Injury during anaesthesia

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Iatrogenic injury is a broad term that may be defined as ‘harm, hurt, damage or impairment that results from the activities of a doctor’.1 This includes physical injuries, adverse drug reactions, drug errors, surgical mishaps and adverse outcomes associated with equipment failure. Some causes of iatrogenic injury are difficult to avoid, in particular unexpected adverse drug reactions such as anaphylaxis. However, many are the result of human error and may be avoided through anticipation and high standards of practice.

Death is a rare complication of anaesthesia. Reports of its incidence vary widely i.e. from 0.1 per 10000 to 8.8 per 10000 anaesthetics (0.001–0.01%).2 Clearly, case-mix and comorbidity will have a major impact on the incidence. This article focuses on the more minor physical injuries which patients may suffer during anaesthesia. This is described where evidence or consensus exists on how we may avoid these complications. These minor injuries, while not having the headline-grabbing impact of anaesthesia-related death or major disability, are significantly more common, may cause severe pain and suffering, and are often the subject of medical litigation (Table 1).

Table 1 Incidences of the more common injuries occurring during anaesthesia

<table>
<thead>
<tr>
<th>Injury</th>
<th>Incidence</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>1:50 000 (0.02%)</td>
<td>All patients</td>
</tr>
<tr>
<td></td>
<td>1:100 000 (0.001%)</td>
<td>ASA I and II</td>
</tr>
<tr>
<td>Anaphylaxis</td>
<td>1:10 000 (0.01%)</td>
<td></td>
</tr>
<tr>
<td>Awareness</td>
<td>1:300 (0.03%)</td>
<td>With muscle relaxants</td>
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<tr>
<td></td>
<td>1:300 (0.3%)</td>
<td>Without muscle relaxants</td>
</tr>
<tr>
<td>Ocular injury</td>
<td>1:1000 (0.1%)</td>
<td></td>
</tr>
<tr>
<td>Blindness</td>
<td>1:125 000 (0.0008%)</td>
<td>All surgery</td>
</tr>
<tr>
<td>Sore throat</td>
<td>1:2 (45%)</td>
<td>Tracheal tube</td>
</tr>
<tr>
<td></td>
<td>1:5 (20%)</td>
<td>Laryngeal mask</td>
</tr>
<tr>
<td></td>
<td>1:10 (10%)</td>
<td>Face mask</td>
</tr>
<tr>
<td>Oral trauma</td>
<td>1:20 (5%)</td>
<td>All oral trauma</td>
</tr>
<tr>
<td></td>
<td>1:100 (1%)</td>
<td>All dental injury</td>
</tr>
<tr>
<td></td>
<td>1:500 (0.02%)</td>
<td>Requiring intervention</td>
</tr>
<tr>
<td>Peripheral nerve injury</td>
<td>1:250 (0.4%)</td>
<td>General anaesthesia</td>
</tr>
<tr>
<td>(permanent and temporary)</td>
<td>1:500 (0.02%)</td>
<td>Nerve block</td>
</tr>
<tr>
<td></td>
<td>3:10 000 (0.03%)</td>
<td>Spinal/epideral anaesthesia</td>
</tr>
</tbody>
</table>

Key points

Many injuries sustained during anaesthesia are due to human error and may be avoided through high standards of clinical practice.

Dental injury occurs during 1% of general anaesthetics and is the commonest cause for litigation against anaesthetists.

Peripheral nerve injury is usually due to poor patient positioning during general anaesthesia or to intra-neural injection during regional anaesthesia.

Ocular injury occurs during 0.1% of general anaesthetics, and is usually corneal.

Blindness occurs following 1 in 125 000 (0.0008%) general anaesthetics.

Muscular and cutaneous injuries are commonest in the elderly and debilitated; they may be fatal in these patients.

Injuries during airway management

Oral injury occurs during 1 in 20 general anaesthetics (5%).2 Oral (especially dental) injury is the most frequent cause for complaint and litigation against anaesthetists.

Dental

Dental injury occurs during 1% of general anaesthetics.3 It is most commonly sustained during laryngoscopy and requires intervention in only 2% of cases.2 The teeth most likely to be injured are the upper incisors, most commonly in patients aged 50–70 yr.3 While preoperative assessment of dentition may guide anaesthetists as to which patients are at risk of dental injury, the majority of incidents are not associated with predicted difficult intubation.3 Dental protectors (as worn by rugby players and boxers) may protect the teeth from injury; however, they may cause dental damage themselves and make laryngoscopy more difficult. A small proportion of dental injuries occur at the time of extubation, often in patients who have occluded their tracheal tube through biting. This situation can be avoided by inserting a Guedel airway or bite-block.

