Regional Anaesthesia

Regional anaesthesia involves the introduction of drugs with the intention of blocking the nerve supply to a specific part of the body such as a limb. In most cases it provides a safer alternative to general anaesthesia as well as prolonged postoperative analgesia. Regional anaesthesia is achieved by using local anaesthetic drugs that block nerve conduction.

Types of Regional Anaesthesia

A. Central Neural Blocks
   - Spinal anaesthesia (intrathecal or subarachnoid block)
   - Epidural anaesthesia
   - Caudal anaesthesia
B. Peripheral Nerve Blocks
C. Intravenous Regional Anaesthesia (IVRA)
D. Topical and Infiltration anaesthesia
E. Others: Intrapleural analgesia, ophthalmic anaesthesia

Advantages of regional anaesthesia

1. Conscious patient - able to warn of adverse effects (during carotid surgery, and trans-urethral resection of prostate), less interruption of oral intake.
2. Avoidance of adverse effects of general anaesthesia like nausea, vomiting, sore throat and hang over.
3. Effects of general anaesthesia respiratory function and mechanics can be avoided when appropriate regional technique is chosen.
4. Avoids hazards of unconsciousness like aspiration of gastric contents, anatomical damage to skin, joints, nerves etc.
5. Better postoperative pain relief, decreased narcotic use, faster recovery.
6. It reduces stress response to surgery.
7. Reduced blood loss particularly with pelvic and hip surgery.
8. Decreased incidence of pneumonia, and DVT.

Complications of regional anaesthesia

1. Technical: failure of the technique, direct trauma to nerves and blood vessels (bleeding and haematoma), pneumothorax with intercostal and intrapleural block.
2. Excessive local anaesthetic volume can result in total spinal during epidural and phrenic nerve block during brachial plexus block.
3. Those related to specific technique: Hypotension, bradycardia and headache following spinal or epidural analgesia. Rare possibility of nerve injury with peripheral nerve blocks.
4. Drug related: Local anaesthetic toxicity due to intravascular injection or systemic absorption, overdose of local anaesthetic, anaphylactoid reaction and methaemoglobinaemia (prilocaine)

**Contraindications**

- Absolute: Patient refusal, anaesthetist’s inexperience and localised infection at the site.
- Relative: Abnormal anatomy or deformity, coagulation disorders, neurological disease.

**Pharmacology of local anaesthetic drugs**

Local anaesthetic drugs can reversibly block the nerve conduction and produce loss of sensation. They can be classified in to amides or esters depending upon the chemical link between the amino and aromatic chain.

- Esters contain ester linkage and are relatively unstable in solution. They are hydrolysed in the body by plasma esterases. They are more likely to produce hypersensitivity reaction due to para-aminobenzoic acid which is one of the breakdown product. Examples: cocaine, procaine and amethocaine
- Amides contain amide linkage and are stable in solution. They are metabolised by amidases in liver. Hypersensitivity reaction to amides are very rare. Examples: lignocaine, prilocaine, bupivacaine and ropivacaine.

**Mechanism of action**

Most local anaesthetics are weak bases. When deposited in tissues (which normally have alkaline pH) they dissociate into ionised and unionised forms. The unionised form can cross the biological membranes and enter into the neurons. Within the nerve cell the molecules again dissociate into ionised and unionised form. Here the ionised component blocks the sodium channels from inside and blocks the conduction of impulses.

Clinical features produced by the block are affected by

- Patient variables like age, fitness, pregnancy etc.
- Individual drug characteristics
- Concentration and dose used: Higher concentration and dose reduces onset time, and increase density and duration of block
- Site of injection: Injection to the site with high vascularity results in increased systemic absorption of the drug.
- Additives: vasoconstrictors such as adrenaline and felypressin reduce absorption and prolong the block
- Hyaluronidase increases the tissue penetration and improves the spread of local anaesthetic, used in eye blocks.
- Dextrose is used in spinal anaesthetic solution to increases baricity.
Toxicity of local anaesthetics

Systemic or localised toxicity usually occurs due to the accidental intravascular injection of local anaesthetic, subarachnoid injection or use of excessive dose. It primarily involves central nervous system and cardiovascular system. Initial symptoms in an awake patient include feeling of light headedness, dizziness and circumoral numbness. Then progresses to drowsiness, muscle twitching and generalised convulsions. Respiratory centre may be involved resulting in respiratory arrest. Cardiovascular toxicity usually occurs at a higher dose than that needed for CNS toxicity. It depresses the pacemaker activity and results in bradycardia and sinus arrest.

