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Anaesthesia for open eye injuries

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Introduction

Ocular injuries are a significant global health problem with 19 million cases of unilateral blindness. The greatest proportion of open eye injuries are due to blunt trauma. Intraocular foreign bodies and penetrating injuries account for the remainder. In South Africa, males have a greater risk of ocular trauma with exposure to high-risk occupations (industry and agriculture), as compared to females. The majority of patients are between the ages of 21 and 40 years.[1] Nearly half of all ocular traumatic injuries occur in children usually during unsupervised play in the home.[2]

The goals of anaesthesia for open eye injuries include the provision of analgesia, optimal surgical conditions, and avoidance of increases in intraocular pressure (IOP) to mitigate the risk of ocular content extrusion.[3,4]

Definitions and classification

Open eye injuries are described by anatomical site, and mechanism of injury.[5,6] Eye rupture, usually following blunt eye trauma, occurs at the weakest sites structurally such as the limbus and behind the insertion of the rectus muscles. Eye lacerations are subclassified as either penetrating, perforating or intraocular foreign body.[5,7]

Open eye injuries are further classified based on the anatomical location of the injury. A zone one injury (Figure 1) involves the cornea and limbus. A zone two injury refers to a rupture or laceration located in the anterior 5 mm of the sclera not extending into the retina and a zone three injury is a full-thickness scleral laceration or rupture found more posterior than 5 mm from the limbus.[8]

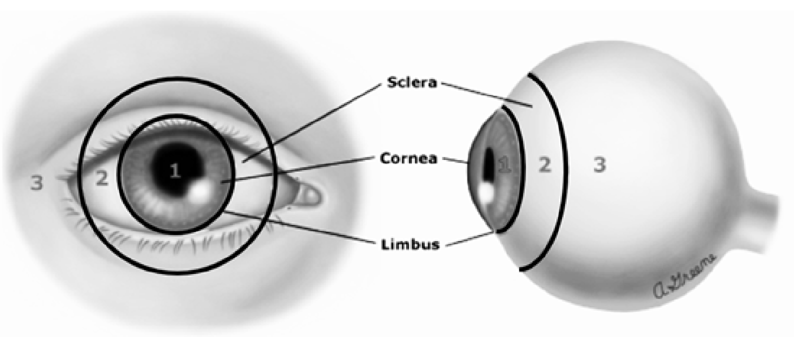

Figure 1: The anatomical zones of open eye injury[8]

Anatomy

The eye is composed of three layers (Figure 2). The external fibrous layer consists of the cornea and sclera. The middle vascular layer is made up of the choroid, ciliary body, and iris and the internal layer is the retina. The lens delineates the anterior structures, the iris, anterior chamber, and cornea from the posterior structures, the vitreous, retina, choroid, and optic nerve.[7]

Intraocular pressure

Normal intraocular pressure (IOP) is 16±5 mmHg in the sitting position and a value more than 24 mmHg is considered pathological.[3,9] Normal IOP is necessary to maintain the refracting index of the eye and cornea curvature.[7] IOP should be maintained in as normal a range as possible during intraocular surgery, especially in the context of an open eye.[10]

Increases in IOP can cause retinal ischaemia, corneal opacification, choroidal and intraocular bleeding. Expulsion of intraocular contents can occur in the case of an open eye.[3] Hypoventilation, hypoxia, venous obstruction and hypertension can marginally increase IOP.[7] External pressure from face masks, fingers, orbital tumours, contraction of the extraocular muscles, or retrobulbar haemorrhage also increase IOP.[4] Positioning such as supine, prone, and Trendelenburg positions raise IOP.[7]

Under general anaesthesia, the most significant increase in IOP occurs at laryngoscopy and emergence. This increase is even greater with repeated laryngoscopy attempts. Videolaryngoscopy causes a smaller increase than direct laryngoscopy, and insertion of laryngeal mask airway results in little or no increase in IOP. Coughing, straining, and vomiting can increase IOP up to 30 to 40 mmHg.[3]

The use of ocular blocks initially increases IOP by 5 to 10 mmHg, but this returns to baseline