If a tooth is accidentally avulsed, it should be re-implanted in its socket and a dental surgeon consulted at the earliest opportunity.

Lips and oropharyngeal mucous membrane

Injuries to lips and oral mucous membrane are easily caused if adequate care is not taken during laryngoscopy, insertion of laryngeal masks or manual maintenance of the airway using a face mask. Most injuries heal uneventfully, but may be quite distressing after operation. Soft paraffin ointment should be applied to any cuts on the lips to minimize postoperative discomfort. The rarer, but more severe injury

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of dissection of the pharyngeal mucosa during nasal intubation has been reported, leading to surgical emphysema following positive pressure ventilation.\(^8\)

**Tracheobronchial injuries**

Intubation-related injuries to the tracheobronchial tree are rare but potentially life-threatening. Dissection of tracheal or bronchial mucous membrane through forceful intubation, tracheal laceration causing pneumomediastinum, and tracheal rupture, either by penetration with a stylet or by over-inflation of the cuff, have all been reported in the literature.\(^5\) Incidence of such injuries emphasizes the importance of meticulous care during intubation, even in the emergency setting. Appropriate sizing of the tracheal tube is important and a smaller tube should be used if resistance is met during intubation. Cuff-related ischaemic injury to the respiratory epithelium following appropriate inflation has declined since the move from low-volume, high-pressure cuffs to high-volume, low-pressure cuffs. However, even low-pressure cuffs are associated with a reversible reduction in ciliary function.

**Vocal cords**

Laceration and contusion of the vocal cords may result in sore throat, dysphonia and dysphagia. Rarely, ischaemic injury may result in granuloma formation or scarring.

**Sore throat**

Sore throat occurs after 45% of anaesthetics involving a tracheal tube;\(^2\) this is reduced to 20% when a laryngeal mask is used and 10% when a face mask only is applied.\(^1\) It is almost always self-limiting and responds well to over-the-counter, local-anaesthetic-based throat lozenges. Rarely, soft palate and uvular ischaemia have been reported; complaints of a particularly painful or persistent sore throat should prompt examination of the patient’s oropharynx.

**Oesophageal injuries**

The potentially fatal complication of oesophageal perforation is rare but can occur following inadvertent Instrumentation or intubation of the oesophagus.

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**Table 2. Common peripheral nerve injuries and their aetiologies\(^9\)\(^10\)**

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Common aetiologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ulnar nerve</td>
<td>Compression at superficial condylar groove of the elbow. Less compression with arm in supination</td>
</tr>
<tr>
<td>Brachial plexus</td>
<td>Excessive stretch (arm in abduction with lateral rotation of the head to the opposite side), or compression (upward movement of the clavicle and sternal retraction). Regional block</td>
</tr>
<tr>
<td>Lumbosacral root</td>
<td>90% are in association with regional technique (55% spinal and 37% epidural). Pain or paraesthesia during needle insertion or injection of drug are suggestive of damage. Multiple unsuccessful attempts increase likelihood of damage</td>
</tr>
<tr>
<td>Radial nerve</td>
<td>Compression of the nerve between the edge of the operating table and the humerus. It may occur when the patient is in the lateral position and the uppermost arm is abducted beyond 90(^0) and suspended from a vertical screen support</td>
</tr>
<tr>
<td>Sciatic nerve</td>
<td>Especially at risk in a thin patient on a hard table and when the opposite buttock is elevated as in the hip pinning position. In the lithotomy position, maximal external rotation of the flexed thigh may damage the nerve by stretch</td>
</tr>
<tr>
<td>Common peroneal nerve</td>
<td>Compression against the head of the fibula in the lithotomy position or between the fibula and the operating table in the lateral position</td>
</tr>
</tbody>
</table>