Treatment of local anaesthetic toxicity
- Summon for help
- Stop injecting the drug
- Airway, breathing and circulation: The airway should be maintained and 100% oxygen should be administered by face mask. Check pulse, blood pressure, oxygen saturation and ECG.
- Treat the convulsions using diazepam 2.5 mg i.v, lorazepam 4 mg i.v. or thiopental 50 mg i.v.
- Hypotension and bradycardia should be treated with intravenous atropine 0.3 – 3 mg and rapid infusion of intravenous fluids (Colloids or crystalloids). Occasionally adrenaline may be necessary to treat hypotension.
- Any concurrent acid base and electrolyte abnormalities should be corrected.

Commonly used local anaesthetics

Lignocaine: It is an amide local anaesthetic with fast onset of action. It has a moderate duration of action, about 1-2 hours. It produces moderate vasodilatation. It is less toxic than bupivacaine. It is used for infiltration of surgical wound sites, epidural anaesthesia and for selected nerve blocks.
Maximum dose: 3 mg/kg for plain solution and 7 mg/kg with adrenaline

Bupivacaine: It is an amide local anaesthetic with moderate onset of action. It has a long duration of action, about 2-4 hours. It is more cardio-toxic than other local anaesthetics. It is more potent than lignocaine. It is used for infiltration, epidural, spinal and peripheral nerve blocks.
Maximum dose: 2mg /kg

Levobupivacaine: It is a levorotatory enantiomer of racemic bupivacaine. Clinically it is similar to bupivacaine. The important difference is that it is less cardiotoxic.
Maximum dose: 2mg /kg

EMLA cream is a Eutectic Mixture of Local Anaesthetics. It is a mixture of 2.5% prilocaine and 2.5% lidocaine, used for topical anaesthesia. It should remain in contact with skin for 60 minutes to produce adequate analgesia. Commonly used in children to provide analgesia during vene-puncture.
Amethocaine is an ester, used similar to EMLA to produce topical anaesthesia. It has faster onset and longer duration of action as compared to EMLA cream.

Cocaine is an ester, a potent vasoconstrictor hence useful in reducing bleeding.

**Practical aspects of using local anaesthetics**

- **Dose:** Should not exceed maximum allowable dose to avoid toxicity.
- **Toxicity** also depends on the vascularity of the site of injection and metabolic status of the patient.
- **Should** choose the drug with least toxicity. For example levobupivacaine instead of bupivacaine or lignocaine instead of bupivacaine.
- **Dose calculation:** Local anaesthetic drugs are presented as percentage solutions. For example 1% lignocaine contains 1gm of lignocaine in 100ml of solution or 10mg per each ml of solution. For a patient weighing 70 kg, a total dose of 210 mg for plain lignocaine, one can use 21 ml of 1% lignocaine or 42ml of 0.5% lignocaine. Adrenaline is usually added at a dilution of 1:200,000. That means each ml of solution contains 5 microgram of adrenaline (1gm in 200,000ml, 1mg in 200ml, 1000microgram in 200ml).

**Spinal Anaesthesia**

Spinal anaesthesia was first performed for surgery by August Bier in 1899. It can be used for surgical procedures to the lower part of body, usually below the level of umbilicus. Commonly used for Caesarean section, inguinal hernia repair, pelvic surgery, transurethral resection of prostate and lower limb surgery. It can be used in combination with general anaesthesia for providing intra-operative and postoperative analgesia. Spinal anaesthesia is produced by injecting a small volume local anesthetic in to the cerebrospinal fluid (CSF) in the subarachnoid space.

