Complications of regional anaesthesia

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Most complications of regional anaesthesia are relatively minor, easily managed and temporary but in rare instances serious and permanent damage occurs (Figure 1). Complications may be directly related to the performance of the technique or may result from poor management of the block. Some complications are common to all major regional anaesthetic techniques while others are specific to individual techniques (e.g. pneumothorax associated with the supraclavicular brachial plexus block). Anaesthetists must familiarize themselves with these specific complications before using a particular technique. Proper training and supervision to acquire the necessary level of competence, plus appropriate safeguards to minimize the risks, are necessary to ensure that the incidence of serious complications is kept as low as possible.

<table>
<thead>
<tr>
<th>Complications in order of frequency</th>
<th>Estimated frequency</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1= Direct nerve damage</td>
<td>1:10,000 – 1:30,000</td>
<td>No effective treatment. Most improve over 1–6 months</td>
</tr>
<tr>
<td>1= Spinal haematoma</td>
<td>1:150,000 – 1:220,000</td>
<td>Requires urgent evacuation. May cause paraplegia</td>
</tr>
<tr>
<td>1= Spinal infection</td>
<td>1:100,000 – 1:150,000</td>
<td>Evacuation and aggressive antibiotic therapy required. May cause paraplegia</td>
</tr>
<tr>
<td>4= Drug error</td>
<td>Unknown</td>
<td>Avoidable. May be fatal</td>
</tr>
<tr>
<td>4=Systemic toxicity</td>
<td>Unknown</td>
<td>May be fatal unless treated promptly</td>
</tr>
<tr>
<td>6= Respiratory depression</td>
<td>Unknown</td>
<td>Beware neuraxial opioids</td>
</tr>
<tr>
<td>6= Hypotension</td>
<td>Common with epidural/spinal</td>
<td>Treat effectively to avoid complications (see text) Beware neuraxial opioids</td>
</tr>
<tr>
<td>8 Confusional states</td>
<td>Common in the elderly</td>
<td></td>
</tr>
<tr>
<td>9 Pruritus/urinary retention/nausea</td>
<td>Up to 16% incidence</td>
<td>Treat effectively</td>
</tr>
<tr>
<td>10 Technical failure</td>
<td>5–25% for different techniques</td>
<td>Consider alternative strategy</td>
</tr>
</tbody>
</table>

**Complication or side-effect?**

Major regional anaesthetic techniques produce physiological consequences arising from the motor, sensory and autonomic blockade. It is important to distinguish side-effects from potential complications to prevent the former becoming the latter (Figure 2). Side-effects are predictable and can be beneficial, whereas complications are usually unexpected and may cause harm even when recognized and treated promptly.

**Physiological side-effects of regional anaesthesia and their potential complications**

<table>
<thead>
<tr>
<th>Side-effect</th>
<th>Block technique</th>
<th>Potential complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor block</td>
<td>Spinal/epidural/major limb</td>
<td>Damage to limb</td>
</tr>
<tr>
<td>Motor block</td>
<td>High spinal/thoracic epidural</td>
<td>Respiratory failure</td>
</tr>
<tr>
<td>Sensory loss</td>
<td>All central/peripheral blocks</td>
<td>Thermal/pressure injury</td>
</tr>
<tr>
<td>Proprioception loss</td>
<td>Upper/lower limb</td>
<td>Impaired balance/mobility</td>
</tr>
<tr>
<td>Phrenic nerve block</td>
<td>Brachial plexus</td>
<td>Respiratory failure</td>
</tr>
<tr>
<td>Recurrent laryngeal nerve block</td>
<td>Brachial plexus</td>
<td>Hoarseness, aspiration</td>
</tr>
<tr>
<td>Autonomic blockade</td>
<td>Spinal/epidural</td>
<td>Hypotension, bradycardia, visceral dysfunction</td>
</tr>
</tbody>
</table>
The effects of motor, sensory and proprioceptive block are minimized by adequate support for the affected limbs, avoidance of joint hyperextension or flexion and protective padding of pressure areas, especially heels and elbows. Other side-effects need careful monitoring until the effects of the block wear off. Autonomic nerve dysfunction may require the urinary bladder to be catheterized until the block regresses and the pulse rate and blood pressure may need supporting with intravenous fluids, inotropic and vagolytic drugs. In healthy patients without cardiorespiratory risk factors, the systolic blood pressure may drop by 30% from its preoperative value without any increase in risk to the patients. In older patients, or those with cardiac risk factors, a reduction of 20–25% is the maximum before treatment should be initiated to restore it towards the normal value for the individual patient (Figure 3). In patients under 45 years (especially fit young men), spinal anaesthesia may produce bradycardia without significant hypotension and, in this patient group, heart rates of less than 50 beats/min may be associated with sudden cardiac arrest. It is sensible to maintain the heart rate above 50 beats/min in all patients undergoing spinal or epidural blockade.

