Cervical spine disease and anaesthesia

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Abstract

Surgery on the surgical spine is commonly performed to relieve compression of the spinal cord (myelopathy), a nerve root (radiculopathy) or to provide bony stabilization to prevent secondary neurological injury. The pathological causes of myelopathy and radiculopathy are a common consequence of osteoarthritis or less commonly due to tumours, trauma, disc herniation, infection and multisystem disease and in some conditions as a result of their associated pathologically or surgically induced instability. Successful anaesthetic management should involve a meticulous preoperative assessment of the patient's airway, a systemic review especially in patients with comorbidities & multisystem disease and attention to their medication and analgesic requirements. Preoperative discussion with the surgical team allows planning of airway management, patient positioning, cardiovascular support (in cases with the potential for significant blood loss), the availability of appropriate blood products and monitoring, postoperative pain management and ward destination.

Keywords Anaesthesia; analgesia; cervical spine disease; difficult airway; instability; myelopathy; radiculopathy; spinal cord perfusion

Learning objectives

After reading this article you should have an understanding and awareness that in the context of patients anaesthetized for cervical spine operations:

- many patients with cervical spine disease have difficult airways and there is a risk of spinal cord injury during anaesthesia
- operations on the cervical spine have the potential for significant perioperative blood loss and severe postoperative pain
- careful preoperative planning is therefore vital to ensure appropriate patient airway management, surgical positioning, spinal cord perfusion and monitoring, blood product availability, analgesia and postoperative ward destination

Introduction

Cervical spine disease is common. Approximately two-thirds of the UK population suffer with neck pain at some stage during their life.[1] This article describes the common categories of cervical spine pathology requiring surgical intervention. It reviews the surgical treatments, their approaches, and the anaesthetic management required to facilitate the safe care of such patients throughout their perioperative journey.

Pathology of cervical disease

The majority of cervical spinal surgery is undertaken in order to relieve compression of the spinal cord (myelopathy), a nerve root (radiculopathy) or to provide bony stabilization to prevent secondary neurological injury. Underlying causes for spinal cord compression or vertebral instability may be due to congenital abnormalities or may be acquired (Box 1). The commonest acquired cause is *cervical spondylosis* which is due to osteoarthritis of the cervical spine and is characterized by *osteophyte formation* (intervertebral joint bony outgrowths). Other less common causes of compression include *tumours*, *trauma*, *disc herniation*, *infection* and multisystem diseases such as *rheumatoid arthritis* and *ankylosing spondylitis*. In addition to neural compression, in some cases (e.g. following trauma, spondylolisthesis, rheumatoid arthritis or infection) there may be associated spinal instability (see Box 2). Spinal instability may also result from surgery to remove spinal tumours; all such instability requires surgical fixation to prevent secondary neurological injury.

Surgical procedures and approaches

Decompression of the cervical spinal cord may be performed through anterior or posterior approaches. Anterior approaches are performed for compression between C3—C7 and usually involve an anterior cervical decompression combined with fusion. Higher

Causes of cervical spine disease

Congenital conditions

Basilar impression
- Primary e.g. atlanto-occipital fusion, hypoplasia of the atlas
- Secondary — developmental osseous softening e.g. osteogenesis imperfecta

Occipito-cervical synostosis e.g. Kippel-Feil syndrome
Odontoid anomalies (associated with ligamentous laxity) e.g. Morquio's Syndrome, Down's syndrome

Acquired conditions

Mechanical lesions — cervical spondylosis, disc herniation, spondylolisthesis
Inflammatory disease — rheumatoid arthritis, ankylosing spondylitis
Infections — osteomyelitis, tuberculosis
Metabolic disease — osteoporosis, Paget's disease
Trauma
Malignancy — primary or metastatic disease, myeloma

Box 1

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Definitions of cervical spine instability

General

Loss of the ability under normal physiological loads to maintain relationships between vertebrae in such a way that there is neither initial nor subsequent damage to the spinal cord or nerve roots and there is neither development of incapacitating deformity or severe pain[2]

Radiological measurements

Translation

C1—C2: anterior atlanto-dental interval (ADI) >5mm, posterior ADI <13mm

C2—T1: >3.5mm between points on adjacent vertebrae

Angulation

>11 degrees between vertebrae

Although these values have been widely used, there is poor correlation between radiographic abnormalities and neurological symptoms

Integrity of the anterior and posterior spinal columns

The spine can be thought of as two columns (anterior and posterior); anterior column disruption tends to make the spine unstable in extension, and posterior column damage favours instability in flexion

Box 2

cervical pathology often requires a transoral approach with or without a mandibular split. Techniques to provide posterior decompression of the spinal cord include cervical laminectomy or laminoplasty or relief of nerve root compression by foraminotomy. On occasions anterior decompression is combined with posterior spinal fixation and the anaesthetist often provides elective postoperative ventilation as there is an increased risk of airway obstruction due to tissue oedema.

