

Spinal surgery: non surgical complications

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INTRODUCTION

During the last decade rapid expansion has taken place in corrective spinal surgery with the possibility of improving the quality of life, even in severely compromised patients.

The flip side of the coin has been the emergence of the following important factors:

- The necessity for careful patient selection
- The need for greater surgical expertise
- The need for precise instrumentation
- Meticulous attention to preoperative care and anaesthetic technique; prevention of hypoxic-ischaemic episodes; administration of supportive drugs; meticulous control of fluid and electrolyte balance
- The prevention of complications, including iatrogenic ones
- The need for informed nursing care and physiotherapy

COMPLICATIONS

The complications that can occur are numerous, but most can be prevented, or respond to early recognition and treatment.

The following will be discussed in this article:

- Invasive procedures
- Epidural injections
- Blood transfusions
- Fluid balance
- Anterior cervical surgery
- Spinal cord damage
- Ischaemic optic neuropathy
- Embolism → fat and air
- Systemic Inflammatory Response Syndrome (SIRS)
- Pulmonary problems
- Ileus
- Injury to intra-abdominal structures
- Infection
- Thrombo-embolism
- Chronic pain
- Chronic drug administration
- Renal dysfunction
- Haemodynamic
- Mental status changes
- Non-fusion

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Invasive Procedures (apart from the definitive surgical procedure)

Arterial cannulation

Central venous cannulation

Catheterisation of the bladder

Discography: recently a patient initially developed a low CSF pressure headache as a complication of discography, which cleared up rapidly, but was followed after ± 3 days by the development of thrombosis of the superior sagittal sinus. With a dural puncture, an early blood patch should be considered. (this case is obviously anecdotal)

Epidural Injections – complications include:

- *Acute retinal necrosis syndrome after epidural corticosteroid injections for back pain.*
Patients should be advised to report visual abnormalities that develop after treatment. Patients who develop symptoms should be promptly referred for dilated fundoscopic examination.¹
- *Intrathecal perforation or spinal cord penetration with administration of cervical epidural steroid injections.*
The neurological injury can be the result of penetration by the needle, haematoma or adverse effects from neural tissue exposure to the steroid or to a preservative in the medication, which can have a deleterious effect when placed in or near neural tissue.²
- *Infection*
- Postdural puncture low CSF pressure

Complications of Blood Transfusion³

- *Incorrect blood product transfused (1 : 12,000)*
- *Transfusion of a transmissible disease (1 : 400,000)*
- *Acute haemolytic reaction*
- *Delayed haemolytic reaction*
- *Transfusion - related acute lung injury, (using a leukocyte filter or leukocyte free blood should prevent this)*
- *Immune - mediated platelet destruction*
- *Allergic reactions*
- *Febrile non-haemolytic reactions*
- *Transfusion-associated graft - versus host disease*

Utilising cell savers, autotransfusion techniques and the administration of recombinant human erythropoietin and an intravenous iron preparation can limit transfusion of banked blood.

Fluid Balance

- *Dehydration*

A potent laxative is often administered preoperatively especially if an anterior procedure is to be carried out. Severe loss of fluid can occur with acute dehydration and loss of electrolytes. Oral intake should be supplemented with preoperative intravenous fluids. Preoperative dehydration is one of the reasons for oliguria during the immediate postoperative period.

- *Overhydration*

Postural changes and blood loss can elicit haemodynamic changes with significant changes in the blood pressure and tissue perfusion. Therefore there is a general tendency to fluid loading to correct the haemodynamic instability. Unless meticulous attention is given to urinary output, fluid overload may occur.

Patients undergoing extensive corrective spinal surgery have intolerance for both hypovolaemia and overhydration.

- *Reactions to colloid administration*

These have been reported, both to the gelatins and starch solutions.

Complications of Anterior Cervical Surgery^{4, 5, 6, 7}

Damage to various structures in the region of exposure may occur: Oesophagus, trachea, carotid artery, vertebral artery, internal jugular vein, laryngeal nerves.

- *Dysphonia*

Hoarseness can occur as a result of endotracheal intubation, with increased endotracheal cuff pressure as a result of placement of the retractors against the trachea; oedema; and damage to the recurrent laryngeal nerve with vocal cord dysfunction. The dysphonia may resolve or may be permanent, depending on the cause.