**Nerve injury**

Peripheral nerve injury occurs during 0.4% of general and 0.1% of regional anaesthetics.\(^6\) During general anaesthesia, the commonest cause is poor patient positioning. Reported incidences vary. The ulnar nerve is damaged most commonly (0.33% of general anaesthetics); this is three times as common as injury to other nerves. Other nerves at high risk during general anaesthesia include the brachial plexus, lumbosacral roots, radial, sciatic and common peroneal nerves. The mechanism of injury to superficial nerves is usually compression of the vasa vasorum and subsequent ischaemia. Whole limb ischaemia can also occur as a result of poor positioning, which may give rise to compartment syndrome and resultant nerve injury. Ischaemic injury in this situation is more likely to occur during periods of generalized ischaemia and poor peripheral perfusion with hypotension and hypothermia. Patients most at risk are the elderly and those with underlying neuropathy (e.g. diabetes), anatomical predisposition to ischaemia of the ulnar nerve (i.e. ability to escape the ulnar groove) and metabolic derangements. Superficial nerves (e.g. ulnar and common peroneal) are especially vulnerable in thin patients. Common aetiologies for specific peripheral nerve injuries, other than predisposing and systemic factors, are shown in Table 2.

Meticulous care should be taken when positioning patients to avoid compression of superficial nerves from arm boards, leg stirrups or retractors. Padding should be used beneath tourniquets and over pressure points and extreme joint positions, particularly of the shoulder and head, should be avoided. Tourniquet times must also be carefully monitored.\(^6\)\(^7\)

Peripheral nerve injury following regional anaesthesia occurs in approximately 1 in 5000 peripheral nerve blocks (0.02%).\(^2\) Factors which may increase the likelihood of nerve injury during regional anaesthesia include high injection pressure, use of long-bevelled needles, performance of nerve blocks in the unconscious patient, seeking of paraesthesia, and failure of muscular twitch to disappear when the nerve stimulator current is <0.2 mA. The evidence supporting these factors is not strong; most recommendations are based on consensus or indirect evidence.

The incidence of nerve injury following central neuraxial block is 0.3–10 per 10 000 (0.003–0.1%).\(^2\) Currently, the consensus is
that the performance of central blocks in an anaesthetized patient increases the likelihood of nerve injury because the patient cannot warn of the impingement upon a nerve. Pain or paraesthesia during needle insertion or injection of drug is suggestive of nerve injury and multiple unsuccessful attempts increase the likelihood of damage. The incidence of other complications associated with central neuraxial blocks such as epidural abscess (1:2000–1:7500; 0.01–0.05%) and epidural haematoma (1:150 000–1:200 000; 0.0005–0.0007%) are not influenced by the conscious level of the patient during insertion.

Most perioperative nerve injuries recover within a period of months following surgery. However, all patients should be referred to a neurologist for assessment and follow-up.

**Ophthalmic injuries**

Perioperative eye injuries are rare (<0.1% during general anaesthesia); they account for 2% of claims against anaesthetists.8 Corneal abrasions are the most common injury; they are caused by direct trauma, exposure keratopathy or chemical injury.8 General anaesthesia reduces the tonic contraction of the orbicularis oculi muscle, causing lagophthalmos. Therefore, the anaesthetist must ensure that the eyes are fully closed in order to avoid exposure keratopathy. In addition, general anaesthesia reduces tear production and tear-film stability, resulting in corneal epithelial drying and reduced lysosomal protection, increasing the vulnerability of the cornea to direct trauma from objects such as face masks, laryngoscopes, identification badges, stethoscopes, or drapes. Apparently trivial contact can result in corneal abrasion which can be excruciatingly painful in the postoperative period. Chemical injury can occur if cleaning materials are inadvertently splitt into the eye. The only antiseptic skin preparation that is not toxic to the cornea is povidone–iodine 10% aqueous solution. Therefore, this is the agent of choice if skin preparation of the face is required.8

Methods to prevent perioperative corneal injuries include simple manual closure of the eyelids, taping the eyelids shut, use of eye ointment, paraffin gauze, bio-occlusive dressings and suture tarsorrhaphy. However, none of the protective strategies are completely effective; vigilance is always required.

Postoperative blindness is a much rarer complication of anaesthesia; its incidence is 1 in 125 000 anaesthetics (0.0008%).1 The most frequent cause is ischaemic optic neuropathy,9 Ocular blood flow is determined by arterial pressure, ocular venous pressure and ocular vascular resistance. Therefore, ischaemia of the optic nerve can be caused by arterial hypotension, elevated venous or intraocular pressure, increased resistance to flow, or decreased oxygen delivery (e.g. anaemia and hypoxaemia). Retinal blood flow is subject to autoregulatory control and is maintained at a constant level until intraocular pressure reaches 40 mm Hg. At an intraocular pressure of 60 mm Hg, blood flow to the optic nerve at the disc stops, but flow is maintained in the choroidal and retinal circulation. Infarction at this watershed leads to anterior ischaemic neuropathy, giving rise to a visual field defect, a pale oedematous optic disc and oedema of the optic nerve in the posterior scleral foramen.

