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Patient Positioning During Anaesthesia

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INTRODUCTION

Different patient positions are required to provide access for different surgical procedures. Each position has implications for ventilation and haemodynamics, as well as exposing patients to possible complications such as nerve injury and pressure sores. The anaesthetist plays an important role in minimising the risks associated with these positions. Common positions include supine, lithotomy, lateral, prone and sitting.

SUPINE

The supine position is used for the majority of surgical procedures.

Supine positioning has an effect on ventilation by leading to a significant reduction in functional residual capacity (FRC) in the anaesthetised patient. As the FRC decreases there is potential for the closing capacity to exceed the FRC, which can lead to V/Q mismatch and subsequent hypoxaemia. Certain patient groups are more at risk of this occurring. These include the elderly who have higher closing capacities and the obese or pregnant patient who already have a reduced FRC. The effect can be mitigated with application of positive end expiratory pressure (PEEP).

Supine positioning has important haemodynamic consequences for pregnant patients. Supine positioning of a pregnant woman greater than 20 weeks (although it has been reported as early as 16 weeks) can lead to aortocaval compression. The gravid uterus compresses the inferior vena cava (IVC) and aorta, decreasing venous return to the heart, thus lowering cardiac output and impairing uteroplacental perfusion. To prevent this while supine, the uterus must be displaced. This can be achieved by using a tilt on the table or by placing a wedge under the patient's right hip.

Complications

Complications that can arise during supine positioning include neuropathies and pressure areas, where a reduction in perfusion leads to tissue ischaemia and subsequent tissue breakdown. Pressure areas of concern during supine positioning include the occiput, sacrum and heels.

Common mechanisms contributing to nerve injuries include compression, excessive stretch or ischaemia. Ulnar neuropathies are among the most common peripheral neuropathies reported after surgery. The ulnar nerve is vulnerable as it takes a superficial path near the medial epicondyle of the humerus. To minimise the risk of injury to the nerve, the forearm should be supinated and slightly flexed. This is because the nerve may be compressed against the table if it is pronated and extended. Extreme flexion that may occur when the arm is folded tightly across the chest can also lead to nerve injury, through compression by surrounding ligaments.

Brachial plexus neuropathies have also been reported and therefore abduction of the arms should be limited to less than 90 degrees to limit stretch on the plexus. External rotation of the arm and posterior displacement should also be avoided. The head should be maintained in the neutral position, if possible, or turned towards the abducted arm.

LITHOTOMY

Lithotomy position is used for variety of procedures including gynaecological and urological surgery. Lithotomy position is often combined with Trendelenburg position, which may exacerbate cardiovascular and respiratory implications.

As with any change in position, care must be taken to ensure that there is no dislodgement or movement of the endotracheal tube with any positional changes.

Placing the legs in lithotomy position decreases the blood volume in the leg veins and redistributes this blood volume centrally, increasing venous return to the heart and therefore cardiac output. In susceptible patients, this increase in central blood volume can lead to pulmonary oedema. On returning the legs to the supine position at the end of the procedure, blood will again fill the venous system of the legs. Venous return will decrease, leading to a fall in cardiac output. Hypotension may result until baroreceptor reflexes are activated. Blood pressure must be monitored closely during these periods and treated accordingly.

Complications

Peripheral neuropathies have been associated with use of the lithotomy position. Certain nerves are particularly vulnerable in this position and include the sciatic, common peroneal and saphenous nerves. As the common peroneal nerve runs superficially over the fibular head and pressure from leg supports may lead to nerve injury, it is important to pad the area and avoid any pressure on the nerve. The saphenous nerve may also be damaged by pressure from leg supports as it passes over the medial condyle of the tibia. Flexion and external rotation at the hip can stretch and damage the sciatic nerve. When positioning during anaesthesia, always consider the normal range of movement for the patient and limit the positioning to this. It is important to monitor patient positioning throughout the procedure, as the leg supports may be moved once the patient has been draped, making assessment of the movement at the hip joint more difficult. Both legs should be positioned in stirrups simultaneously to avoid inadvertent musculoskeletal injury.

The lithotomy position is also associated with the uncommon complication of compartment syndrome of the lower leg. Decreased arterial perfusion to the legs, due to both elevation of the limbs and obstruction of venous drainage, contribute to a rise in compartment pressure. Ischaemia-reperfusion may lead to oedema and further increases in compartment pressure. Although it has been reported in shorter cases, patients are at greatest risk of compartment syndrome during prolonged procedures of more than four hours. Other factors associated with compartment syndrome include hypotension, hypovolaemia and the degree of leg elevation. Patients may complain of pain that is out of proportion to clinical findings. Classical signs such as paraesthesia and pain on passive toe extension typically occur later in the process. Anaesthetists need to be aware of the potential for this complication and consider intermittently lowering the legs during prolonged procedures in lithotomy. Always consider the syndrome in patients complaining of calf pain in the Post Anaesthesia Care Unit (PACU).

Obstruction to venous drainage also predisposes patients to development of venous thrombosis. Therefore, prophylaxis with compression stockings or sequential compression devices should be considered in all cases.

