Regional anaesthesia for orthopaedic procedures

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Learning Objectives

After reading this article you should:

- Understand the uses and benefits of regional anaesthesia
- Know the contraindications for regional anaesthesia
- Understand patient preparation and monitoring for performing regional anaesthesia
- Understand the different techniques for performing regional blocks
- Be able to describe commonly performed blocks used in orthopaedic surgery
- Be familiar with complications and their management

Abstract

Regional anaesthesia is apposite for orthopaedic surgery for anatomical reasons and to reduce complications from general anaesthesia. A reduction in pain scores, drowsiness and nausea can improve postoperative mobility and facilitate earlier hospital discharge. Disadvantages include block failure, nerve injury, local, possible loss of motor function and proprioception and local anaesthetic toxicity.

Complications are rare but may be reduced by the use of ultrasound and nerve stimulation, performing the block on a conscious patient and stopping injection if there is pain or high resistance. Patients should be assessed preoperatively to rule out contraindications such as local infection or coagulopathy, and clear explanations of the procedure and any possible complications should be given.

Patients should also be assessed postoperatively and any suspicious findings investigated promptly and followed up until there is complete resolution.

Keywords

Regional Anaesthesia, Orthopaedic surgery, Ultrasound, Peripheral nerve block, Analgesia, Nerve Injury

Royal College of Anaesthetists CPD matrix: ???

Introduction

With the exception of spinal surgery, almost every orthopaedic surgical procedure can be carried out under or supplemented with a regional local anaesthesia block. With the increasing emphasis on day case surgery, enhanced recovery protocols and a growing body of evidence to support improved outcomes, the role of regional anaesthesia is becoming increasingly important. Used in isolation for anaesthesia, and in combination with sedation or general anaesthesia, it has many advantages. Many patients undergoing orthopaedic surgery are elderly and have co-morbidities such as hypertension, respiratory impairment, obesity or difficult airway such that regional anaesthesia can be a very useful option. It is associated with less airway manipulation, fewer cardio-respiratory depressant drugs, less acute postoperative delirium, less nausea and vomiting and improved analgesia. Uncontrolled pain in the postoperative period can also impair mobilisation and decrease the utilisation of physiotherapy. A multimodal approach of regional blocks and systemic analgesia provides the best balance of satisfactory analgesia and side effects. Regional anaesthesia may also prevent or diminish the development of chronic pain syndromes

as it reduces sensitisation of the central nervous system after acute tissue injury. The advantages of regional anaesthesia are set out in Box 1.

Box 1. Advantages of regional anaesthesia

- Less airway manipulation and cervical spine movement
- Better postoperative respiratory function
- Reduced physiological stress
- Reduced postoperative delirium
- Reduced postoperative nausea and vomiting
- Reduced blood loss (central neuroaxial techniques)
- Improved mobility and functional recovery postoperatively
- Reduced risk of deep vein thrombosis (central neuroaxial techniques)
- Facilitates patient communication
- Reduction in chronic pain syndromes
- Lower cost than general anaesthesia
- Decreased recovery room and hospital stay

Disadvantages to regional anaesthesia (Box 2) include block failure, nerve injury and local anaesthetic toxicity. Contraindications are listed in Box 3.

Box 2. Complications and disadvantages

- Intrinsic failure rate and technical difficulties
- Damage to surrounding structures
- Intravascular injection
- May not cover the whole operative area
- Sudden block recession with rebound pain
- Postoperative injury to the anaesthetised limb due to loss of sensation and proprioception or difficulty walking
- Local anaesthetic toxicity

Box 3. Contraindications to regional anaesthesia

- Patient refusal
- Confused/ uncooperative patient
- Infection at point of injection
- Allergy to local anaesthesia

Specific to central neuroaxial blockade

- Raised intracranial pressure
- Uncorrected hypovolaemia/ cardiac failure/ hypotension
- Aortic stenosis/ fixed cardiac output state

Relative contraindications

- Anticoagulation/ coagulopathy
- Existing neuropathy
- Need to monitor neurologic function postoperatively e.g. compartment syndrome, or risk of intraoperative nerve injury

What are the risks associated with performing regional blocks?

