

# Positioning of the surgical patient

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## Abstract

The positioning of the surgical patient has many implications for the patient. Cardiorespiratory physiology can be affected greatly by pre-morbid patient conditions, particularly diabetes mellitus, ischaemic heart disease, peripheral vascular disease, obesity and respiratory disease. After taking into account these factors, the position of the patient and choice of anaesthesia may exacerbate symptoms and cause significant morbidity. The assessment must be made for each patient to allow optimal surgical access with minimal risk. Nerve damage is an important issue and has medico-legal implications. It is a complication for which no known mechanism of injury exists and usually resolves completely with time. However, because of the fact that the patient is under the control of the physician and does not contribute to the mechanism of injury, it is postulated that the physician is at fault rather than the patient. Complete documentation of the precautions taken during surgery leads to fewer and smaller medico-legal payouts, which highlights the importance of clear and accurate documentation. Ocular damage is a potentially devastating complication, which needs special care and attention at all times. Other problems encountered are joint instability, fixed flexion deformities, compartment syndrome, chronic pain and obesity.

**Keywords** nerve injury; ocular damage; positioning; prone

Correct positioning of the patient should minimize patient risk and optimize surgical access. Major factors to be considered are the reduction of blood loss and the prevention of damage to nerves, soft tissues and bones. There are many positions for different operations detailed below, and for each position a careful benefit-versus-risk assessment should be made. Pre-, intra-, and postoperative measures for minimizing the risk of injury to the patient are given in Table 1.

During a 12-year period the Medical Defence Union<sup>1</sup> reported that 4% of claims against anaesthetists were due to patient positioning or falls in theatre. This equated to 2.5% of costs against

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## Minimizing the risk of injury to the patient

### Preoperative

- Plan the position in communication with the surgeon
- Consider the patient's physiological and mechanical limitations
- Note any co-morbidities that will worsen postural hypotension
- Document any pre-existing neurological deficits
- Consider the benefits and risks of GA or regional techniques
- Allow at-risk patients to position themselves before induction

### Intraoperative

- Ensure that the number of staff and the equipment are appropriate for the position used
- Use padding for all pressure areas
- Protect all susceptible nerves
- Avoid flexion/extension of any joint to its limits (the < 90° rule)
- Secure all monitoring and the endotracheal tube

### Postoperative

- Be aware of the continuing effects of regional anaesthesia
- Note any surgical instructions for postoperative positioning
- Place the patient in left lateral recovery position after rapid-sequence induction
- Elevate affected limbs to reduce swelling
- Consider a head-up position to aid respiratory function
- Give appropriate care to protect patients initially agitated on recovery

GA, general anaesthetic

**Table 1**

anaesthetists, and represents a completely preventable contribution to medico-legal costs and patient morbidity.

## Physiology

Physiological changes in the cardiovascular and respiratory systems are especially affected by positioning.

**Cardiovascular system:** general anaesthesia frequently results in hypotension due to decreases in systemic vascular resistance, heart rate and myocardial contractility. The autonomic nervous system may also be affected, with a decrease in the baroreceptor reflexes. Causes of autonomic dysfunction such as diabetes mellitus, paraplegia and central blockade further compound these effects.

Hypovolaemia due to dehydration or haemorrhage leads to worsening postural hypotension, which is exaggerated by tilting a patient's head up, causing venous pooling in the legs. This position is used for head and neck surgery to avoid venous engorgement and hence bleeding. It also reduces intracranial pressure in head-injured patients, and the transducer for measuring this should be kept at the level of the Circle of Willis. Conversely, a prolonged head-down position increases venous return and preload, thus potentially causing acute heart failure in patients with poor ventricular function.

Venous air embolism is a risk in patients with negative venous pressure in a surgical field above the level of the heart. This is of particular importance in neurosurgical anaesthesia. Although diagnosis can be difficult, it usually presents with a sudden drop in end-tidal CO<sub>2</sub>, followed rapidly by a fall in blood pressure and oxygen saturation. Treatment involves flooding the surgical field, dropping it below the level of the heart and supportive measures to maintain the blood pressure. Aspiration of a central venous cannula to minimize the size of or remove the air bubble is sometimes attempted.

**Respiratory system:** in healthy patients, changes to the respiratory system due to posture have little impact, but in patients with significant respiratory disease, knowledge of respiratory physiology and its implications becomes important.

Optimal oxygenation of a patient involves ventilating and perfusing the same regions of the lung. In supine, prone or lateral positions, optimal ventilation (V) and perfusion (Q) matching is achieved in spontaneously breathing patients.