Anaesthetic conduct

Preoperative assessment

Careful preoperative assessment includes a thorough general history and examination. There should be particular focus on the cause and mechanism of the cervical spinal pathology and the procedure to be performed. Some vascular cervical spinal tumours are amenable to preoperative embolization.

Airway assessment is of paramount importance. Most patients undergoing elective surgery will have a stable cervical spine and no airway concerns. However, some cervical spine pathology (e.g. ankylosing spondylitis, spinal instability, trauma) presents the potential for airway difficulties including problems with face mask ventilation and laryngoscopy. Reduced mouth opening and poor mandibular protrusion appear to be better indicators of difficult laryngoscopy rather than reduced neck extension probably because impaired cranio-cervical junction extension itself is a predictor of difficult direct laryngoscopy and is often associated with temporomandibular joint dysfunction.[3,4]

Respiratory function must be carefully assessed, especially in patients with significant scoliosis, spinal cord injury and rheumatoid arthritis. A vital capacity of less than 15 ml/kg indicates poor respiratory reserve and often these patients require prolonged postoperative ventilatory support. Assessment of cardiovascular instability needs to be made in patients with severe scoliosis, muscular dystrophy or multisystem conditions such as rheumatoid arthritis, ankylosing spondylitis, malignancy or with those with autonomic dysreflexia following spinal cord injury above T7. Hypertensive patients should have their blood pressure controlled preoperatively to avoid ischaemic cardiac events, excessive bleeding and to ensure optimal spinal cord perfusion intraoperatively.

Neurological deficits need to be accurately documented preoperatively especially in high cervical trauma patients with associated head injury (5% of severe head injured patients have unstable spines). In this situation intracranial pressure monitoring should be used perioperatively especially if prone positioning for posterior spinal surgery is planned.

Cervical spine disease such as cervical spondylosis resulting in radiculopathy and myelopathy may be associated with significant chronic pain. Attention should be directed to planning appropriate postoperative analgesia. Gabapentin or pregabalin have been shown to be of benefit if started in the early preoperative period and continued postoperatively.

High cervical cord lesions may be associated with bulbar dysfunction and careful consideration of nutritional needs may determine that nasogastric feeding or insertion of a percutaneous gastrostomy (PEG) should be performed before surgery.

Haematological evaluation is essential. Many patients will be receiving non-steroidal anti-inflammatory drugs (NSAIDs) and these should be stopped 48 hours preoperatively to allow platelet function to return to normal. Some patients with rheumatoid arthritis may have anaemia of chronic disease. Many of the procedures can be long and involve significant blood loss and an appropriate volume of blood should be cross-matched.

Finally, patients with multisystem disease may be receiving immunosuppressant drugs that may cause hepatic or renal impairment.

Perioperative management

Induction and maintenance of anaesthesia: if there are no obvious airway concerns an intravenous induction may be performed and usually involves an opioid and hypnotic combination together with a non-depolarizing neuromuscular blocking drug to facilitate tracheal intubation. A single dose of ketamine (0.5 mg/kg) at induction has been shown to improve postoperative analgesia.[5] A prophylactic antibacterial agent is also administered at induction as is intravenous dexamethasone.

Following induction and intubation, balanced anaesthesia is maintained with an oxygen, air and volatile anaesthetic agent. Total intravenous anaesthetic techniques with a propofol and remifentanil combination are increasingly used especially when motor and sensory evoked potential monitoring of spinal cord function is employed as volatile agents degrade potential signals.