Special care must be taken with the patient hands, which when placed by the patient's side may be injured when the table position is altered. Hands must be adequately protected and then monitored with any movement of the table in order to avoid crush injuries.

LATERAL

The lateral position is utilised for a variety of surgical procedures including thoracic, hip and shoulder surgery.

Access to the airway when a patient is positioned laterally is suboptimal. Therefore the airway device must be properly secured to prevent inadvertent dislodgment during the procedure.

Ventilation in the anaesthetised patient is altered in the lateral position. Perfusion is greatest in the dependent lung and ventilation is greatest in the non-dependent lung, which leads to V/Q mismatch. This can lead to hypoxia in susceptible patients. This differs from the awake spontaneously breathing patient where both perfusion and ventilation are greatest in the dependent lung.

Although haemodynamics are unlikely to be affected, consider the placement of the blood pressure cuff. Placement on the lower arm may lead to compression of the cuff and therefore inaccurate readings.

Complications

The radial nerve and the common peroneal nerve are particularly susceptible to positioning injury in the lateral position. The radial nerve of the superior arm may be injured when the arm is suspended, if the shoulder is abducted to greater than 90 degrees. To prevent this injury, abduction of the shoulder should be limited to less than 90 degrees. The forearm can be supported with specially designed rests, or the upper arm can hug a pillow. The common peroneal nerve may be compressed against a hard table where it passes superficially against the fibular head and should be appropriately padded. Additionally, the saphenous nerve needs to be protected with padding placed between the legs. The head must be supported so as to maintain the neck in a neutral position and prevent stretching of the brachial plexus.

An axillary roll can be used to support the thorax and prevent compression of the lower arm. It must be placed caudad to the axilla on the rib cage. Placing this roll in the axilla can lead to pressure on the brachial plexus and subsequent neuropathy.

Ensure the ear has not folded during positioning and all pressure areas have been appropriately padded. After positioning laterally, confirm the eyes are taped shut and that pressure is not being applied to the globe.

PRONE

This position is utilised for several different types of surgery including intracranial and spinal surgery and Achilles tendon repair. The airway is very difficult to access after a patient has been positioned prone and therefore care and attention must be spent securing it. Tapes or ties are appropriate, but consider the pressure that a tie may exert on the face when the patient is turned. Take care when turning the patient, as the tube is vulnerable to movement and tube position should be rechecked clinically after turning.

Ventilation may actually improve with prone positioning due to an increase in FRC relative to the supine position. However, if pressure is exerted on the abdomen this effect may be reduced due to raised intra-abdominal pressure and a decrease in compliance. Patients should be supported on bony areas with supports placed across the chest (just below the clavicle) and the pelvis, allowing the abdomen to remain free of pressure.

Studies have shown that prone positioning causes a decrease in cardiac output. Contributing to this is a reduction in venous return, effects on arterial filling and decreased left ventricular compliance due to higher intra-thoracic pressures. Again, any pressure on the abdomen can accentuate this by compressing the IVC and decreasing venous return. During spinal surgery, compression of the IVC may also lead to surgical difficulties. Blood unable to return to the heart via the IVC will alternatively be shunted through the vertebral column venous plexus and increase blood in the surgical field.

Access to the patient is limited once the patient is positioned. Consider this when securing intravenous access and avoid intravenous cannulae in the antecubital fossa, as these are likely to become kinked while prone. Disconnect nonessential lines when turning the patient to minimise the risk of inadvertent removal.

Cardiopulmonary resuscitation is problematic in the prone position and positioning of defibrillator pads is very difficult. In high risk cases, consider application prior to turning the patient prone.

Complications

Arms should be positioned either by the patient's side or with the hands above the head. If the hands are positioned above the head, the shoulder must be abducted less than 90 degrees without posterior movement at the shoulder, the elbows should be flexed and the hands should be pronated to minimise risk of injury to the brachial plexus.

The head and neck should be maintained in a neutral position throughout. There is potential for both spinal nerve injury and for carotid or vertebral artery blood flow to be reduced with excessive movement.

There are many potential pressure areas in the prone patient. Special head rings minimise pressure areas on the face, but it is important to ensure there is no pressure on the eyes or nose. Pressure areas may develop on the breasts, genitalia and over bony prominences.

Post-operative visual loss has been reported following prone surgery. Retinal ischaemia can result from direct pressure on the eye, so the head should be carefully positioned to ensure no pressure is exerted on the eyes at any time. Ideally, the headrest should be foam. Goggles are not recommended as they can move and apply pressure to the eye. Some anaesthetists advocate regular checking of the eyes throughout a procedure to ensure no movement has occurred, whereas others feel this actually increases the chances of patient movement and therefore risk to the eye. Consider discussing the risk of eye injury with all patients who will be positioned prone. Ischaemic optic europathy is another form of eye injury which is associated with prone positioning and spinal surgery, but the pathogenesis is not completely understood. Recommendations to prevent its occurrence include maintaining the head in a neutral position, avoiding Trendelenburg positioning and maintaining arterial blood pressure.
It is important that patients remain anaesthetised until they have been repositioned supine.

