muscle layers
- before costal angle $\Rightarrow$ give off lateral cutaneous branch $\Rightarrow$ supplies late trunk & abdo
- cross over innervation means have to block at least 1 level above & below
- LM technique:
  - identify correct rib level:
    - count down from spinous process C7
    - upwards from 12th rib
    - down from inf border of scapula T7
  - inject in post axillary line (or further posterior ie behind angle of rib)
  - palp sup & inf borders of rib above & below
  - stretch skin slightly cephalad
  - insert 22G needle perpendicular to touch cauda border of rib. withdraw 2mm
  - relax skin (needle now angulated caudad)
  - advance past rib border feeling pop as it pierces fascia of internal intercostal mm
- aspirate then inject 3-5ml/level

**Sono-Anatomy**
- prob in sagital plan as LM technique
- look for pleura
- use IP (needle entry caudad) or OOP
- move needle tip to caudad border of rib above just above pleura
- LA injection in correct plane ⇒ depression of pleura inwards

**Side Effects**
- vascular space ⇒ risk of toxicity if multiple levels blocked

**Complications**
- PTX
- haematoma

**Notes**
- PVB or epidural much better options if multiple level or longer block required
- good option if pt anticoagulated
- avoid PTX!!!

---

**Thoracic Paravertebral Block**

**Indications**
- breast surgery
- thoracotomies
- open cholecystectomies
- renal surgery/fractured ribs

**Sono-Anatomy**
- ultrasound in para-saggital plane so can see multiple transverse processes on screen (2-3cm off mildine to operative side)
- need to visualise pleura & slightly above superior costo-transverse ligament
- slow movement into space in plane with careful needle tip control so as not to puncture pleura
- 15-20ml at single level to attain spread cauda & cephalad
**Boundaries**
- **Ant/lat:**
  - Parietal + visceral pleura
  - pleural space
  - lung parenchma
- **Medially:**
  - Vertebral body, disc, foramina
- **Laterally:**
  - post intercostal membrane
  - intercostal space
- **Post:**
  - SCTL
  - rib

**Side Effects**
- epidural spread
- SNS block

**Advantages**
- as good as epidural for analgesia with ↓ side effects
- mastectomy under PVB alone - limited evidence to suggest ↓ Ca recurrence
- infection/haematoma away from spinal cord

**Disadvantages**
- ↓ spread of segments covered above & below

**Complications**
- PTX
- LAST
- intravascular injection
- ischaemia/abscess

**Neuraxial Techniques**

**Anatomy**
- Spinal cord terminates as conus medullaris
  - adults: L1 lower border of vertebral body adults
  - infants: L3
- conus medullaris attached to coccyx by filum terminale:
- neural fibrous band
- surrounded by cauda equina:
  - = nerves of lower Lx & Sx roots
  - ∴ runs from L1 - S2
- meninges in bony vertebral column:
  - pia mater: (deep)
    - high vascular
    - closely envelops cord ⇒ creates filum terminale
  - arachnoid mater:
    - non vascular
    - delicate
    - effectively adhered to dura mater
  - dura mater (superficial):
    - longitudinally organised fibroelastic membrane
    - continuous from cranial dura mater ∴ runs foramen magnum ⇒ S2 (attaches to coccyx)
- spaces:
  - Subarachnoid space (between pia mater & arachnoid mater)
    - contains:
      - CSF
      - spinal nerves
      - trabecular network
      - blood vessels which supply spinal cord
      - dentate ligaments - lat extensions of pia mater - supply lat support from bone to spinal cord
    - space ends S2 in adults (lower in children)
      ⇝ despite spinal cord ending at L1-L2
    - Extends laterally along nerve roots to dorsal root ganglia
  - Subdural space =
    - potential space inbetween dura & arachnoid mater
    - not used intentionally by anaesthetists
    - symptoms of injection: (see later)
  - Epidural space =
    - from foramen magnum to sacral hiatus
    - outside boundaries:
      - ant: PLL
      - lat: pedicles & intervertebral foramina
      - post: ligamentum flavum
      - cephalad: foramen magnum
      - caudal: coccygeal ligament
    - internal boundaries = dura mater
    - = a low pressure area containing:
      - areolar tissues
      - loose fat
      - blood vessels & lymphatics
      - internal vertebral venous plexus
    - is segmented & discontinuous with:
      - epidural space septa - explain unilateral block
      - dorsal median connective tissue
  - Ligamentum flavum:
    - nonuniform ligament, different space to space
    - composed of 2 curvilinear ligaments which join in the middle
maximal thickness in Lx region 2-5mm