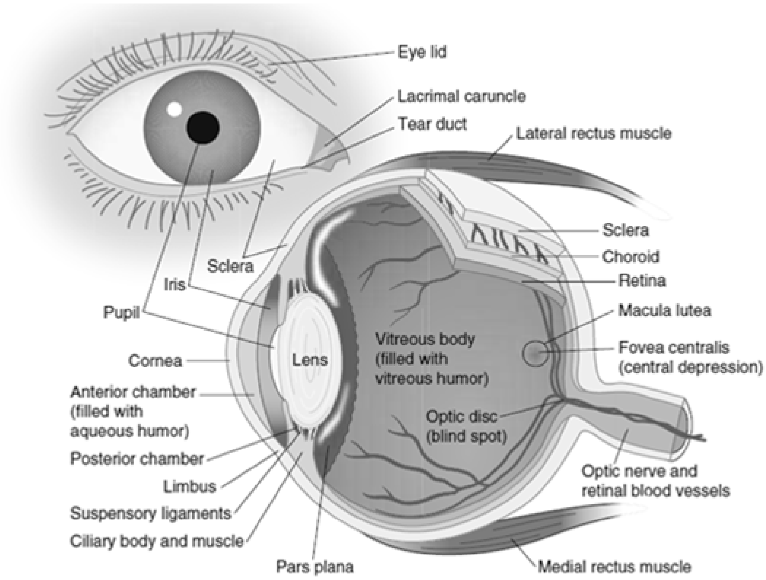

Figure 2: The anatomy of the eye[7]

within five minutes. Peribulbar blocks cause the greatest increase, likely due to the higher volume of local anaesthetic used.[3,7]

Conversely, large decreases in IOP increases the risk of retinal detachment, vitreous haemorrhage, and corneal oedema. Hypotension, hyperventilation, and hypothermia also decrease IOP.[4]

Most drugs used in anaesthesia either have minimal effect on IOP or decrease IOP, with a few exceptions. The majority of sedatives and induction agents reduce IOP in a dose-related manner.[4,11] Opioids generally cause a small decrease in IOP.[4] Dexmedetomidine decreases IOP and can be used to attenuate the sympathetic stimulation of induction when given as a premedication.[11] Ketamine does not increase IOP in paediatrics if a dose of < 4 mg/kg is used. In the adult population, however, less conclusive evidence exists.[12,13] Succinylcholine has been reported to increase IOP by 6 to 12 mmHg.[9] This was originally attributed to the contraction of extra ocular muscles, causing globe compression. This theory was disproven in 1993 by Kelly et al.[14] Other postulated mechanisms include reduced aqueous humour outflow, increased choroidal blood volume, and increased central venous pressure.[3]

Preoperative assessment and premedication

A routine pre-anaesthetic assessment should be carried out with careful attention to the patient's history of prior anaesthetics, in particular a history of a difficult airway or nausea and vomiting. Ask about the time of last oral intake of fluids and solids. Determine the mechanism of trauma, and the possibility of associated injuries to the cervical spine, maxillofacial structures and intracranial trauma that could impact your anaesthetic plan. Take note of the ophthalmological examination with regards to the size of the defect. The larger the defect the greater the risk of extrusion. Ask about standard issues such as allergies, medications, and comorbid diseases. On physical examination, pay attention to the airway to assess the possibility of a difficult airway.[4,7]

It is important in these patients coming for head and neck procedures with suspected or documented coronavirus disease 2019 (COVID-19) to implement the necessary infection control measures to limit transmission of severe acute respiratory syndrome coronavirus 2 (SARS - CoV 2).[15]

If anxiolysis is desired, a benzodiazepine such as intravenous (IV) midazolam 1 to 2 mg can be used as it does not alter IOP.[10] However, exercise caution in older adults, consider dose titration in 0.5 mg increments. An alternative premedication is dexmedetomidine IV 0.2 to 0.8 mcg/kg administered over 10 minutes. This may cause hypotension and bradycardia and should be avoided or used at a lower dose in patients with hypovolaemia, cardiovascular disease, and older age.[4,7,11]

