

Patient Positioning

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Aims

- Knowledge of the haemodynamic changes associated with positioning and management strategies;
- Knowledge of central and peripheral nerve injuries associated with the various patient positions;
- How to optimise patient positioning to favour induction;

Positions

- 1) Supine
- 2) Lateral
- 3) Lithotomy/Lloyd Davies
- 4) Head up/Deck chair
- 5) Trendelenberg/ Head-down
- 6) Prone

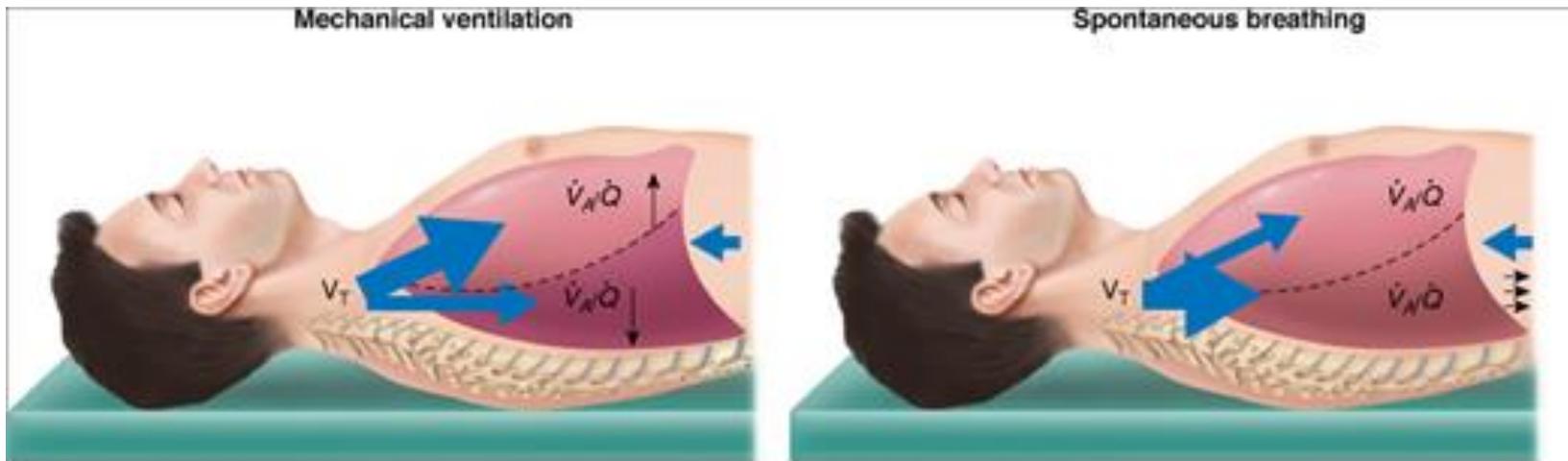
Supine - Respiratory

- Tongue falls back and the pharyngeal structures collapse due to a loss of muscular tone, causing airway obstruction
- Lying flat, allows the abdominal contents to distend into the chest cavity, ↓FRC.
- This causes problems with gas exchange because ↓pulmonary compliance and ↑ventilation-perfusion mis-matching.
- If the closing capacity of the alveoli encroaches upon the FRC, then the alveoli are likely to collapse causing atelectasis and hypoxaemia.

GI:

- Lying flat and relaxation of the lower oesophageal sphincter under general anaesthesia, ↑potential risk of aspiration of gastric contents.

Supine - Respiratory



Source: Tobin MJ; *Principles and Practice of Mechanical Ventilation*, 3rd Edition; www.accessanesthesiology.com
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Supine - CVS

- Redistribution of blood from venous capacitance vessels within the lower limbs. ↑pre-load and ↑cardiac output.
- Offset some of the vasodilatation caused by anaesthetic techniques.
- Severe hypotension can occur because the IVC can be compressed against the vertebral bodies, especially in obese/pregnant patients.
- In pregnant patients, the IVC is compressed significantly by the gravid uterus 'Supine hypotensive syndrome': use a 15 degree left lateral tilt/wedge/Manual displacement of uterus.