Vertebral Anatomy

Overview

Cervical Vertebrae
**Thoracic Vertebrae**

- Intervertebral facets on arc of circle
- Transverse process
- Spinal canal
- Articular facets for ribs
- Body
- Superior articular facet
- For rib
- Demifacets for ribs
- Vertebral notch (for spinal nerve)
- Spine
- Interior articular facet

**Lumbar Vertebrae**

- Spine
- Superior articular facets (face postero-medially)
- Transverse process
- Spinal canal
- Body
- Pedicile
- Interior articular facet (faces antero-laterally)

**Sacral Vertebrae**

- Sacral canal
- Direction of emerging nerve
- For L 5
- For ilium (sacroiliac joint)
- Posterior foramina seen through anterior foramina
- Coccyx
- Sacral promontory
Structures When Passing Needle
- Skin to sub arachnoid space:
  - skin
  - sub cut fat
  - supraspinous ligament
  - interspinous ligament
  - ligamentum flavum ⇒ give of resistance
    ⟹ = 1st pop
  - dura & arachnoid mater (hopefully together)
    ⟹ = 2nd pop

Epidural Analgesia
- Can provide complete analgesia for 3-5 days

Benefits
- Efficacious
- ↓ ed atelectasis & pulmon infection, better cough
- ↓ post op ACS:
  - ↓ sympathetic stress thus ↓ myocardial oxygen requirement
  - ↓ hypercoagulable states & fibrinolytic function is improved
    ↓ proven benefit in graft survival in vascular surgery
- Quicker post op mobility ⇒ ↓ post op DVT
- ↑ gut action by ↓ pain & ↓ opiate need ie less ileum
- Intraop epidural ↓ s post op blood transfusions
  ↓ BUT no ↑ survival benefit in high risk patients

Disadvantages
- complications of insertion
- hypotension
- Pruritus: epidural > spinal
- ↑ anaesthetic time
- ↑ ed post op care needed
- does not cover visceral pain - only somatic

Contraindications
- Patient refusal
- Untrained staff
- Contraindications to needle placement:
  - Local or general sepsis
  - Hypovolaemia
  - Coag disorders:
    - Platelets <80
    - INR >1.5
  - Concurrent anticoag drugs
  - Central neurological diseases

Tips
- Breakthrough pain:
  - Add oral paracetamol or NSAID
  - Bolus dose 3-5ml then ↑ infusion rate
  - Check all connections and infusion site
  - Check block - if patchy withdraw catheter to 2cm in space
  - Bolus fentanyl 50-100mcg or pethidine 25-50mg
• Pruritis:
  • Give naloxone 50-100mcg & consider adding 300mcg to infusion fluids
  • Remove opioid from infusion
  • Try antihistamines or ondansetron
• Hypotension:
  • Check fluid status
  • Check block height ⇒ ↓ infusion rate
  • Ephedrine/metaraminol
• Motor block -
  • ↓ infusion rate
  • ↓ LA concentration
• Shivering: try fentanyl, pethidine, tramadol, ondansetron

Complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Incidence (%)</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dural puncture</td>
<td>0.16–1.3</td>
<td>Bed rest, analgesia, hydration, blood patch (see p748)</td>
</tr>
<tr>
<td>Headache</td>
<td>16–86</td>
<td>Bed rest, analgesia, hydration, suspect dural puncture</td>
</tr>
<tr>
<td>Nerve or spinal cord injury</td>
<td>0.016–0.56</td>
<td>Immediate neurological assessment (see p32 and p1178)</td>
</tr>
<tr>
<td>Catheter migration</td>
<td>0.15–0.18</td>
<td>Remove catheter and reSITE if appropriate</td>
</tr>
<tr>
<td>Epidural haematoma</td>
<td>0.0004–0.03</td>
<td>MRI or CT scan, immediate neurosurgical assessment, Antibiotics (see also p1105 and p1171)</td>
</tr>
<tr>
<td>Epidural abscess</td>
<td>0.01–0.05</td>
<td></td>
</tr>
<tr>
<td>Respiratory depression</td>
<td>0.13–0.4</td>
<td>Decrease in opioid concentration may be required</td>
</tr>
<tr>
<td>Hypotension</td>
<td>3–30</td>
<td>IV fluids ± vaspressors. Temporarily reduce or stop infusion</td>
</tr>
<tr>
<td>Pruritus</td>
<td>10</td>
<td>Naloxone IV (50–100µg) ± antihistamine</td>
</tr>
<tr>
<td>Urinary retention</td>
<td>10–30 (males)</td>
<td>Check for catheter migration. Consider epidural haematoma (p1171 and p1174)</td>
</tr>
<tr>
<td>Motor block</td>
<td>3</td>
<td>Catheterisation</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>Possible increased risk of anastomotic leakage after bowel surgery. No evidence to support this</td>
</tr>
</tbody>
</table>