Direct damage

There may be inadvertent damage to the nerve or surrounding tissue by the needle. Depending on the location of the block, neurological injury after peripheral nerve block can range from 0.03% for supraclavicular to 0.3% for femoral nerve to 3% for interscalene blocks. Intra-neural or injection directly into the spinal cord can cause direct damage to the nervous tissue. Vascular injury may result in a haematoma with subsequent damage due to tissue compression. The brachial plexus lies close to many vascular structures and the risk of pneumothorax during supraclavicular blocks is also high due to the proximity of the parietal pleura.

Risks associated with injectate

High volumes of local anaesthetics may be required for an adequate block. Miscalculation of maximum dose or inadvertent intravascular injection can lead to local anaesthetic toxicity including seizures and cardiovascular collapse.

Injection into the wrong place, for example intra-thecal injection during epidural or interscalene block can lead to a total spinal block, causing rapid loss of consciousness and cardiorespiratory arrest.

With central neuroaxial blockade, sympathectomy can result in hypotension and bradycardia, especially if there is hypovolaemia. Post dural puncture headache occurs in approximately 1% of people and can be reduced with smaller and "pencil point" needles. Introduction of infection into the epidural or dural space can, rarely, lead to meningitis or abscess formation.

True local anaesthetic allergy is rare.

Table 1. Maximum dose of commonly used local anaesthetics

Local anaesthetic	Safe dose alone (mg/kg)	Safe dose with adrenaline (mg/kg)
Lignocaine	3	7
Levo-bupivacaine	2	2.5
Ropivacaine	3	4
Prilocaine	6	9

Box 4. Recommendations for local anaesthetic use

- For surgical anaesthesia and rapid onset, use 1-2% lignocaine or prilocaine
- For prolonged postoperative analgesia, use levo-bupivacaine or ropivacaine
- Ensure you can see the spread of local anaesthetic if using ultrasound - if not, it may be intravascular
- Stop injection after every 5 ml to aspirate and check for intravascular injection

- Slow incremental injection of the local anaesthetic usually allows for signs of systemic toxicity to be detected before cardiorespiratory arrest occurs
- Stop injecting and reposition the needle if the patient complains of pain or if resistance is felt
- Never exceed the maximum dose of local anaesthetic

Patients on anticoagulant drugs (Table 2)

There is no set guidance for the risks of performing peripheral nerve blocks in patients on anticoagulant drugs, however the risks are likely comparatively less than with central neuroaxial blockade (CNB). In order to help guide decision making, it may be prudent to divide blocks into deep and superficial, and those with a high risk of venous or arterial puncture. When a catheter is used, the same guidance as for CNB should be used.

Table 2. Acceptable time after drug administration for CNB performance (adapted from AAGBI guidance Nov 2013)

Drug	**Advice**
NSAIDS -Aspirin, Diclofenac	No additional precautions
Thienopyridines	Stop Clopidogrel and Prasugrel for 7 days
Dipyridamole	No additional precautions
GPIIb/IIIa receptor antagonists	Stop Abciximab for 48 hours Stop Eptifibatide and Tirofiban for 8 hours
Unfractionated heparin-i.v.	Stop infusion for 2-4 hours and check APTT has returned to normal. Check platelets for HIT
Unfractionated heparin-s.c.	Wait 4-6 hours after last dose or check APTT is normal
Low molecular weight heparin	Prophylactic dose - wait 12 hours Therapeutic - wait 24 hours
Fondaparinux	Prophylactic - wait 36 hours (consider anti Xa levels) Therapeutic - Avoid

Danaparoid	Avoid
Warfarin	Stop for 4-5 days until INR is < 1.5
Oral thrombin blockers - Dabigatron	Creatinine clearance >80mls/min 24 hours Creatinine clearance 50-80mls/min 72 hours Creatinine clearance <50mls/min 96 hours
Direct Xa inhibitors - Rivaroxaban	Prophylactic 18 hours Treatment 48 hours

Choosing the right patient

Ensure your block is appropriate for both the surgery and the patient. For surgical anaesthesia, ensure that your block will cover all necessary areas of the surgical field, including the tourniquet, and has sufficient time to be effective. Performing a block on a trauma patient can reduce pain, but there is still controversy around whether regional anaesthesia hinders diagnosis of compartment syndrome. Use of a low concentration infusion of long acting local anaesthetic coupled with low dose boluses of short acting local anaesthetic for operative interventions in a monitored patient can achieve both excellent analgesia and allow detection of breakthrough pain.