Airway management: there is no clear evidence that direct laryngoscopy in skilled hands in association with manual in-line stabilization (MILS) has produced spinal cord injury.[6] However; the airway management of patients with a difficult airway clearly

Airway options for the difficult airway, unstable cervical spine and/or emergency situation

Asleep fibreoptic intubation
Awake fibreoptic intubation
Direct laryngoscopy with or without manual inline stabilization (MILS)
Rapid sequence induction with MILS
Tracheostomy (under local or general anaesthesia)

Box 3

requires the involvement of an anaesthetist not only competent in routine direct laryngoscopy but also more advanced techniques (Box 3). Whatever the experience of the anaesthetist, they should only embark on a technique of tracheal intubation with which they are familiar. The choice of whether an oral or nasal tracheal tube is used depends on whether an asleep or awake intubation technique is employed, surgical access issues (transoral surgery is more easily performed with a nasotracheal tube), and whether post-operative ventilation is planned (a nasotracheal should not remain for more than a few days because of the increased risk of sinusitis). An awake fibreoptic intubation in the authors' opinion is the most appropriate technique when dealing with an obvious difficult airway; however, patients with anteriorly located lesions at the cranio-cervical junction or in those with severe high cervical myelopathy may be most safely managed by performing a tracheostomy before surgery.

Spinal cord perfusion: the anaesthetic technique should ensure an adequate spinal cord perfusion at all times (Box 4). Normotension must be meticulously maintained and hypotension treated promptly and effectively. Large bore intravenous cannulae, intraarterial and central venous access are often required to facilitate optimal intravenous fluid or blood product administration or the judicious use of vasopressors. The use of a cell saver device may be considered especially if a significant blood loss is anticipated. The surgeon may request the insertion of a lumbar subarachnoid drain following induction of anaesthesia to ensure cerebral spinal fluid (CSF) pressures are kept at a appropriate level to optimize spinal cord perfusion.

Positioning: access to the airway intraoperatively is limited, especially if the head is fixed in head pins. It is important to pay meticulous attention to eye and limb padding to avoid corneal abrasions and pressure sores respectively. Careful positioning of the neck in a neutral position is vital, especially in patients with myelopathy or unstable cervical spines. If the patient is in the prone position, the neck needs to be positioned well clear of the mattress to avoid venous and/or lymphatic obstruction which can result in neck, face and airway oedema. Some centres choose to position the patient awake following an awake fibreoptic intubation, and if no new neurological symptoms occur anaesthesia can be induced. However, most position the patient following anaesthesia and use radiological screening to confirm the correct spinal alignment and monitor somatosensory evoked potential (SSEP) and/or motor evoked potential (MEP) to confirm spinal cord integrity.

Patients undergoing posterior cervical spinal surgery in the prone position should be placed on an appropriate mattress (e.g. a Montreal mattress) which allows free abdominal movement ensuring effective mechanical ventilation and does not impede venous return. Care must be taken to ensure the eyes are taped and padded to prevent corneal abrasions; furthermore, optic nerve hypoperfusion can occur if the patient is placed in the head down Trendelenburg position and this must be avoided.

Spinal cord perfusion

SCPP = MAP − CSF pressure
Mean arterial pressure (MAP)
Spinal cord perfusion pressure (SCPP)
Cerebral spinal fluid (CSF)

Box 4

Monitoring: in addition to standard and invasive pressure monitoring, SSEPs and MEPs are useful as a guide to cord perfusion but are sensitive to hypotension and volatile anaesthetic agents.[7]

Postoperative management and complications

Analgesia: pain may be prominent following cervical spine surgery. Morphine is usually administered towards the end of the procedure, and continued postoperatively, either as a patient-controlled preparation, oral morphine elixir solution or slow-release formulations. Supplementation with regular paracetamol, NSAIDs, clonidine and ketamine is used depending on the need. Gabapentin may be continued into the postoperative period and nocturnal amitriptyline can be helpful if neuropathic pain is prominent.

Airway and feeding: following cervical spinal fusion a previously 'easy' airway may become 'difficult'. Airway obstruction may occur after anterior cervical surgery due to haematoma formation especially if a neck collar conceals its presence. In many cases the obstruction is due to tissue swelling especially if the operative approach entailed combined surgery on the anterior and posterior cervical spine. Such patients should remain intubated and mechanically ventilated overnight to allow time for the swelling to resolve and only extubated when it has be shown that the airway is unobstructed by demonstrating a leak around the deflated tracheal cuff. Patients can also develop post-operative swallowing difficulties, necessitating nasogastric feeding.

General: some patients require a prolonged stay in the critical care setting for respiratory support, weaning or haemodynamic management following rebleeding or sepsis events.

The surgical team should clearly document and communicate the stability of the cervical spine and any mobility issues. ◆

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