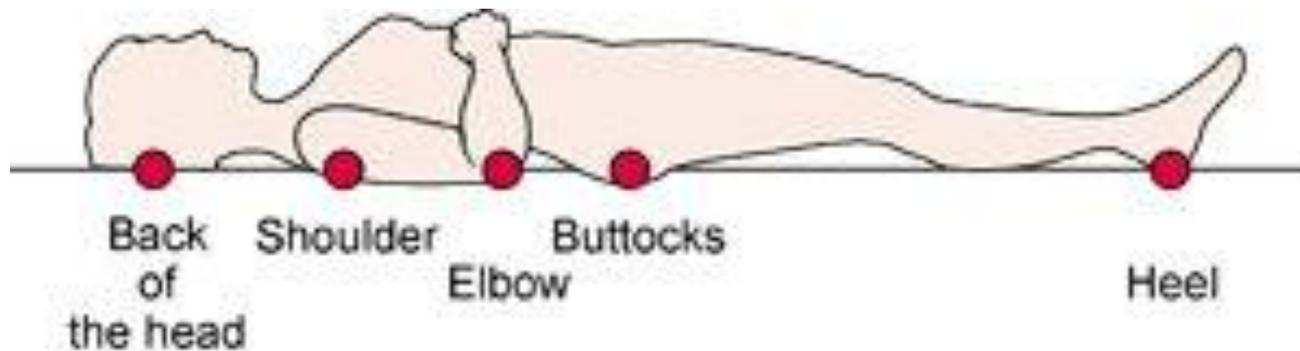
Supine - Neuro

- Brachial plexus is susceptible to injury from compression onto the fixed, hard structures its lies near (the clavicle, 1st rib and proximal humerus).
- Ideally, arms should be:
 - adducted, and crossed across the abdomen or chest;
 - or, straight and with hands supinated by the side of the patient;
- Arm-board: the arm should only be mildly abducted, supinated and the head turned towards this abducted arm.
- This prevents compression of the ulnar nerve at the elbow and prevents traction on the brachial plexus.

Supine – Eyes + Pressure Areas

- Under GA; protective reflexes are lost as is muscular tone. This puts the eyes at risk of injury.
- Risk of corneal abrasion due to the lack of the corneal reflex, and from direct trauma from facemasks, airway devices, airway devices ties, catheter mounts, HME filters.
- Corneal drying can occur if the eyes are uncovered for 10 minutes.
- The occiput is at risk of a pressure sore, therefore a pillow or head ring should always be used.
- The heels are at risk too, therefore gel heel pads should be used.
- The sacrum is also at risk and should be padded.