When in the lateral position, the dependent lung receives the greater perfusion. In the spontaneously breathing patient the dependent lung is also best ventilated because of greater diaphragmatic excursion and optimal compliance. However, during positive pressure ventilation of a paralysed patient the upper lung is better ventilated whilst perfusion remains greater in the dependent side. This worsens the V/Q mismatch. The protective mechanism of hypoxic pulmonary vasoconstriction, which decreases the perfusion to non-ventilated parts of the lung, is markedly decreased during anaesthesia, again worsening the V/Q mismatch.

The functional residual capacity (FRC) is an important lung volume, which when maintained, prevents collapse or atelectasis, and acts as an oxygen store in preoxygenated patients. The FRC is decreased by 20% in the supine position and by 20% with anaesthesia. It is also decreased in obese patients and in restrictive lung disease. It is increased by positive end expiratory pressure and in patients with asthma.

### Nerve damage

Nerve injuries during surgery are thought to arise from stretch and/or compression of vulnerable peripheral sites. Injuries considered to be due to malpositioning may actually be caused by retractors or brachial plexitis.<sup>2</sup> The mechanism of action is often unknown but local ischaemia and segmental demyelinations are possible causes. Long tourniquet times, repeated non-invasive blood pressure readings and reduced perception by the patient due to regional anaesthesia may all play a part.

Data taken from the American Society of Anesthesiologists closed claim project<sup>3</sup> reveals that the ulnar nerve is the most commonly affected nerve (25%), followed by brachial plexus (19%), spinal cord (16%), lumbosacral nerve root (15%) and, finally, the sciatic nerve (5%). This finding is not surprising when the anatomy of the ulnar nerve (bending around the medial epicondyle in the elbow joint) is considered. Damage may be prevented by having the patient's arm palm down when straight or avoiding a greater than 90° of flexion when bent. Documentation of the measures taken to protect nerves is vital. Medico-legal defence becomes difficult without records, and substantially higher payouts are given if substandard care is assumed. Whilst prevention remains of paramount importance, with appropriate

diagnosis and management most injuries typically improve over time, which varies from weeks to months.

### Musculoskeletal damage

Many musculoskeletal abnormalities have the potential to cause harm. Fixed flexion deformities can lead to skeletal and nerve damage when anaesthetized patients are placed in an unsuitable position. It is advisable to ask patients to position themselves before induction so that they are comfortable and not causing any abnormal stretching or pressure to nerves. If possible, anaesthesia should be performed in this position.

Fractures may present a problem, as they are potentially unstable and are a risk for neurovascular damage. Patients with malignancy or osteoporosis may incur a fracture after what would seem a trivial insult and must be moved cautiously.

Compartment syndrome is a risk to patients who have fractures or who have spent a long time in the lithotomy position, especially with a head-down tilt. This syndrome may be due to hypoperfusion and prolonged external compression from leg supports. Maintaining perfusion pressure and limiting the time in lithotomy to less than 5 hours reduces the risk.

Joint instability is seen in many conditions, such as rheumatoid arthritis, and can lead to nerve damage. The most important and potentially catastrophic is atlanto-axial instability, which could lead to spinal-cord compression.

Patients with chronic pain (usually back pain) may develop a worsening of symptoms if positioned poorly, especially during lengthy procedures.

### Ocular damage

Ocular damage has been reported many times during non-ophthalmic surgery.<sup>4</sup> There is an increased incidence in patients with, for example, pre-existing hypertension, diabetes, sickle cell disease and arteriosclerosis. Precipitating factors for ischaemic optic neuropathy include prolonged hypotension, the prone position, direct pressure on the globe and a long operation time. The prone position can lead to visual loss related to decreased venous return, direct compression to the orbit and corneal abrasions, especially in patients with a flattened nose bridge or exophthalmos. During surgery, the patient's eyes should be taped closed, lubricated and padded as necessary, and the utmost care should be taken to prevent pressure to the globe.

### Obesity

An obese patient can cause many difficulties with positioning with respect to the size and weight restriction on operating tables and attachments. There can also be problems with gaining surgical access and monitoring. These patients are a challenge to move once asleep, and it may be of benefit to anaesthetize them on the operating table in the correct position if safe to do so. If any table tilt is to be used the patient should be secured with straps.

### Other issues

Pressure sores can be caused or worsened by long operations, especially in patients with peripheral vascular disease or diabetes. Care must be taken to reduce pressure to at-risk areas. Patients with abdominal distension placed in the prone position are at risk of a further rise in the intra-abdominal compartment pressures, reducing perfusion to organs, especially the kidneys.

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