Management of physiological hypotension, bradycardia and the ‘total spinal’

**Physiological hypotension and bradycardia**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Timing</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crystalloid, 500–1000 ml</td>
<td>When block is performed</td>
<td>15–20 min</td>
</tr>
<tr>
<td>Crystalloid, 500–1000 ml</td>
<td>As block develops</td>
<td>20–30 min</td>
</tr>
<tr>
<td>Colloid, 500–1000 ml</td>
<td>During surgery</td>
<td>Dependent on blood pressure</td>
</tr>
<tr>
<td>Ephedrine, 3 mg boluses: total 30 mg</td>
<td>As block develops</td>
<td>Dependent on blood pressure</td>
</tr>
<tr>
<td>Atropine, 0.3 mg boluses or</td>
<td>If heart rate &lt; 50 beats/min</td>
<td>Dependent on heart rate</td>
</tr>
<tr>
<td>Glycopyrrolate, 200 µg boluses</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total spinal anaesthesia**

- Intravenous fluids as above but over shorter timescale. Rapid administration of crystalloid, 1000 ml, then colloid, 500 ml. Repeat as necessary to maintain systolic pressure > 100 mm Hg
- Respiratory support (100% oxygen via a face mask progressing to assisted manual ventilation)
- Tracheal intubation if unconsciousness occurs
- Atropine, increments of 0.3 mg, used to treat bradycardia
- Ephedrine, 10 mg increments to a total of 30 mg, to restore systolic pressure > 100 mm Hg
- Intravenous infusion of epinephrine may be necessary to maintain this level of blood pressure until the block begins to wear off
- Slight head-down tilt (10–20°) and slight lateral tilting may be used to maximize venous return
- Maintain supportive measures, until level of spinal block regresses

**Technique-related complications**

**Failure:** many regional blocks are technically demanding and failure rates range from 5 to 25% for different techniques. One of the most significant risk factors for serious neurological damage is multiple attempts at a regional technique. If technical difficulties are encountered, a rapid risk assessment is necessary to evaluate whether to continue with the procedure, to seek more experienced assistance or to consider an alternative anaesthetic technique. As a general rule, two to three unsuccessful attempts are an indication to seek help or use an alternative technique. This particularly applies to central neuraxial blocks and brachial plexus blocks.

The ‘failed spinal’ is a specific example where a repeat injection should not be made. If CSF is aspirated and local anaesthetic injected but an adequate spinal block does not occur, repeated local anaesthetic injection can cause neurological damage, probably because of maldistribution of the drug in the CSF and localized nerve toxicity resulting from high concentration of local anaesthetic around a few nerve roots.

The ‘total spinal’: the inadvertent injection of a large (20–30 ml) volume of local anaesthetic into the CSF is a particular hazard of epidural blocks but can happen with cervical plexus, interscalene brachial plexus, paravertebral and psoas sheath blocks. The spinal nerve root dural cuffs may extend beyond the intervertebral foraminae and local anaesthetic can be injected into CSF with these techniques. The effects of a total spinal can be catastrophic unless rapid and effective treatment is instituted.
All anaesthetists performing such blocks must be able to recognize the signs and symptoms of a total spinal and be able to treat them appropriately. The signs vary depending on the volume injected and the spinal level at which the injection is made. Typically there is rapid onset of profound motor blockade and high dermatomal sensory block (within 1–5 minutes) as the local anaesthetic spreads rostrally in the CSF. It may reach the cervical spine and produce motor weakness of the upper limbs and respiratory embarrassment or even respiratory failure as the phrenic nerves are blocked. If the local anaesthetic reaches the cerebral CSF, unconsciousness, respiratory arrest, severe hypotension and pupillary dilatation occur. Treatment is aimed at maintaining adequate oxygenation, protecting and securing the airway in the event of unconsciousness, restoring stable haemodynamics, and supporting the patient until the effects of the total spinal regress (Figure 3).

**Equipment:** modern regional anaesthetic equipment is made to rigorous safety standards and should not cause problems in routine use. The main risks are associated with catheter insertion and removal for central and peripheral blocks. Epidural catheters can penetrate epidural blood vessels, the subdural layer of the dural sac and pass through the dura into the CSF. This can happen at the time of insertion or subsequently during the infusion, therefore all bolus injections or continuous infusions have the potential to cause intrathecal spread. Peripheral catheters can penetrate blood vessels and also the epidural or intrathecal space through intervertebral foramina.

If an excessive length of catheter is inserted it can exit the epidural space or the peripheral nerve sheath, encircle a nerve root or form a knot, which increases the risks of damage when the catheter is removed. Attempts to withdraw the catheter through the needle can shear off a length of catheter, which is left in the epidural space or a peripheral nerve sheath. The insertion or removal of epidural catheters increases the risk of epidural haematoma formation.