Anaesthetic technique

Induction

General anaesthesia is the most common anaesthetic technique for procedures for eye trauma, especially for open eye injuries. Monitoring should include standard anaesthetic monitors, with additional monitoring based on the patients comorbidities.[7]

Most central nervous system depressants lower IOP, these include volatile anaesthetics, hypnotics and opioids.[3] A reasonable induction sequence is an anaesthetic induction agent such as propofol 1.5 to 3 mg/kg, administered with an opioid and a selected neuromuscular blocking agent (NMBA).[10] In elective sequence and rapid sequence induction (RSI), IV lignocaine 1 to 1.5 mg/kg should be considered two minutes prior to induction to mitigate the increase in IOP that occurs during laryngoscopy.[16] All doses of the anaesthetic induction agent, opioid, and lignocaine should be reduced in older adults and those with haemodynamic instability.[10]

Full stomach and open eye

Succinylcholine can be used in unfasted patients. Typically it causes an increase in IOP of 8 to 10 mmHg and returns to baseline in 7 to 10 minutes.[4,7] Historically, there has been concern that the use of succinylcholine in patients with open eye injuries could further damage the eye due to this increase in IOP. To date, there are no reported cases of vitreous extrusion with the use of succinylcholine.[17] Although the increase in IOP is not insignificant, the increase associated with coughing is three times greater.[4] Current evidence suggests our efforts should focus on creating optimal intubating conditions and the avoidance of coughing and straining, versus the avoidance of succinylcholine.[4,7,9]

A dose of succinylcholine 1.5 mg/kg for RSI has the advantage of rapid onset, short duration of action and excellent intubating conditions.[18] A suitable alternative technique for RSI is the use of an NMBA administered with an appropriate dose of an induction agent to achieve similar conditions without an increase in IOP.[7,9,18] If sugammadex is available, a dose of rocuronium 1.2 mg/kg may be used for RSI in a "full stomach and open eye" scenario. Sugammadex can be administered for rapid reversal of rocuronium if an unexpected difficult airway is encountered.[4,7]

Remifentanil is another option for RSI when succinylcholine is contraindicated, and the prolonged duration of action from NMBAs is unsuitable. Administration of remifentanil at a dose of 3 to 5 mcg/kg combined with propofol 2 to 2.5 mg/kg provides excellent intubating conditions after 1 to 2.5 minutes. Consider dose reduction of both agents in older adults and those with haemodynamic instability.[10]

Maintenance of anaesthesia

Volatile anaesthetic agents decrease IOP through several mechanisms. Decreasing production and increasing outflow of aqueous humour, decreasing extraocular tension, and lowering arterial blood pressure.[3] Desflurane can possibly cause airway irritation and coughing when high concentrations are used at induction. Nitrous oxide has no effect on IOP and only needs to be avoided if intraocular "bubbles" are being used or if there is concern regarding vascular air embolism or pneumothorax.[4,7]

Total intravenous anaesthetic (TIVA) decreases IOP and is a reasonable alternative to an inhalation technique. TIVA with propofol is ideal for patients at high risk for postoperative nausea and vomiting (PONV). Combinations of agents administered by both routes also results in satisfactory anaesthesia and decreases IOP.[4,7,10]

Emergence

It is vital to prevent coughing, retching, and vomiting during and after extubation.[3] Prophylactic antiemetics such as ondansetron 4 mg and dexamethasone 4 mg should be administered prior to emergence to reduce the incidence of PONV. Prior to extubation, IV lignocaine can reduce coughing, but may also increase the awakening time.[4] Other alternatives include an infusion of remifentanil ≥ 0.1 mcg/kg/min with extubation or a "deep extubation" in fasted patients.[10]

Regional anaesthesia

Open eye injuries can be repaired under an orbital block and monitored anaesthetic care (MAC) depending on the degree of injury (zone 1 and 2 only).[19] It is important to keep fluctuations in IOP during the block and surgery to a minimum.[7,20] The outdated adage that regional is contraindicated for open globe injuries has been debunked.[13] Regional anaesthesia (RA) such as retrobulbar or peribulbar blocks were historically avoided due to the potential for extrusion of ocular contents.[3] There was also the additional concern of altered eye anatomy and tissue distortion from trauma, bleeding, and oedema, making blocks more technically difficult.