As with any anaesthetic, a full history and systemic review should be taken with extra focus on any coagulation disorders, anticoagulant therapy, neurological disorders and previous regional blocks. A full physical examination should include a neurological examination of the limb to be anaesthetised, and any pre-existing deficits noted and documented. Ensure that your patient is cooperative and will be able to lie still in the correct position for the duration of surgery.

Evaluate the risks and benefits and make sure you have had a full discussion with your patient beforehand. The sequence of events should be discussed and it should be explained to the patient that they might feel touch but not pain to avoid the patient panicking when surgery begins. Advice regarding keeping the anaesthetised limb away from extremes of heat and safe from excessive force or pressure should be given, as well as clear nursing instructions. The patient should understand that, as the block wears off, they will feel pain and analgesia should be given early rather than waiting for this to become intolerable.

Specific risks and consequences of the block should be explained, for example Horner's syndrome, a hoarse voice and difficulty coughing (phrenic nerve paralysis) with an interscalene block. It is essential that to have a fully informed, cooperative patient before starting.

Techniques

The technique of performing nerve blocks has evolved and changed with advances in technology. Original landmark and nerve stimulator techniques are fast being replaced and supplemented by ultrasound, although a thorough understanding of anatomy is essential. Landmark, nerve stimulation and ultrasound can be used individually or in combination. The most effective and safest way should be using a combination of all three.

Drugs

Longer acting amide local anaesthetics such as ropivacaine and levo-bupivacaine are commonly used for nerve blocks. Concentration can be decreased to reduce the extent of motor block. The addition of adrenaline is not recommended for long acting drugs and the use of adjuvants such as opioids and alpha-2 agonists is controversial apart from opioids with neuraxial blocks which is a well tested technique. Liposomal bupivacaine has become available in some countries and has a very long duration of action – experience is still being gained with its use.

Landmark

The landmark technique uses anatomical landmarks and tactile feedback from 'pops' through fascial planes to allow deposition of local anaesthetic into the nerve vicinity.

Nerve stimulation

Nerve stimulators localise the nerve by eliciting muscular twitches. The nerve stimulator should initially be set to 2 mA. Once the correct twitches are elicited, the current should be reduced to 0.5 mA, with twitches maintained. If twitches are still present at 0.2 mA this is suggestive of intra-neural needle placement and it should be repositioned. The twitches should disappear on injection of local anaesthetic, as the nerve is pushed away and loses function. Any pain or paraesthesia on injection

suggests intra-neural placement and must stop immediately. Some advocate the use of in-line pressure monitors to detect possible intra-fascicular injection

Ultrasound

Ultrasound can visualise the nerve and the spread of the local anaesthetic. Nerve stimulators and ultrasound can increase success and decrease the amount of local anaesthetic needed to produce a successful block. By directly visualising the nerves and local anaesthetic spread, the onset is quicker and volume of local anaesthetic can be reduced, thus decreasing the risk of local anaesthetic toxicity and unwanted side effects such as motor block.

The in-plane approach visualises the entire shaft of the needle whereas the out of plane approach will only visualise the point at which the needle crosses the ultrasound beam. The second technique may cause less pain due to the needle traversing less tissue, however, it requires a thorough knowledge of anatomical relationships and careful injection to evaluate the correct position of the needle tip.

Although needle placement can be seen in real-time, ultrasound is not fail safe. Picture quality may be compromised due to obesity and artefacts may distort the image. Reverberation from the needle, mirror images and being unintentionally slightly off plane may give a false impression as to the location of the needle tip. Compression of venous structures may obliterate the image, therefore risking inadvertent venous injection.

A number of needles have been developed with features that make visualisation of the needle tip easier. By texturizing the surface, ultrasound beams are reflected at different angles, thus making the shaft more echogenic and increasing visibility.

Sedation

Sedation may be beneficial for both block placement and intraoperative anxiolysis. Some blocks cause some discomfort, take time to perform and take time to develop, meaning the patient may become anxious and lose confidence. Light sedation can help with this, providing that the patient is conscious enough to report any paraesthesia or pain.