Supine – Eyes + Pressure Areas



Lateral - Respiratory

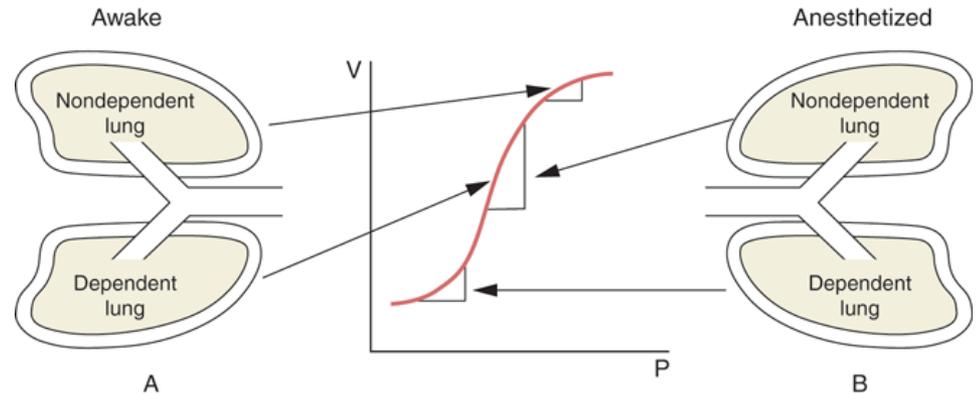
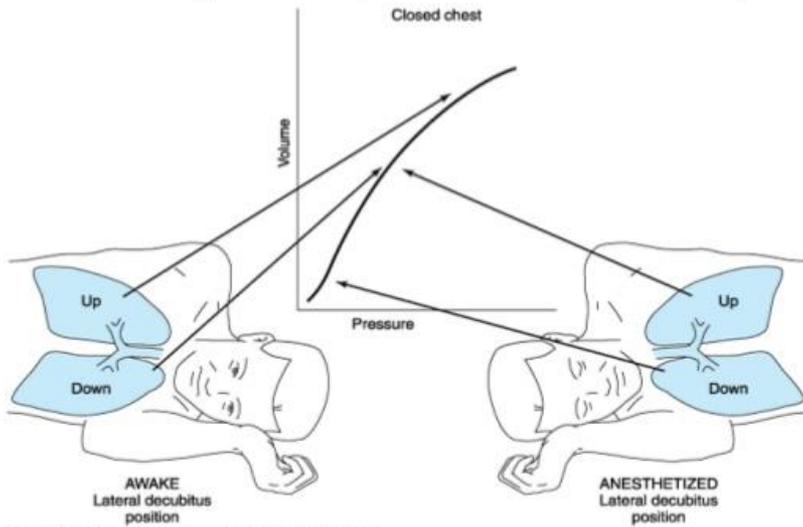
- The dependent (inferior) lung is relatively under-ventilated and over-perfused whilst the non-dependent (superior) lung is over-ventilated and under-perfused;
- Doesn't cause a significant ventilation-perfusion mis-match and is a very well tolerated position in most patients;
- Patients with lung pathology are the most likely to become compromised leading to hypoxaemia

GI:

- Left lateral is theoretically beneficial to prevent risk of aspiration;
- Right lateral has a theoretically increased risk of aspiration;

Lateral - Respiratory

Respiratory Physiology (lateral decubitus position) in anaesthetised pt



Source: Longnecker DE, Brown DL, Newman MF, Zapol WM: *Anesthesiology, 2nd Edition*: www.accessanesthesiology.com

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Lateral – Respiratory - OLV

- PPV to one lung:
 - Non-dependent lung is no longer ventilated, but receives perfusion despite hypoxic pulmonary vasoconstriction;
 - Substantial ↑shunt, thus causing hypoxaemia;

Lateral - CVS

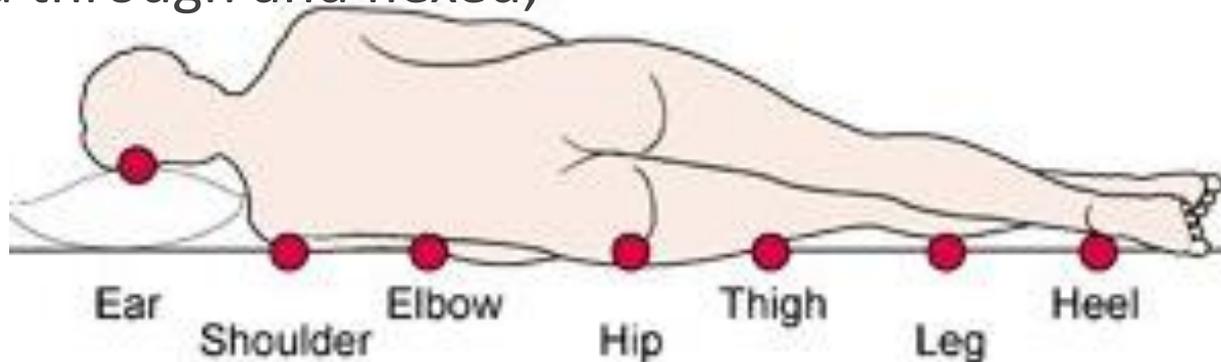
- Usually well tolerated with minimal changes;
- Venous hypertension can occur in the dependent (lower) arm usually due to outflow obstruction.
- Prevented by flexing the arm and lying it adjacent to the head on the pillow (much the same as in the recovery position).