The posterior part of the optic nerve is supplied by the pial branches of the ophthalmic artery. These vessels are incapable of autoregulatory control and therefore the posterior part of the optic nerve is more vulnerable to ischaemia in the event of a fall in perfusion pressure or anaemia, leading to posterior ischaemic optic neuropathy. This gives rise to a slower onset of visual field defect and mild optic disc oedema. Patients at higher risk of ischaemic optic neuropathy include those with diabetes, hypertension, smoking and polycythaemia. Other factors associated with increased risk of ischaemic ocular injury include the prone position (doubles intraocular pressure), surgery causing major blood loss and hypotension (e.g. spinal surgery), cardio-pulmonary bypass and bilateral neck dissection.

Postoperative blindness may also be caused by central retinal artery occlusion, either by emboli from cardiac or carotid lesions, or from direct pressure on the eye, in conjunction with perioperative ischaemic optic neuropathy. Examination shows a pale retina with a cherry red spot.10

It is essential, during anaesthesia, to prevent any mechanical pressure to the globes and to maintain mean arterial pressure. Horseshoe headrests should not be used for prone patients as they have been implicated in nearly all cases of direct eye pressure damage in the prone position. All patients complaining of postoperative visual disturbance require urgent review by an ophthalmologist. Although vision rarely returns after ischaemic optic neuropathy, treatment may improve the visual field defect following central retinal artery occlusion.

**Skin and muscle injury**

**Skin injury**

Sustained, increased pressure on an area of body surface can cause a reduction in skin perfusion which may result in ischaemia and tissue necrosis.7 This is most likely when the pressure is exerted over bony prominences and in patients who are elderly, poorly nourished, immobile, incontinent, suffering from chronic disease and sedated or unconscious. The development of a pressure sore in the postoperative period may be secondary to events that occurred during the intra-operative period. Therefore, it is essential, when positioning the patient, to dissipate pressure over as large a surface area as possible, use appropriate padding and maintain vigilance over pressure points, particularly during prolonged surgery. Often, persistent redness is the first sign that skin has been poorly perfused; these suspect areas must be watched very closely.

**Alopecia**

Postoperative alopecia is a rare complication caused by pressure-induced ischaemia, often associated with the use of head supports such as the head ring or jelly doughnut. Additional risk factors
are prolonged surgery and intra-operative hypotension. The incidence can be reduced by occasional intra-operative head repositioning.

**Tourniquets**

When used incorrectly, tourniquets can cause skin and soft tissue damage, dislodge deep vein thrombi and produce nerve and muscle ischaemia. Contraindications to the use of a tourniquet include sickle cell disease, peripheral neuropathy, limb infections and peripheral vascular disease, including deep vein thrombosis. The tourniquet should be applied with adequate padding to the proximal limb, avoiding bony prominences. Inflation pressures should be 50 and 100 mm Hg above systolic blood pressure for arms and legs, respectively. Tourniquet time should not exceed 2 h without a reperfusion time of at least 20 min in healthy patients.

**Burns**

Monopolar surgical diathermy uses high frequency alternating current which can generate local temperatures of up to 1000°C. Current passes from the active electrode, held by the surgeon (high current density), through the body, returning via the patient plate electrode (low current density) to the generator. If the return pathway is interrupted by incorrect placement of the patient plate electrode, any points of contact between metal and skin (e.g. ECG electrodes) will provide an alternate return pathway resulting in burns. The patient plate electrode should have good contact with dry, shaved skin. The contact surface area should be at least 70 cm² and should be away from bony prominences, scar tissue and metal implants. Incorrect placement of the patient plate electrode is the most common cause of accidental diathermy burns. However, careless surgical technique can also cause local burns. The local concentration of high density currents will cause skin burns if the active electrode touches skin. Any pools of spirit-based skin preparation fluids can heat up and even ignite during diathermy use. Bipolar diathermy, in which current passes only between the two points of the diathermy forceps, is inherently safer. It should be used on appendage surgery (e.g. digits and penis); monopolar diathermy can lead to large currents persisting beyond the operative site, causing tissue burns.

**References**


Please see multiple choice questions 17–20.