Intraoperatively an infusion of a drug such as propofol or dexmedetomidine can be used. Care should be taken to not over sedate a patient since a cooperative under sedated patient is much better than an over sedated disinhibited patient. In addition to standard AAGBI monitoring (blood pressure, ECG, pulse oximetry) capnography attached to a facemask or nasal cannulae is useful for assessing adequacy of ventilation.

Box 5. Preparation

- Obtain informed patient consent
- Have a trained assistant
- Ensure rapid access to resuscitation equipment and drugs including intralipid, ALS drugs, oxygen, suction, defibrillator
- Ensure intravenous access
- Attach monitoring as recommended by AAGBI- blood pressure, ECG, pulse oximetry
- Ensure all necessary equipment is present:

Ultrasound machine +/- nerve stimulator

Cleaning solution e.g. 2% chlorhexidine (0.5% in CNB)

Lignocaine to anaesthetise skin for needle injection

Appropriate local anaesthetic for nerve block

Appropriate choice of block needle

STOP BEFORE YOU BLOCK

Reconfirm surgical side with patient and consent form

Upper limb blocks

Intravenous blocks

Bier's Block

Intravenous anaesthetic can be used for anaesthesia of the wrist and hand. Anaesthesia develops within minutes and lasts about 90 minutes. A small cannula for local anaesthetic is placed distally in the operative hand and another in the opposite

hand for drugs and fluids. A double tourniquet is placed on the upper arm and the arm is exsanguinated with elevation or an Esmarch bandage. Both cuffs are inflated, then either lignocaine or prilocaine is injected. The distal cuff is then deflated. After approximately 45 minutes, the majority of patients report discomfort at the site of the tourniquet. At this point, the distal cuff can be inflated and the proximal cuff deflated to provide immediate pain relief and a further 15 to 30 minutes of relative comfort. Local anaesthetic can only escape into the systemic circulation by deflation of the tourniquet. For this reason, the proximal cuff should only be deflated once the distal cuff is inflated. The anaesthetist should have immediate access to the tubing and pressurising unit, and if the procedure lasts less than 30 minutes, the tourniquet should be intermittently deflated and inflated, to allow only small amounts of local anaesthetic to leak out into the systemic circulation at one time so the patient can be monitored for signs of toxicity.

Peripheral nerve blocks

The sensory innervation of the upper limb is almost entirely supplied by the brachial plexus, which lies superficially and is easily blocked at a number of sites (Figure 1). A single injection can provide anaesthesia and long lasting analgesia for the entire arm. Individual nerves can be easily visualised and blocked at the elbow or forearm to supplement an inadequate brachial plexus block. Unfortunately, it also lies very close to a number of other important structures, such as major blood vessels and the pleura. Ultrasound has greatly improved the safety of these blocks.

Table 3. Brachial plexus blocks

Block	Indications	Pitfalls	Complications
Interscalene	Anaesthesia of shoulder to upper arm	Ulnar nerve commonly missed	100% paralysis of ipsilateral phrenic nerve. Horner's syndrome, hoarse voice.

			Risk of injection into the spinal cord or into vertebral artery.
Supraclavicular	Complete anaesthesia from mid humerus to fingers	Difficult without ultrasound. Close proximity to pleura	3-6% chance of pneumothorax without ultrasound 50% incidence of paralysis of phrenic nerve
Infraclavicular	Anaesthesia of elbow to fingers	Sedation may be required due to discomfort from depth of block. Musculoskeletal nerve may be missed	Risk of puncture of subclavian vessels
Axillary	Anaesthesia of elbow to fingers	Patient needs to be able to abduct arm to 90 degrees. Musculocutaneous nerve needs to be blocked separately	Risk of puncture of axillary vessels

Mid-arm blocks and wrist blocks

These blocks can be used to supplement brachial plexus blocks, or to provide postoperative analgesia for patients having general or regional anaesthesia. They can be used as sole anaesthesia for minor hand surgery, avoiding the motor blockade of

proximal blocks, however, due to the lack of coverage for tourniquet pain, surgical time is limited to approximately 20 minutes.