• Spinal infection:
  • Classic triad of epidural abscess (0nly seen together in 13%):
    - Fever (66% on own)
- Backache (75% on own)
- Neurological signs (very late sign)
- Normal bloods mean nothing
- If suspect should remove immediately and send line tip to lab
- 90% infections are bacterial (mostly staph aureus)
- MRI early before neurology develops
- Once muscle weakness develops:
  - only 20% will regain full function even after surgery
  - Better prognosis: <36hrs, extent compression, younger
- Mortality 10%
- Needs percutaneous aspiration & Abx

**Drugs in Epidural**
- Standard protocols used in different institutions:
  - Light mix - bupivacaine 0.125% & fentanyl 2mcg/ml
- Infusion rates:
  - 8-15ml/hr adult
  - 4-8ml/hr >70yr olds

**Spinal Anaesthesia**

**Dosing**
- Older & pregnant need less
- 2.5 - 3mls of hyperbaric will reach T6-T10 in most non pregnant young if placed in lying shortly after injection
- If isobaric LA given dose needs to be higher
- Lignocaine not used
- Ropivocaine not licensed for intrathecal use
- Hyperbaric solutions:
  - Used to get higher block
  - More hypotension
- Isobaric:
  - Produce lower block height
  - Less hypotension

**Contraindications**
- Absolute:
  - Local sepsis
  - Refusal
  - Anticoagulation (see epidural)
- Relative:
  - Aortic or mitral stenosis
  - Hypovolaemia/hypotension
  - Prev back surgery - possibly technically difficult
  - Neurological disease
  - Spinal stenosis - ↑↑ed risk of complications
  - Systemic sepsis - ↑ed risk of meningitis/epidural abscess

**Complications**
- Hypotension
- Bradycardia -
  - block into mid thoracic region
• Can progress to cardiac arrest
  • High block ⇒ compromised breathing ⇒ total spinal
    • Urinary retention
    • Nerve damage -
      - permanent injury 1:25,000 to 1:50,000
      - Paraplegia or death 1:50,000 to 1:140,000
• Post dural puncture headache
• Infection/Abscess
• Meningitis - 1:50,000
• Bleeding - ↑ed risk with epidural

Complications of Neuraxial Block

Hypotension
• Avoid aortocaval occlusion (pregnancy) ⇒ move to full lateral position
  └ measure bp on dependant arm
• IV fluid bolus
• Vasopressor/inotrope - ephedrine vs metaraminol

Subdural block
• When epidural catheter placed between dura mater & arachnoid mater
• Less than 1:1000 BUT may be indistinguishable from epidural placement
• Definitive diagnosis is radiological
• Characteristics of subdural block:
  • Slow onset 20-30min which is much more extensive than volume should dictate
    └ may extend to Cx dermatomes with Horners syndrome
  • Patchy & asymmetrical block with sparing of motor fibres to LLs
  • Total spinal with top up dose
    └ due to ↑volume ⇒ rupture of arachnoid mater
• Rx by stopping infusion and re-siting catheter

Total Spinal
• If initial plan is epidural incidence = 1:5,000 - 1:50,000
• Features:
  • Rapid onset BUT can be delay upto 30mins
    └ change maternal position or migration of catheter
  • Rapid rising block
  • Impaired coughing
  • Loss hand/arm strength
  • Difficulty talking, breathing & swallowing
  • Cardiovascular depression ⇒ resp paralysis ⇒ unconsciousness ⇒ fixed dilated pupils
• Rx:
  • Maintain airway & ventilation
    └ may need intubation if if not fully unconscious in order to protect airway
  • Avoid aortocaval compression (pregnant)
  • Ventilation for 1-2hours may be required

IV injection of LA
• IV or partial IV catheter poisoning occurs in at least 5% epidurals
• Every dose is a test dose
• Strategies to reduce risk:
  ‣ Always check for blood in catheter
  ‣ Always think of LA poisoning with every dose even if prev had no issues
  ‣ Divide all large LA doses into smaller aliquots
  ‣ Use low toxicity LAs
• LA toxicity algorithm