SITTING / BEACH-CHAIR

The sitting or beach-chair position is commonly used in shoulder surgery and in some intracranial surgery, particularly of the posterior fossa.

Access to the airway may be limited by surgical draping and the surgical field will be close to the airway, so it is essential to ensure the endotracheal tube is well secured.

Hypotension may result after sitting the patient up. In an awake patient, the sympathetic nervous system will be activated by the baroreceptors upon sitting up and there will a rise in systemic vascular resistance which maintains blood pressure. In the anaesthetised patient, these reflexes are less active and significant hypotension can result. It is important to sit patients up slowly and treat hypotension with volume resuscitation and vasopressors.

Placement of the blood pressure cuff is of paramount importance. If non-invasive blood pressure monitoring is used, the cuff must be placed on the non-operative arm and not on the leg. The blood pressure to the brain will be 15-20mmHg lower than what is being detected in the arm and this should be accounted for. If invasive blood pressure monitoring is used, it is advisable to place the transducer at the level of the tragus to allow for this. Guidelines suggest that mean arterial pressure should be maintained >70mmHg, or within 25% of baseline blood pressure after the hydrostatic gradient has been taken into account.

Complications

Cerebral ischaemia has rarely been reported in beach chair/sitting surgery and is thought to result from hypotension, leading to inadequate cerebral perfusion. As such, hypotension should be avoided. If hypotension is unable to be effectively treated, lay the patient supine. Hypocapnia should also be avoided in ventilated patients, as it may lead to cerebral vasoconstriction and may impair cerebral perfusion. Consider the appropriateness of each patient for sitting position surgery, particularly those who are at increased risk of cerebral ischaemia.

Venous air embolism is a potential complication of surgery in the sitting position. Negative venous pressure may occur at the surgical site when in the sitting position; this is particularly so intracranially, as the veins are held open by dura and bone. The effects of the air embolism depend on its size. A small embolism (<10mL) will only be detected by transoesophageal echocardiography, but the anaesthetist should alert the surgeon to look for the source. A moderate-size air embolism (10-50mL) will be noticed clinically with a decrease in end-tidal carbon dioxide and a rise in heart rate and blood pressure from a sympathetic response. If being monitored, a rise in pulmonary artery pressure will be noted. A large embolus (>50mL) can be catastrophic, leading to tachycardia, arrhythmias, hypotension, right ventricular failure and cardiac arrest. A decrease in oxygen saturation may not be seen if a high inspired oxygen concentration is being used. If an air embolism occurs, alert the surgeon who will apply fluid to the surgical field and attempt to find the source. Increase the oxygen concentration to 100%, manage hypotension with fluid resuscitation and vasopressors, and treat any arrhythmias. If possible, place the patient in the left lateral Trendelenburg position. Attempting to aspirate air via a central venous catheter will not be successful in many cases but can be attempted.

Patients with a patent foramen ovale, or other shunts from the right to left heart, are susceptible to paradoxical air embolism. If air enters the systemic circulation, even small amounts can lead to ischaemia and have devastating consequences.

Care should be taken to apply padding to all pressure points, particularly the heels, ankles and elbows. Ensure arms are supported. Avoid excessive flexion of the neck as cases of quadriplegia have been reported.

TRENDELENBURG

Trendelenburg is the term used when the patient is tilted 15 degrees or greater head down. Prolonged Trendelenburg positioning can lead to facial and laryngeal oedema. This should be assessed for prior to extubation with a cuff leak test in cases with steep positioning, or where there is evidence of facial oedema. Minimising the amount of intravenous fluid administered during the case may help lessen the incidence of this complication.

The endotracheal tube tip may move caudad during positioning, leading to endobronchial intubation. The Trendelenburg position leads to a further reduction in FRC from the supine position, due to further cephalad movement of the diaphragm. Trendelenburg predisposes to atelectasis and causes decreased respiratory compliance, so patients may need higher airway pressures to achieve adequate tidal volumes. Barotrauma may result from high peak inspiratory pressure.

With steep Trendelenburg positioning, the patient may slide down the table and care must be taken to secure the patient prior to tilting the bed. Arms must be secured to prevent falling from arm boards, which can lead to brachial plexus injury.

Trendelenburg position will lead to increases in intracranial and intraocular pressure and should be avoided in patients who cannot tolerate this.

REVERSE TRENDELENBURG

FRC is increased in the reverse Trendelenburg position relative to supine. Lung compliance also increases and therefore care must be taken with lung volumes during positive pressure ventilation.

Hypotension may result from positioning in reverse Trendelenburg and the anaesthetist should account for the hydrostatic gradient between the blood pressure cuff and the brain, to prevent cerebral hypoperfusion.

SUMMARY

A range of patient positions are required to optimise surgical access, however each position has consequences and potential risks that need to be considered. In all positions, particular care needs to be taken to ensure pressure areas are padded and limbs are positioned anatomically to minimise the risk of nerve injury.

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