**Mechanism of Action**

Spinal anaesthesia results in a rapid onset of block, usually within 3-5 minutes depending on the local anaesthetic drug used. Maximal effects may take up to 30 minutes. Acts mainly at spinal nerve roots, although some effect is possible at the cord itself. Following effects are produced by blocking various nerve fibres during the onset of spinal anaesthesia.

**Autonomic block:** Smaller sympathetic fibres are more easily blocked than larger sensory and motor fibres. Hence, the ‘sympathetic’ block appears earlier than sensory or motor block. Block of thoraco-lumbar (T1 –L2) sympathetic outflow produces vasodilatation, reduced venous return and hypotension.
Sensory block: level of block produced depends on the volume of drug injected into the CSF. Sensory block results in loss of pain, temperature sensation. Pressure sensation usually preserved.

Motor block: Results in weakness of lower limbs, abdominal muscles and if extends to the thoracic segments produces weakness of intercostals muscles. As diaphragm is innervated by phrenic nerve (C3-5), respiratory function can still be maintained.

Anatomy

The spinal cord terminates at L1 or L2 in adults and L3 in infants. The line joining the top of the iliac crests corresponds to L4 vertebral level and is called Tuffier’s line (figure 6.1). The subarachnoid space ends at S2 in adults. The subarachnoid space extends laterally along the nerve roots to the dorsal root ganglia.

Figure 6.1 Land marks for spinal and epidural anaesthesia

Technique

A complete preoperative assessment of the patient should be performed and an informed consent should be obtained. Facilities for resuscitation and progression to general anaesthesia must be available. Intravenous access should be secured before commencing the block and standard monitoring should be established.
Figure 6.2 MRI scan: Anatomy of epidural and subarachnoid space.

The patient should be sitting or lying on their side. Flexion of the lumbar spine opens the intervertebral spaces. Appropriate interspinous space should be identified (usually L3-4, L4-5 or L2-3 interspaces can also be used). Anaesthetist scrubs and dons with sterile gown and gloves. The back is cleaned using standard antiseptic solution an draped. The chosen interspace is infiltrated with local anaesthetic. The spinal needle is inserted in the midline, aiming slightly cranially. Resistance increases as the ligamentum flavum is entered and with further advancement of the needle dura is encountered, with a sudden "give" as the dura is pierced. Correct placement of the needle is confirmed by cerebrospinal fluid at the hub. Spinal injection can also be performed using para-median approach. After confirming the correct placement local anaesthetic drug is injected. Usually a volume of 2 to 3 ml is injected depending on the level of block required and the physical status of the patient. Either heavy bupivacaine 0.5% or plain bupivacaine 0.5% is the commonly used. Fentanyl 15 to 25 micrograms is commonly added to improve the quality of block.
Figure 6.3a, 6.3b and 6.3c Technique of spinal anaesthesia

**Epidural Anaesthesia**

Epidural anaesthesia is produced by injecting a large volume (10-20ml) of local anaesthetic drug in the epidural space. Epidural space is potential space that lies between the dura and periostium lining the inner aspect of vertebral canal. On the posterior aspect, ligamentum flavum completes the boundary between the lamina. It extends from the foramen magnum to the sacral hiatus. Epidural space contains fat, areolar tissue, lymphatics and internal vertebral venous plexus.

**Epidural versus Spinal anaesthesia**

Spinal anaesthesia is usually used as single injection (although not commonly used, catheter can be inserted in to the subarachnoid space and continuous spinal anaesthesia is possible). Spinal anaesthesia produces dense, rapid onset of block with small dose of local anaesthetic. As a single dose duration of action is limited.

In epidural anaesthesia a catheter is usually inserted and a continuous infusion or intermittent top ups of local anaesthetic can be used to extend the duration. Compared to spinal anaesthesia it requires large volume (10-20 ml of local anaesthetic). Onset of block is slower over 15 to 30 minutes and hence provides better cardiovascular stability compared to spinal anaesthesia (slow onset of cardiovascular effects). It may result in patchy block and missed segments are possible.