- *Dysphagia*

Difficulty in swallowing is a well-known complication and can be transient or may become chronic. It may result from oedema; haematoma; damage to the recurrent laryngeal nerve; perforation of the pharynx or oesophagus; or damage to the superior laryngeal nerve with pharyngeal sensory loss.

As a result of the dysphagia aspiration of secretions from the oro-pharyngeal area as well as aspiration of regurgitated stomach contents may lead to pulmonary pathology.

If the dysphagia persists, a videofluoroscopic study should be performed and rehabilitation advised if indicated.

Adrenalin inhalations immediately after extubation and during the first 24 hours postoperatively may prevent the above symptoms in a significant number of patients.

- *Damage to the hypoglossal nerve*

This can occur with paralysis of the ipsilateral side of the tongue.

- *Upper airway obstruction*

Secondary bleeding is a potentially fatal complication. Even a relatively small haematoma can cause venous congestion

and oedema, with complete upper airway obstruction. Regular measurements of the neck circumference should be done, and an increase in circumference reported.

Spinal cord damage^{8, 9, 10, 11, 12}

In spite of the spinal cord's adaptability to chronic compression, the spinal cord like the rest of the central nervous system cannot withstand acute phenomena such as distraction or pressure.

- *Direct injury to the cord*

The mechanisms for injury to the cord can be direct contusion of neural elements as a result of the surgery or distraction of the cord, which can occur at a local level or at a regional level with extended instrumentation. Compression of the cord can occur as a result of a haematoma or as a result of migration or displacement of a bone graft or displacement of a screw. Damage could also have been sustained as a result of a previously misplaced screw, which was replaced in a more perfect position. With delayed onset of neurological signs an epidural haematoma should be suspected. Any delay in evacuation of an epidural haematoma can lead to permanent neurological impairment.

- *Ischaemic injury to the cord*

In cases of ischaemia not only is the oxygen supply jeopardised, but also the removal of products of metabolism such as lactic acid and CO₂ is inhibited. The low pH in ischaemic tissue can lethally damage cells.¹³

The spinal cord is provided with a blood supply just adequate for its needs. The blood supply can be compromised locally as a result of traction on or compression of the blood vessels, or of ligation of a main feeder branch to the anterior spinal artery.

Systemic low flow states exacerbate damage produced by direct pressure on the cord or as a result of distraction of the cord. Causes of systemic low flow states are intra-operative blood loss which can be extensive especially in patients undergoing reduction of scoliosis or extended rescue surgery, or can be due to the effects of anaesthetic drugs or can occur as a result of deliberate hypotension. Deliberate hypotension is usually requested by the surgeon in order to improve operating conditions and to reduce blood loss. Even with deliberate hypotension bleeding can still be excessive during posterior spinal procedures possibly as a result of backflow into the extradural veins. The effects of hypotension and traction or direct pressure on the cord are additive, and the supposed benefits of deliberate hypotension must be weighed very carefully against the risks.

The prone position can cause hypotensive episodes as a result of compression of the inferior vena cava as well as pooling of blood in the legs. During the periods when pressure is applied to the patient's back for the introduction of the instrumentation there can be significant exacerbation of the hypotension.¹⁴

- *Haemodilution*

Below a certain level haemodilution may decrease the threshold of spinal cord tolerance against hypoxia or hypotension. A spinal cord insult that may initially be reversible, can be rendered irreversible as a result of subsequent hypoxic or ischaemic episodes.

Ischaemic Optic Neuropathy^{15, 16, 17, 18, 19}

There have been a number of reports of visual loss following lumbar spine surgery. Certain vasculopathic systemic diseases such as diabetes mellitus or hypertension may be risk factors in the development of ischaemic optic neuropathy, but it can occur without any predisposing factors.

In the prone position the intra-ocular pressure increases progressively during extended surgery. With a lowered systemic blood pressure, the intra-ocular perfusion pressure can be severely compromised. Pressure on the eye or eyes, or an increase in the venous pressure as a result of increased intravascular volume or the Trendelenburg position can lead to a further decrease of intra-ocular perfusion pressure.