Lateral - Neuro

- Brachial plexus injury on the non-dependent (upper) side may occur if the head and neck are not supported sufficiently by a pillow or head rest.
- Padding/pillows should be placed between the legs preventing injury to the saphenous nerve and to prevent mechanical damage to the knees.
- Padding to the lower legs to prevent injury to the common peroneal nerve.

Lateral – Eyes + Pressure Areas

- This position has the highest incidence of ocular injuries, in particular corneal abrasions which occur equally in both eyes.
- The dependent hip and shoulder are at risk of pressure bruising/sores, therefore padding should be used;
- Post-operative shoulder pain is common if the arm is not pulled through and flexed;



Lithotomy - Respiratory

- From the supine position into legs up, there will be movement of the bronchial tree/mediastinum cephalad.
- The abdominal organs push into the thorax and ↓FRC, but to a lesser degree than the head-down/trendelenberg position.
- This can result in stimulation of the carina by an endotracheal tube causing bronchospasm or displacement resulting in endobronchial intubation.

GI:

- The flexed hips causes an increase in intra-abdominal pressure increasing the risk of regurgitation.

Lithotomy - CVS

- Leg elevation causes emptying of the lower limb venous pools into the systemic circulation.
- The resultant increase in central venous pressure and right atrial pressure activates atrial stretch receptors and causes a tachycardia – ‘Bainbridge Reflex’.

Lithotomy - Neuro

- Extreme flexion at the hips can cause nerve damage by stretching the sciatic and obturator nerves or by direct compression of the femoral nerve under the inguinal ligament.

Lithotomy – Eyes + Pressure Areas

- Eyes require precautions as per supine;
- Both hips and knees should be elevated simultaneously as there is a risk of hip dislocation.
- Calf compression occurs due to flexion at the knees and leg elevation above the heart which predisposes to venous thrombo-embolic events and compartment syndrome if surgery exceeds 4-5 hours.
- Therefore flowtron boots should be used.

Head-Up/Deck Chair - Respiratory

- The seated position maintains the normal ventilation-perfusion ratio which favours ventilation due to maintained normal torso posture.
- Apices being preferentially ventilated and the bases preferentially perfused.

GI:

- Minimal effects

Head-up - CVS

- This system is the most affected, with venous pooling in the lower limbs in the presence of vasodilatation, which can lead to resistant hypotension;
- Risk of Barzold-Jarisch Reflex if combined with ISBP block;
- Excessive neck flexion/extension may cause obstruction to the neck veins;
- Risk of venous air embolism, more likely to be caused during craniotomy/posterior fossa surgery;
- It is caused by the cranial venous plexus being below atmospheric pressure in the head-up position and the non-collapsible nature of the dural sinuses which can entrain air into the venous system.

Head-up - Neuro

- Unsupported upper limbs can cause rotator cuff and brachial plexus injuries due to the traction caused by the weight of the limb.

Head-up – Eyes + Pressure Areas

- Eyes require extra precautions;
- Eye padding and shields are used to prevent inadvertent pressure or injury from surgeons and surgical equipment.

- A pillow or support should be placed under the knees to prevent the patient sliding down the operating table.
- This also maintains a degree of hip flexion preventing stretch of the sciatic nerve and retains the lumbar lordosis preventing back pain.

Head down - Respiratory

- Invasion of the thorax by the abdominal organs pushing on the diaphragm leads to a reduction in the FRC and consequent atelectasis.
- This lead to a greater ventilation-perfusion mis-match, with more lung perfused but less ventilated leading to hypoxaemia.
- Risk of laryngeal oedema during lengthy procedures.