Lower limb blocks

Central neuroaxial blocks (CNB)

For lower limb surgery, epidurals and spinal blockade produce excellent anaesthesia and analgesia. The blocks are familiar to all anaesthetists and results are usually reliable. Compared to other blocks, CNB is easy to perform, has a short learning curve and reliable results. Undesirable side effects such as bilateral sympathetic blockade, impaired mobilisation and risk of infection and haematoma may make it unsuitable for some patients.

Peripheral nerve blocks (Figure 2 and Table 4)

Lower limb nerve blocks are slightly more technically difficult than upper limb blocks due to the lack of a single superficial plexus. They are more often used in conjunction with general anaesthesia due to the use of proximal tourniquets, however, they can be used as sole anaesthesia in a patient in whom a central neuroaxial technique may be unsuitable.

The lumbar plexus (L1-4) gives rise to the ilioinguinal, genitofemoral, obturator, femoral and lateral femoral cutaneous nerves and mainly innervates the inguinal regions and the anterior aspect of the thigh. Innervation below the knee is supplied by the sacral plexus (L4-S4) with the exception of the medial cutaneous aspect of the calf which is supplied by the saphenous nerve (L3,4) which arises from the femoral nerve (L2-4). The main nerve of the sacral plexus is the sciatic nerve, which is actually the common peroneal and tibial nerve combined. The sciatic nerve divides about 6-7 cm proximal to the popliteal crease. The common peroneal nerve winds around the fibular head and divides into deep and superficial branches. The deep peroneal nerve supplies sensation to the dorsum of the foot between the first and second toe, and motor innervation to the short and long extensors of the foot and toes. The superficial peroneal nerve supplies sensation to the remainder of the dorsum of the foot.

Table 4. Peripheral nerve blocks

Block	Indication	Pitfalls	Complications
Lumbar plexus	In conjunction with a sciatic nerve block, can produce total anaesthesia for hip procedures	Difficult to perform. Patient required to be in the lateral decubitus position. May require sedation (deep block)	Retroperitoneal haematoma (anti-coagulation). Risk of spinal or epidural spread. Risk of injury to the kidney or ureter
Femoral/ fascia iliaca block	Anterior thigh procedures including TKA and ACL reconstruction and analgesia for femoral fractures		Injury to femoral vessels
Adductor canal block (saphenous nerve)	Post operative analgesia for knee, foot or ankle surgery (usually in conjunction with a popliteal block)		Risk of intravascular puncture
Sciatic	Below the knee procedures, proximal and mid tibial fractures, below knee amputation	Misses medial aspect of the lower leg	Haematoma formation due to deep position
Popliteal block (sciatic nerve)	Ankle and forefoot surgery	Misses medial aspect of the lower leg	Risk of intravascular puncture

Ankle	Foot procedures such as toe amputations, hammer toe corrections	Can be uncomfortable as requires multiple injections	Minimal

Postoperative follow up

Patients should be followed up postoperatively, not only to assess for complications, but also to ensure they have adequate analgesia after the block wears off.

Neurological complications can occur at different times, depending on the aetiology. They may occur due to direct damage due to needle placement, compression from haematoma or local anaesthetic volume, or later on from removal of indwelling catheters. Neurology should be assessed distal to the block site in the hours following catheter removal, and any neurological deficit that occurs in the weeks after even a single shot injection should be investigated.

Follow up is mandatory until both motor and sensory functions are back to normal. However, remember not all nerve injuries are due to the nerve block. Injury can occur intraoperatively from positioning, surgical injury or tourniquet, postoperatively from pressure injury to an anaesthetised limb or from over tight dressings and plaster casts.

Management of neurological injury

If neurological symptoms are detected postoperatively, investigation and management should be swiftly dealt with in order to limit any potential permanent damage.

In the case of acute motor loss or bladder dysfunction post central neuroaxial blockade, MRI studies should be carried out as soon as possible; epidural haematoma should be evacuated within 6 hours to expedite recovery.

MRI is also the mode of choice to visualise other nerve plexi in the upper or lower limbs. Any compression should be relieved within 4 hours to maximise outcome. In

patients with prolonged areas of paraesthesia, EMG and neurophysiology can be helpful in determining the aetiology.

Permanent nerve damage is rare and most nerve injuries are transient and often subclinical. With a resolving neurological deficit, often reassurance and time to recover is the best course of action.

Further reading

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