**Spinal needle design** – there has been an apparent increase in the risk of spinal cord injury associated with the use of some pencil-point needles. There have been similar concerns regarding the relative benefits of pencil-point and short bevel cutting points for peripheral block techniques. Pencil-point needles reduce the risk of post-dural puncture headache (PDPH), a particular problem in obstetric anaesthesia, compared with short bevel cutting spinal needles (Quincke type). However, there is concern that pencil-point needles have to be inserted further into the intrathecal space to ensure that the lateral orifice of the needle is within the CSF. If the needle is inserted above the level of L3/4 this may lead to the tip of the needle penetrating the conus medullaris. Current opinion suggests that short bevel cutting needles for peripheral blocks and spinal blocks offer the best balance of risk to benefit for ease of performance and least risk of nerve damage. The higher risk of PDPH in obstetric patients merits the use of pencil-point needles, especially the Whitacre tip design, but the spinal should be performed no higher than L3/4 if possible.

**Management-related complications**

Management complications result mainly from a failure of proper patient selection, choice of technique, poor standard of performance and patient management during the course of the regional anaesthetic technique.

**Major neurological complications:** all major regional anaesthetic techniques have the potential to cause significant neurological damage, though the incidence of permanent damage is small. Figure 4 lists the causes of serious neurological complications. There are few treatments for serious neurological damage, and some (e.g. surgical evacuation of an epidural haematoma or abscess) carry significant morbidity and limited potential for improvement. The key to avoiding these problems is to have appropriate strategies in place to minimize the risk of complications and to investigate them urgently in a logical and systematic manner if they arise (Figure 5).

**Infection:** the risks of serious central or peripheral nervous system infection are low, and with strict adherence to sterility during the block performance there is little likelihood of infection being introduced. Patients with existing bacterial or viral infection and those who are immunocompromised present a special risk. Patients with a proven bacteraemia or septicaemia may benefit from regional anaesthesia, but each patient requires careful risk assessment, and appropriate antibiotic therapy should be instituted before the block. Epidurals are probably safer than spinals in this context because breaching the dura may increase the risk of meningitis. The role of regional anaesthesia in patients with HIV or genital herpes remains uncertain, though spinals and epidurals have been used in these high-risk patients without significant problems.
Major neurological complications

Failure of technique
- Primary (multiple attempts)
- Secondary (failed spinal)

Direct nerve trauma
- Needle damage to spinal cord or major peripheral nerve/plexus
- Intraneural injection

Infection
- Viral/bacterial
- Perineural
- Epidural/intrathecal

Haematoma
- Epidural
- Brachial plexus

Drug toxicity
- Transient neurological symptoms (TNS)
- Adhesive arachnoiditis
- Drug error

Miscellaneous
- Anterior spinal artery syndrome
- Spinal cord infarction

Investigation, treatment and prevention of nerve damage

Patient assessment
- History and examination for pre-existing neurological disease
- Detailed assessment of benefits and risks of regional technique for each patient
- Change of therapy and clotting screen monitoring for high-risk patients
  - Long-term anticoagulants
  - Thromboprophylaxis treatment
  - Known coagulopathy
  - Other medication that alters platelet function
- Exclude other causes of nerve damage
  - Surgical injury
  - Postural, compression or avulsion damage
  - Ischaemia, compartment syndrome

Define anatomical basis of injury
- Motor, sensory, mixed
- Upper/lower motor neuron
- Central or peripheral nerve injury

Institute proper investigation
- Neurologist and anaesthetist experienced in regional anaesthesia
- Appropriate investigations
  - Urgent MRI or contrast-enhanced CT
  - Baseline electromyelography and/or somatosensory evoked potentials
  - Repeat investigations at regular intervals for 3 months

Treatment
- Urgent (up to 8 hours) surgical evacuation of epidural haematoma or abscess
- All other nerve injury – conservative management for 2–3 months; improvement may continue up to 6 months
- Limited treatment options available and limited benefit from surgical exploration for scarring or nerve repair

Prevention
- Meticulous block techniques
- High standards of asepsis
- Avoid multiple attempts
- Care with intraoperative management
  - Fluid balance
  - Stable haemodynamics
- Good postoperative monitoring
  - Sensory and motor block monitoring
  - Aim for slow regression of motor block with continuing analgesia not anaesthesia
Epidural abscess formation occurs spontaneously in hospitalized patients and the risk of serious infection from regional anaesthesia is little different from the spontaneous occurrence rate. Most infections associated with epidurals are limited to superficial skin or subcutaneous tissue infection along the catheter track with few proven epidural abscesses, though any infection needs to be investigated and treated appropriately.

**Epidural haematoma:** With the increasing use of thromboprophylaxis for surgical procedures there is always the potential for regional anaesthetic techniques to produce an epidural or peripheral nerve sheath haematoma. Following the introduction of low molecular weight heparins into routine surgical practice, there was a marked increase in the number of cases of spinal paraplegia reported in the USA during the 1990s, though in Europe, where a different dosing regimen was used, there were fewer cases of spinal haematoma. Both the European and American Societies of Regional Anaesthesia cover this topic in detail on their websites (see the Further Reading list).

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**FURTHER READING**


http://www.asra.com Contains a revised consensus statement on anticoagulation and regional anaesthesia.

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