Anaesthesia for major spinal surgery

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Abstract

Major spinal surgery is performed for a wide variety of conditions including degenerative diseases, scoliosis and autoimmune diseases. Anaesthesia often presents several challenges to the anaesthetist. Careful pre-anaesthetic assessment and planning is important as patients may have multiple comorbidities. Important perioperative issues to consider include aspects of airway management, neurophysiological monitoring, patient positioning, blood conservation strategies, pain management and specific complications such as perioperative visual loss.

Keywords Blood conservation; degenerative diseases of the spine; neurophysiological monitoring; perioperative visual loss; prone position; scoliosis; spinal cord monitoring; spinal surgery

Royal College of Anaesthetists CPD Matrix: 2A04, 3A08

Learning objectives

After reading this article, you should be able to:

- understand the general principles in preoperative assessment for major spinal surgery
- appreciate the main pathological conditions presenting for major spinal surgery
- understand the perioperative anaesthetic considerations for major spinal surgery
- recognize, minimize and manage the specific complications associated with major spinal surgery

General considerations in preoperative assessment and consent for major spinal surgery

A detailed history and physical examination with a review of pertinent clinical investigations should precede any spinal surgery. Anaesthetic considerations will depend on the primary pathology requiring surgery as well as any comorbidities present.

A full physical examination with an emphasis on the airway, cardio-respiratory and neurological systems should be performed, as this will have implications on the planning and conduct of anaesthesia.

Patients with rheumatoid disease may have restricted mouth opening due to temporo-mandibular joint stiffness. Neck movement may be reduced due to degenerative disease of the cervical spine. Atlanto-axial instability, when present, may result in neurological damage if the cervical spine is not adequately protected during airway manipulation. Active flexion and extension should therefore be examined and the range of motion possible as well as any neurological compromise should be clearly documented. An X-ray series of the cervical spine in flexion and extension should be performed in patients who are at risk of atlanto-axial subluxation. An atlanto-axial distance of greater than 4–5 mm on lateral views, or 3.5 mm in antero-posterior views, is indicative of atlanto-axial subluxation.[1] Airway manipulation and control may be challenging in these patients and so an appropriate airway strategy and back-up plan must be established before induction of anaesthesia.

Concomitant cardiac problems may be associated or unrelated to the primary disorder affecting the spine. Patients with severe scoliosis may have pulmonary hypertension, cor pulmonale and right heart failure secondary to restrictive lung disease and chronic hypoxaemia. Rheumatoid disease is associated with valvular problems and ischaemic heart disease. Assessment and preoperative management should proceed according to international consensus guidelines such as the 2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Non-cardiac Surgery, which include protocols on further investigations such as echocardiography and invasive coronary interventions.[2] Restrictive lung disease should be objectively assessed using lung spirometry as this will inform decisions regarding postoperative ventilatory support.

Routine blood tests include a complete blood count, renal function tests, and a blood type and cross match. Other investigations may be indicated depending on patients' comorbidities. Any co-existing medical illness should be reviewed and optimized before elective spinal surgery.

Previous anaesthetic charts, if available, should be carefully reviewed to identify any history of anaesthesia-related problems such as difficulty with intubation.

The consent process is important in ensuring that the patient understands the potentially devastating complications of major spinal surgery (e.g. permanent spinal cord damage) and has realistic expectations of the surgical outcome. In addition to the risks of general anaesthesia in general, which are low, the complications specific to prolonged surgery in the prone position should also be highlighted and understood. These are further discussed below.

Some of the primary pathologies requiring spinal surgery are:

Degenerative diseases of the spine

Spondylosis is a broad term encompassing degenerative diseases of the spine, usually due to the natural process of ageing. Commonly associated changes include osteoarthritis of the facet

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joints, spondylolisthesis, prolapse of intervertebral discs and spinal stenosis. Osteoarthritic changes in the facet joints may cause painful movement of the neck and lower back. Spondylolisthesis is secondary to unstable facet joints, resulting in slippage of a vertebral body on the adjoining vertebral body. Vertebral disc prolapse occurs due to progressive desiccation of the nucleus pulposus and annulus fibrosus. Any combination of these pathological changes may result in radiculopathy and neurological symptoms. Surgical intervention such as spinal fusion is indicated if symptoms are refractory to conservative treatment.