GI:

- Associated with passive regurgitation due to relaxed lower oesophageal sphincter under GA and gravity and the highest rate of aspiration in an unprotected airway.
- The abdominal organs are also pushed into the thorax.

Head down - CVS

- Increased systemic vascular resistance due to a significant portion of the body being above the level of the heart;

Head down – Neuro + Eyes

- There is raised intra-cranial pressure due to engorgement of the head and neck veins;
- There is also raised intra-ocular pressure.
- Procedures in excess of 4 hours will cause facial oedema and airway tissue engorgement;
- Excessively prolonged procedures can be associated with cerebral oedema;

Prone - Airway

- Need a secure airway for stability during transfer and intra-operatively;
- High vigilance is required due to the lack of access to the airway;
- A securely fastened, reinforced, cuffed endotracheal tube is the default airway of choice.
- Experienced anaesthetist is required due to the risk of accidental extubation, in expert hands, airway rescue can be achieved with use of a supraglottic airway.
- Fibre-optic intubation can occur directly if this is to hand or by using the supra-glottic airway as a conduit if already in position.

Prone - Respiratory

- A beneficial ventilation-perfusion profile is achieved due to ↑FRC and ↑perfusion of lung leading to an ↑arterial partial pressure of oxygen. Chest wall and lung compliance remain unchanged.
- Sometimes compression of the thorax may occur and ↓dynamic chest compliance will ↑peak airway pressure.
- Ensure breathing circuit and patient should be checked to ensure there is no compression of the circuit, kinked tubing, endo-tracheal tube moving causing endo-bronchial intubation or bronchospasm.

Prone - CVS

- Hypotension with a reflex tachycardia usually results from turning the patient into the prone position.
- Due to a ↓ pre-load which is caused by some or all of the following:
 - blood pooling to dependent areas in the vasodilated state;
 - compression of the IVC by the abdominal organs;
 - poor positioning of the patient causing compression of the thorax and raised intra-thoracic pressure;
 - use of positive pressure ventilation and PEEP (Positive end-expiratory pressure);

Prone – Central Neurology

- Cerebral blood flow:
 - Cerebral blood flow is maintained if the head and neck are kept in the neutral position during positioning and the operation.
 - Turning the head to the side or having hyper-flexion of the neck causes compression of neck vessels causing a reduction in cerebral arterial blood flow and causing a reduction in cerebro-venous drainage.

Prone – Peripheral Nerves

- All peripheral nerves are at risk of injury in the prone position;
- Placing the arms by the side provides the greatest protection to the brachial plexus, axillary vessels and ulnar nerve, however may not be feasible due to requiring venous and arterial access.
- Ulnar nerve injury if the elbow is not padded or the forearm supinated;
- Lateral cutaneous nerve of the thigh is at risk from compression injury from support mattress;
- The supra-orbital and facial nerves are at risk of compression injury if padding to the face is not sufficient or moves intra-operatively.

Prone – Pressure Areas

Table I Pressure injuries

Direct pressure injuries	Indirect pressure injuries
Skin necrosis	Macroglossia and oropharyngeal
Contact dermatitis	Swelling
Tracheal compression	Mediastinal compression
Salivary gland swelling	Visceral ischaemia—liver, pancreas
Breast injury	Avascular necrosis of femoral head
Injury to the genitalia	Peripheral vessel occlusion
Compression of the pinna	Limb compartment syndrome and rhabdomyolysis
Compression of the femoral neurovascular bundle	

Prone - Eyes

- Visual loss due to direct and indirect trauma is highest in the prone position.
- Direct pressure on the globe of the eye can cause central retinal artery occlusion and cause visual loss.
- Indirect visual loss is caused by ischaemic optic neuropathy and is thought to be multi-factorial, but predicted to result from reduced venous drainage causing oedema around the optic nerve.
- This combination is thought to cause a form of compartment syndrome around the optic nerve.

Positioning

- Questions?