**Indications**

- **Surgery:** It can be used as sole anaesthetic for orthopaedic procedures on the lower limb, gynaecological, caesarean section, vascular reconstructive surgery of lower limbs and urological procedures. It is commonly used in combination with general anaesthesia for upper abdominal and thoracic surgery. When used in combination it helps to reduce the stress response and can be extended for post operative period to provide analgesia.
- **Post operative analgesia**
- **Labour analgesia**
- **Chronic pain relief like cancer pain.**
Figure 6.4 Technique of epidural anaesthesia, patient on right lateral position.

**Technique**

The patient position, monitoring and preparation is as mentioned in spinal anaesthesia section. The chosen inter-space is infiltrated with local anaesthetic (1% lidocaine). A midline or para-median approach is chosen. Touhy needle is inserted into the skin and then advanced to a depth of 2-3 cm until a distinct sensation of increased resistance is felt. Then the trocar is removed and a saline-filled syringe is attached. The needle and syringe is slowly advanced, constantly checking for the loss of resistance, which will be felt as the needle exists through the ligamentum flavum and enters into the epidural space (saline is injected). At this stage syringe is removed and catheter inserted for about 15-18 cm at hub. Depth of the needle in the epidural space is noted and the needle is gradually withdrawn. About 3-5 cm of catheter should be left inside the space.

**Complications:**

- Hypotension
- Postdural puncture headache
- Missed segments
- Epidural haematoma
- Total spinal anaesthesia

**Hypotension**

Vasodilation is due to sympathetic block and results in reduced systemic vascular resistance and a reduction in effective circulating volume. 40 to 60% of oxygen should be administered via face mask, administration of vasoconstrictor and intravenous fluids should correct the hypotension. Ephedrine, metaraminol, phenylephrine are the...
commonly used vasopressors. Rarely one may need noradrenaline or adrenaline to treat severe hypotension.

**Ephedrine:** It is a plant alkaloid, indirectly acting sympathomimetic agent. It has both alpha and beta adrenoreceptor effects. It is available as 30mg/ml in an ampoule. It is usually diluted to 10ml with saline or water and given in increments of 1-2 ml (3-6mg) i.v. It causes vasoconstriction and increase in heart rate. Hence it increases blood pressure both by increasing cardiac output and systemic vascular resistance.

**Metaraminol:** It has both direct and indirect actions. It has predominant alpha effects and can produce reflex bradycardia. It is supplied as 10 mg ampoules and usually diluted to 20 mls and given in increments of 1-2 ml (0.5-1mg) i.v. It is slower in onset than ephedrine (about 2 minutes) and causes less tachycardia than ephedrine.

**Phenylephrine:** It is a potent, pure vasoconstrictor which is available in 10 mg ampoules. It should be given at increments of 100 -200 mcg i.v.

### Postdural puncture headache

Dural puncture can be accidental during an epidural block or deliberate during spinal anaesthesia. Leakage of cerebrospinal fluid through the dural hole can lead to intracranial hypotension and stretching of meninges and cranial nerve roots. This can result in head ache which is described as severe head ache usually frontal and bilateral, worsened by standing and relieved by lying. It is also associated with visual disturbance and photophobia. Management involves adequate hydration, simple analgesics and epidural blood patch.

### Total spinal anaesthesia

It is very rare but can be catastrophic if not diagnosed early enough. It usually results from inadvertent injection of planned epidural dose of local anaesthetic in to the sub arcahnoid space. It is characterised by severe hypotension, bradycardia, weakness of upper limbs, inability to talk and respiratory arrest.

Treatment: ABC approach, 100% oxygen, summon for help, rapid infusion of intravenous fluids and vasopressors. Inadequate breathing or respiratory arrest will need ventilatory support until the spinal block wears off completely.