RA is preferred in some centres for selected open globe injuries in the cornea, limbus, and areas in the globe ≤ 5 mm posterior to the limbus.[21] A regional block is more likely to succeed if the wound is anterior and relatively small.[10,13,20] RA may also be considered when vision salvage is unlikely, particularly in a patient with a potentially difficult airway since concerns regarding increased IOP are less critical.[10] Topical anaesthesia with sedation has been reported in selected patients with less severe injuries, This technique may be an option in a patient with a difficult airway.[22]

Paediatrics

For paediatric patients who are fasted, induction of anaesthesia with inhalation agents administered via a face mask is the best technique.[10] If the paediatric patient is combative or agitated, consider sedation with an oral agents such as midazolam 0.5 mg/kg given 20 to 30 minutes prior to induction. Another alternative is intranasal administration of dexmedetomidine.[10]

Summary

Ocular trauma is an important cause of unilateral visual loss and impairment worldwide.[1,10] Visual outcomes in patients with open eye injuries have not been linked to anaesthetic practice but rather to the extent of injury. Open eye injuries are considered urgent situations and it is vital to have a good understanding of the effects anaesthetic agents and anaesthetic interventions have on the patient and surgical conditions.[7] The major goals for ophthalmic surgery is to maintain a stable IOP, a deep plane of anaesthesia to prevent movement and PONV needs to be avoided.[4] Anaesthetic induction with open eye injuries is particularly challenging in a patient who also has a full stomach or a difficult airway.[4,7,10] In South Africa, nearly half of all open eye injuries occur in the paediatric population; this adds further concerns relating to anaesthetising paediatric patients. This review aims to provide a guide to current recommendations, in the absence of local or international guidelines for the provision of anaesthesia in open eye injuries.

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References

1. Sukati V, Hansrajb R. Characteristics of eye injuries in urban KwaZulu-Natal Province, South Africa: 2005-2008. S Afr Optom. 2013;72(3):119-26. https://doi.org/10.4102/aveh.v72i3.285.
2. Grieshaber MC, Stegmann R. Penetrating eye injuries in South African children: aetiology and visual outcome. Eye. 2006;20(7):789-95. https://doi.org/10.1038/sj.eye.6702003.
3. Kelly DJ, Farrell SM. Physiology and role of intraocular pressure in contemporary anesthesia. Anesth Analg. 2018;126(5):1551-62. https://doi.org/10.1213/ANE.0000000000002544.
4. Bourdeu K, Bayes J, Eappen S. Anesthesia for ophthalmic surgery. 3rd Ed. New York, NY: McGraw-Hill Education; 2017. Available from: http://accessanesthesiology.mhmedical.com/content.aspx?aid=1144133135. Accessed 23 Aug 2021.
5. Kuhn F, Morris R, Witherspoon C. Birmingham eye trauma terminology (BETT): Terminology and classification of mechanical eye injuries. Ophthalmol Clin North Am. 2002;15:139-43. https://doi.org/10.1016/S0896-1549(02)00004-4.