Major risks in the development of ischaemic optic neuropathy are the combination of increased intra-ocular pressure, deliberately maintained hypotension, intra-operative anaemia and pressure on the eye or eyes. Treatment is early recognition, ophthalmologic consultation, rapid, aggressive and early increase in blood pressure and the correction of anaemia. The recommended haemoglobin threshold for transfusion may be too low for patients with this complication. Administration of steroids and possibly non-steroidal anti-inflammatory agents (NSAIDs) to reduce swelling may be of value.

Venous Air Embolism²⁰

Although there may be virtually no gravitational gradient between the incision and the right side of the heart as well as a relatively high central venous pressure generated in the prone position, venous air embolism can and does occur.

Fat Embolism Syndrome (FES)^{21, 22, 23}

Fat embolism has been reported following augmentation of pedicle screws with bone cement. Increased intraosseous pressure during injection of bone cement can cause the passage of fat and bone marrow into the venous circulation. This may be the cause of the so-called bone cement implantation syndrome rather than a toxic effect of the bone cement.

Classically the FES presents with respiratory symptoms and signs, mental status change and a petechial rash, which may or may not be present and can easily be missed if not specifically looked for. The fat droplets can be filtered in the lungs. Cerebral involvement occurs when there is a spillover into the arterial circulation, and can vary from minor global dysfunction to severe neurological manifestations. A clinical diagnosis is essential since laboratory and radiographic findings are essentially non-specific and a good prognosis depends on early recognition and aggressive supportive treatment.

Prophylactic steroid administration given before surgery starts, may possibly prevent the development of FES.

Systemic Inflammatory Response Syndrome (SIRS)

Any major trauma including extensive surgery could trigger a pathological host response. Although a systemic inflammatory reaction is usually life-orientated, the response is exaggerated in some patients and may be damaging to end organs, especially the lungs.

Postoperative Pulmonary Complications

Pain, as well as opioid analgesics and mechanical dysfunction can contribute to the development of postoperative pulmonary complications. Postoperative sleep deprivation in a high care

or critical care facility has adverse effects on the respiratory system such as increased upper airway collapsibility, decreased muscle endurance, and decreased response to hypoxia and hypercarbia.²⁴

Postoperative pulmonary complications include pneumonia, blood transfusion related lung pathology, pulmonary embolism (air, fat, thrombus), atelectasis, bronchospasm, pulmonary oedema, FES, and pneumothorax. The clinical picture with pulmonary oedema, FES and transfusion related lung pathology can be very similar. Atelectasis, especially atelectatic areas in the right lower lobe, occurs more commonly than expected and aggressive physiotherapy, inhalations and non-invasive intermittent positive airway pressure ventilation should be part of the postoperative treatment. There is also an increased incidence of pleural effusions with extensive corrective spinal surgery. Most of these do not require drainage. Regurgitation of stomach contents, with aspiration pneumonia can, to some extent, be prevented by nursing the patients in the anti-Trendelenburg position.

Postoperative Hypoxaemia

This may last several days.²⁵ Oxygen therapy as well as non-invasive supportive measures may be required to correct the sub optimal saturation.

Ileus

In most patients there is at least retarded emptying of the stomach. Ileus can be prolonged in patients with previous abdominal pathology, those on anti-depressant drugs and patients requiring prolonged opiate analgesia.

Injury to Intra-abdominal Structures with Anterior Exposure

These include damage to the ureter, especially on the left side, and damage to vascular structures - e.g. the iliac veins or arteries, with either haemorrhage from the vessels or damage to the vessel wall with resultant thrombosis. The above complications occur more readily after previous abdominal surgery.

Infection

Infection can be the cause of significant morbidity. It can be a superficial wound infection or infection in the deeper structures. Treatment with a short course of an oral antibiotic can lead to a prolonged low-grade infection with resistant organisms. Treatment should be with intravenous antibiotics, carefully guided by investigations such as serial blood counts, CRP and procalcitonin estimations, to guide adjustments to the treatment.