**Treatment of Neuro Complication**
- Assess patient promptly
- Full neuro exam well documented
- Initiate appropriate Rx asap:
  ‣ Abx
  ‣ Ref to neurologist/neuro surgeon
  ‣ Imaging - MRI

**Techniques to Prevent Injury**
- US prescan
- Don't perform technique if spinal stenosis
- Comply with anticoag guidelines
- Avoid intra-op hypotension
- Chlorhex:
  ‣ Keep away from block material - use lollipops not poured clear fluids
  ‣ Allow to dry on skin 2-3 min
  ‣ Use 0.5% chlorhex
- Avoid asleep neuraxial in adults
## Coagulation Disorders

### Drugs used in Neuraxial & Deep blocks

Based on Uk doc. US (ASRA) much more conservative

<table>
<thead>
<tr>
<th>Drug</th>
<th>Time to Peak Effect</th>
<th>Elim ½ life</th>
<th>Time after Drug before Block</th>
<th>Administration of drug with neuraxial in place</th>
<th>After block or catheter removal for next drug dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>UFH IV</td>
<td>&lt;30min</td>
<td>1-2hrs</td>
<td>4h or norm APTT</td>
<td>caution</td>
<td>1hr</td>
</tr>
<tr>
<td>LMWH prophylaxis</td>
<td>3-4hr</td>
<td>3-7hr</td>
<td>12hr</td>
<td>caution</td>
<td>4-6hrs</td>
</tr>
<tr>
<td>LMWH Treatment</td>
<td>3-4hr</td>
<td>3-7hr</td>
<td>24hr</td>
<td>not recommended</td>
<td>4-6hrs</td>
</tr>
<tr>
<td>Bivalirudin</td>
<td>5min</td>
<td>25min</td>
<td>10hr or norm APTT</td>
<td>not recommended</td>
<td>6hrs</td>
</tr>
<tr>
<td>NSAIDs</td>
<td>1-12 hrs</td>
<td>1-12 hrs</td>
<td>no probs</td>
<td>no probs</td>
<td>no probs</td>
</tr>
<tr>
<td>Aspirin</td>
<td>12-24hr</td>
<td>irreversible</td>
<td>no probs</td>
<td>no probs</td>
<td>no probs</td>
</tr>
<tr>
<td>Clopidogrel</td>
<td>12-24hr</td>
<td>irreversible</td>
<td>7days</td>
<td>not recommended</td>
<td>6hr</td>
</tr>
<tr>
<td>Ticagrelor</td>
<td>2hr</td>
<td>8-12hr</td>
<td>5 days</td>
<td>not recommended</td>
<td>6hr</td>
</tr>
<tr>
<td>Dipyridamole</td>
<td>75min</td>
<td>10hr</td>
<td>no probs</td>
<td>no probs</td>
<td>6hr</td>
</tr>
<tr>
<td>Warfarin</td>
<td>3-5days</td>
<td>4-5days</td>
<td>INR &lt;1.5</td>
<td>not recommended</td>
<td>immediate post</td>
</tr>
<tr>
<td>Rivaroxaban Proph CrCl &gt;30 Rx CrCl &gt;30</td>
<td>3hrs</td>
<td>7-9hr</td>
<td>7-11hr</td>
<td>18hr 2day</td>
<td>not recommended</td>
</tr>
<tr>
<td>Darbepoetin</td>
<td>0.5-2hrs</td>
<td>12-17hrs 15hr 18hr</td>
<td>2d</td>
<td>3d</td>
<td>4d</td>
</tr>
<tr>
<td>CrCl &lt;50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrombolytic drugs</td>
<td>&lt;5min</td>
<td>4-24mins</td>
<td>10 days</td>
<td>not recommended</td>
<td>10 days</td>
</tr>
</tbody>
</table>

- no concern over herbal medicines
- reversal agent for dabigatran now available = idarucizumab
Evidence For Regional

- lot of studies - RA may be beneficial for some people, for some things
- no studies to demonstrate worse outcomes than GA - only conflicting evidence
- specific patients & settings where clearly beneficial/useful

- DVT risk is ↓ed compared to GA (but that is eliminated with chemical prophylaxis)
- better pain management
- ↓ bleeding post major joint operations
- ↓POCD in short term (no diff long term)
- limited ↓Ca recurrence in breast Ca
- suggest ↓ chronic pain esp in thoracic surgery

- risks of regional complications are small:
  - post op pain:
    - block wearing off - start analgesia very early when block wearing off ie first return of sens
    - select for procedures not painful post op
    - ie have plan