Scoliosis

Scoliosis is a lateral deviation of the spine by more than 10° (as defined by the Scoliosis Research Society). Seventy percent of cases are idiopathic. The incidence is 2–4% and females are more severely affected. It results in a restrictive lung defect and, if severe, can result in pulmonary hypertension, cor pulmonale and, eventually, heart failure. Cobb's angle is a measure of the maximum curvature of the spine. Surgery in the form of spinal reconstruction or fusion is indicated when Cobb's angle is greater than 40–50°, with the aim to arrest the natural progression of the disease in order to prevent further cardiorespiratory deterioration.

Autoimmune diseases

Rheumatoid arthritis is a multi-system disease with a worldwide incidence of approximately 1%. The cervical spine is commonly affected, resulting in atlanto-axial instability and compression of the upper cervical cord. Surgical decompression and stabilization may be indicated in the presence of symptoms or if there is significant atlanto-axial instability.

Intraoperative management

Monitoring

Minimum standards of monitoring during anaesthesia and surgery should conform to AAGBI guidelines. Temperature monitoring is important, as hypothermia impairs spinal cord monitoring and coagulation. Additionally, invasive arterial blood pressure monitoring may be considered for operations where considerable blood loss is anticipated, or duration of surgery is prolonged. Placement of a central venous catheter may be useful for monitoring of fluid status and administration of drugs. A urinary catheter should be inserted and urine output measured.

Induction of anaesthesia

Major spinal surgery is performed under general anaesthesia. Most surgery is performed prone, although there are various anterior approaches. If prone positioning is required, a reinforced endotracheal tube is safer. Following acute spinal cord injury, succinylcholine should be avoided from 72 hours to 6–9 months' post-injury due to the risk of hyperkalaemia. In addition, its use is precluded in muscular dystrophies associated with malignant hyperthermia or anaesthesia-induced rhabdomyolysis. Patients with muscular disorders may also have increased sensitivity to non-depolarizing agents and should be given reduced doses (10–20% of recommended dose) with close monitoring.[3]

Airway management

For patients who are known or predicted to have a difficult airway, a clear airway management strategy must be in place with appropriate back-up plans before the patient is anaesthetized. Direct laryngoscopy with manual in-line stabilization, the standard of care for many years, has been shown to have limited efficacy in limiting excessive spinal movements and may even increase cervical subluxation.[4] An alternative is the video laryngoscope and, although more likely to yield a better view of the glottis compared to direct laryngoscopy, it has not been shown to significantly decrease spinal movement.[5] Hence, awake fibre-optic intubation remains the safest technique for upper airway management. This technique is particularly useful for patients who have an unstable cervical spine or who already have cervical myelopathy, as it is able to facilitate intubation with minimal neck movement and re-assessment of the patient's neurological status following intubation.

Neurophysiological monitoring

Neurophysiological monitoring using somatosensory evoked potentials (SSEP) with or without motor evoked potentials (MEP) is regarded as the standard of care for patients undergoing major spinal surgery. SSEPs involve stimulating a peripheral nerve (e.g. tibial nerve) and detecting the action potential at certain points along the course of transmission towards the central nervous system, such as the lumbar plexus, spinal cord, medulla and finally, the somatosensory cortex. MEPs involve transcranial electrical stimulation via scalp electrodes and monitoring the muscle compound muscle action potentials in the corresponding muscle groups. SSEP monitoring alone is regarded as having sufficiently high sensitivity, specificity and diagnostic power to detect neurological injury of both sensory and motor type, and hence MEP monitoring is less used. In general, both SSEPs and MEPs are depressed by anaesthetic agents in a dose-dependent manner, with the notable exception of etomidate and ketamine. MEPs are more susceptible than SSEPs to the effects of anaesthetic drugs due to the polysynaptic nature of the motor pathways involved in the generation of the motor response. Inhalational agents, in particular nitrous oxide, are more detrimental than propofol-based anaesthesia.[6] Pre-existing neuropathies and diabetes mellitus may adversely affect SSEP and MEP measurements.

Neurophysiological monitoring requires that a neurophysiologist and a qualified electrophysiology technician be present during surgery. Anticipated as well as unanticipated intraoperative events, monitoring goals and contingency plans in the event of significant alterations in signals should be communicated and agreed in advance. Baseline measurements should be recorded after the induction of general anaesthesia. Signal acquisition should be optimized at this stage.

Injury to the spinal cord and associated spinal nerves may occur at any point during the operation and may most obviously result from surgical trauma resulting in the physical disruption of nerve fibres. This is most likely to occur during surgical instrumentation (e.g. insertion of pedicle screws and wires) and extensive osteotomies. However, injury may also occur as a consequence of perturbations in physiological homoeostasis resulting in reduced perfusion and oxygen delivery. It is, therefore, important to maintain normal physiological homoeostasis as much as possible intraoperatively.

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