Thrombo-embolism

Pulmonary embolism and deep vein thrombosis remain a significant problem in patients undergoing extensive spinal surgery. Prophylactic anticoagulant therapy is indicated in most patients undergoing corrective spinal surgery. There should be a high index of suspicion for the development of pulmonary embolism (PE) and any otherwise unexplained pulmonary symptoms should be investigated and aggressively treated. Chest X-rays can be very misleading and if PE is suspected ventilation/perfusion studies or computed tomography utilising a special technique, should be requested.

Deep vein thrombosis (DVT) can occur with very minor or no symptoms. Duplex studies for deep vein thrombosis should be done in case of swelling or pain in a leg or legs. Serial studies should be done in high-risk patients, for instance patients with a history of previous DVT. Serial thromboelastograms can be of value to identify patients at risk.

Chronic pain^{26, 27}

A certain number of patients implicate surgery as the cause of chronic persistent pain. When disc pathology, incomplete decompression, vertebral instability, infection, non-fusion or unrelated pathology has been excluded, a certain number of patients still complain of pain in spite of meticulously executed surgery. In some patients motivational factors may play a role in the persistence of pain.

Complications of chronic drug administration

Many patients presenting for spinal surgery have been on long term NSAID therapy. Preoperative full blood counts should be done routinely to detect bone-marrow depression. NSAIDs are contra-indicated in patients with a history of asthma or gastro-intestinal ulceration. There have been reports that NSAIDs inhibit osteogenic activity and may interfere with spinal fusion. The administration of intravenous NSAIDs can be the cause of significant and even disastrous postoperative oliguria. Administration of the medication in a continuous infusion over 8 to 12 hours can minimise the oliguric effect.

Postoperative Renal Dysfunction

Significant postoperative oliguria with fluid retention can occur. If this is not rectified it can lead to acute oliguric renal failure. Avoidance of preoperative dehydration and hypotensive episodes may prevent this to some extent. Nephrotoxic drugs should only be administered if there are no alternatives. Intake and output volumes should be meticulously monitored and oliguria or a discrepancy between intake and losses corrected.

Haemodynamic Complications include

- *Hypotension*
Hypotension during the early postoperative period is not unusual, and if moderate, does not require intervention, provided the patient is normovolaemic, and excretes a normal volume of urine. Other causes such as pulmonary embolism, myocardial ischaemia and pneumothorax need to be excluded.
- *Dysrhythmias*
Dysrhythmias occur, especially atrial fibrillation, particularly in the elderly, and in patients with a history of hypertension or cardiac pathology.

Symptoms of Orthostatic Intolerance

Postoperative episodes of orthostatic intolerance are common and are associated with increased postoperative morbidity.

Postoperative Mental Status Changes^{13, 24}

Postoperative mental changes are common. An acute confusional state or depressed level of consciousness may represent the initial or the only sign of many underlying complications, or infrequently, of a primary neurological event. The

initial signs may be subtle. Drug effects or withdrawal, electrolyte imbalance, hypoxia, hypotension, hypo- or hyperglycaemia, cardiac or pulmonary insufficiency should be excluded. Most of the causes are reversible, but if uncorrected, may be associated with significant morbidity. It is important to obtain a history of substance abuse. Apart from analgesics, some of the drugs administered postoperatively that could be associated with confusion are anticholinergic drugs, anti-convulsants, benzodiazepines, cimetidine, digitalis, metoclopramide, theophyllin, antimicrobials and propranolol.

Risk factors include advanced age, preoperative cognitive impairment, and preoperative drug abuse and sleep deprivation.

Non-fusion

Treatment for osteoporosis should be considered in patients with decreased bone density.


CONCLUSION

A high index of suspicion and frequent examinations are required for the early recognition of complications and timely intervention.

“Abandonment might (also) be alleged if a patient was not observed often enough to recognize potentially harmful developments in time to safely treat them. The rapidity with which foreseeable complications are likely to develop determines the safe frequency of observation of the patient: If a complication can develop and produce irreversible injury in as little as ten minutes if untreated, then the minimum safe interval between observations is less than ten minutes. The attending physician is expected to either examine the patient at safe intervals or to delegate this responsibility to someone else, such as a nurse or house officer, who is competent to recognize the complication”.²⁸

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