### Assessing the height of block

The block height should be tested and documented before starting the surgical procedure. Most of the lower abdominal surgeries require adequate anaesthesia till T6 –T8 dermatome. Certain anatomical landmarks are used to approximate the level of dermatome.
Table 6.1 Dermatome levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Dermatome</th>
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<tbody>
<tr>
<td>T4-5</td>
<td>Nipple</td>
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<tr>
<td>T6-8</td>
<td>Xiphisternum</td>
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<tr>
<td>T10</td>
<td>Umbilicus</td>
</tr>
<tr>
<td>L1</td>
<td>Groin</td>
</tr>
<tr>
<td>S2</td>
<td>Perineum</td>
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The level of sensory block is usually tested for cold and touch sensation. An ice cube or ethyl chloride spray is used for testing cold sensation and cotton wool is used for testing the touch sensation. One should first test the sensation on the chest or arm (where sensation is normal). Then start working upwards from the feet and lower abdomen until the patient appreciates the sensation. If this is inconsistent or equivocal, the patient can be gently pinched with artery forceps or fingers on blocked and unblocked segments and asked if they feel pain. Patients should be instructed that they may still be aware of touch and pulling sensation but will not feel pain.

Central neuraxial block and anticoagulation

- Patients presenting for surgery can be on anticoagulant therapy or on other drugs that can affect the clotting mechanism. In the presence of abnormal coagulation, a increased risk of epidural or spinal heamatoma is associated with central neuraxial block.

- Central neuraxial block is contraindicated if the patient is on full oral anticoagulation or standard heparin.

- If the patient on warfarin and epidural or spinal anaesthesia is highly indicated, then one should consider discontinuing warfarin 3-4 days prior to the surgery. INR must be less 1.5.

- Low dose standard heparin (5000 units s/c, bd): One should wait at least 4 hrs after a dose before performing Epidural or spinal injection. Heparin should not be administered until one hr following epidural or spinal injection.

- Low molecular weight heparin: Epidural or spinal anaesthesia can be performed 12 hrs after the last dose.

- If intra-operative anticoagulation is required, it should not be given until two hour after the spinal or epidural injection.

- Central neuraxial block is generally avoided if the platelet count is less than 100x10⁹/L.
- Fibrinolytic or thrombolytic therapy is a contraindication for central neuraxial block.

- Above precautions also apply for removal of epidural catheter. Clotting parameters should be near normal before removing epidural catheter.

- Although NSAID’s such as aspirin has effect on platelet function, low dose aspirin do not increase the risk of epidural haematoma. Clopidogrel, an antiplatelet agent should be discontinued about a week before performing epidural or spinal anaesthesia.

**Peripheral nerve blocks**

Minor surgical procedures and procedures on the limbs can be performed using peripheral nerve block alone. Most often peripheral nerve blocks are used in combination with general anaesthesia or spinal anaesthesia to extend the analgesia through postoperative period. Most of the peripheral nerve blocks provide analgesia for a duration of 4 -16 hours depending on the type and concentration of local anaesthetic and any other additive drugs used. Duration of the block can also be extended using catheter technique where a continuous infusion of local anaesthetic can be used.

Following are the common peripheral nerve block used in clinical practice.

**Upper limb blocks:** Brachial plexus block
- Ulnar nerve block at elbow
- Median nerve block at elbow
- Wrist block
- Digital nerve blocks

**Lower limb blocks:** Sciatic nerve block
- Femoral nerve block
- Lateral cutaneous nerve of thigh block
- Ankle block

**Trunk blocks:** Intercostal nerve block
- Thoracic paravertebral block
- Ilioinguinal and iliohypogastric nerve block

**Ophthalmic blocks:** Peribulbar block
- Sub-Tenon’s block

**Intravenous regional anaesthesia (IVRA)**

This technique involves exsanguination of limb and then injection of local anaesthetic into the veins of the limb. Minor superficial surgery of the forearm and hand can be performed. Prilocaine 0.5% and lignocaine 0.5% are suitable local anaesthetics. Long
acting local anaesthetic such as bupivacaine, ropivacaine and levobupivacaine are contraindicated, as their systemic absorption can result in cardiac toxicity.

**Further Reading**


Ankcorn C, Casey WF. Spinal anaesthesia – a practical guide, Anaesthesia update, 1993; (issue 3): http://www.nda.ox.ac.uk