6. Kuhn F, Morris R, Witherspoon CD, et al. A standardized classification of ocular trauma. Ophthalmology. 1996;103(2):240-43. https://doi.org/10.1016/S0161-6420(96)30710-0.
7. Fang Z, Liew E, Keyes M. Anesthesia for Ophthalmic Surgery. 2020. In: Miller's Anesthesia [Internet]. Elsevier. Available from: https://0-www-clinicalkey-com.innopac.wits.ac.za/#!/content/book/3-s2.0-B9780323596046000699?scrollTo=%23hl0000243. Accessed 23 Aug 2021.
8. Andreoli CM, Gardiner MF. Open globe injuries: Emergency evaluation and initial management. 2020. In: UpToDate [Internet]. Wolter Kluwer. Available from: https://www.uptodate.com/contents/open-globe-injuries-emergency-evaluation-and-initial-management/print?search=open. Accessed 12 Jul 2021.
9. Arunakirinathan M, Papamichael E, Hacking R. Use of suxamethonium in open eye injuries: a dilemma with explosive consequences. Br J Hosp Med. 2014;75(7):418. https://doi.org/10.12968/hmed.2014.75.7.418.
10. Macias AA, Bayes J, McGoldrick KE. Anesthesia for emergency eye surgery. 2021. In: UpToDate [Internet]. Wolters Kluwer. Available from: https://www.uptodate.com/contents/anesthesia-for-emergency-eye-surgery/print?search=eye. Accessed 21 Jun 2021.
11. Mowafi HA, Aldossary N, Ismail SA, Alqahtani J. Effect of dexmedetomidine premedication on the intraocular pressure changes after succinylcholine and intubation. Br J Anaesth. 2008;100(4):485-9. https://doi.org/10.1093/bja/aen020.
12. Nagdeve NG, Yaddanapudi S, Pandav SS. The effect of different doses of ketamine on intraocular pressure in anesthetized children. J Pediatr Ophthalmol Strabismus. 2006;43(4):219-23. https://doi.org/10.3928/01913913-20060701-03.
13. Gayer S. Rethinking anaesthesia strategies for patients with traumatic eye injuries: Alternatives to general anaesthesia. Curr Anaesth Crit Care. 2006;17(3):191-6. https://doi.org/10.1016/j.cacc.2006.08.001.
14. Kelly RE, Dinner M, Turner LS, et al. Succinylcholine increases intraocular pressure in the human eye with the extraocular muscles detached. Anesthesiology. 1993;79(5):948-52. https://doi.org/10.1097/00000542-199311000-00012.
15. London MJ. COVID-19: Anesthetic concerns, including airway management and infection control. 2021. In: UpToDate [Internet]. Available from: https://www.uptodate.com/contents/covid-19-anesthetic-concerns-including-airway-management-and-infection-control/. Accessed 3 Sept 2021.
16. Drenger B, Peter J, BenEzra D, Katzenelson R, Davidson JT. The effect of intravenous lidocaine on the increase in intraocular pressure induced by tracheal intubation. Anesth Analg. 1985;64(12):1211-3. https://doi.org/10.1213/00000539-198512000-00016.
17. Vachon CA, Warner DO, Bacon DR. Succinylcholine and the open globe: tracing the teaching. Anesthesiology. 2003;99(1):220-3. https://doi.org/10.1097/00000542-200307000-00033.
18. Tran DTT, Newton EK, Mount VAH, et al. Rocuronium versus succinylcholine for rapid sequence induction intubation. Cochrane Database Syst Rev. 2015;2015(10):CD002788. https://doi.org/10.1002/14651858.CD002788.pub3.
19. McClellan AJ, Daubert JJ, Relhan N, et al. Comparison of regional vs. general anesthesia for surgical repair of open-globe injuries at a university referral center. Ophthalmol Retina. 2017;1(3):188-91. https://doi.org/10.1016/j.oret.2016.11.006.
20. Scott IU, Gayer S, Voo I, et al. Regional anesthesia with monitored anesthesia care for surgical repair of selected open globe injuries. Ophthalmic Surg Lasers Imaging Retina. 2005;36(2):122-8. https://doi.org/10.3928/1542-8877-20050301-08.
21. McClellan AJ, Daubert JJ, Relhan N, et al. Comparison of regional vs. general anesthesia for surgical repair of open-globe injuries at a university referral center. Ophthalmology Retina. 2017;1(3):188-91. https://doi.org/10.1016/j.oret.2016.11.006.
22. Boscia F, La Tegola MG, Columbo G, Alessio G, Sborgia C. Combined topical anesthesia and sedation for open-globe injuries in selected patients. Ophthalmology. 2003;110(8):1555-9. https://doi.org/10.1016/S0161-6420(03)00485-8.