Narrative Review

Endotracheal Intubation versus Supraglottic Airway Device for Eye Surgery in Children

Gita Nath

Consultant, Anaesthesia and Intensive Care, Axon Anaesthesia Associates, Hyderabad

Abstract

General anaesthesia (GA) is required for eye surgery in all children and in some adults, and it necessitates meticulous airway management to achieve good surgical outcomes. During GA, it is mandatory to have an airway device to ensure a patent airway, since immediate access to the airway is difficult due to the nature of surgery. There is some controversy over whether supraglottic airway devices (SADs) or endotracheal intubation (ETI) are more advantageous in this situation. In this narrative review, the various factors determining the choice of airway device will be discussed.

A literature search of PubMed, Google Scholar, Medline and Scopus from 1990 till May 2023 was done, with the following keywords: airway management, eye surgery, intubation, laryngeal mask and supraglottic airway device. Relevant articles were reviewed with specific focus on devices used for airway management.

ETI was routinely used for eye surgery in order to ensure a secure airway and facilitate pulmonary ventilation to control the carbon dioxide level. Laryngeal mask airway (LMA) was introduced into practice in 1987, and its use in eye surgery has been reported since the early 1990's. Since then, several studies have compared the effect of the original LMA and second-generation airway devices on intraocular dynamics and stress response. The anaesthetic requirements in eye surgery are avoidance of increase in the intraocular pressure (IOP), preventing coughing and straining, maintaining an immobile eye, and preventing/treating the oculo-cardiac reflex. SADs have been shown to reduce the stress response as well as increase in the IOP, and are increasingly used for eye surgery. However, there are specific procedures such as vitreo-retinal surgery,

Address for correspondence:
Dr Gita Nath, MD, DA, DNB, FFA RCS
Address: 834, Road No 43, Jubilee Hills
Hyderabad, Telangana 500033
Phone: 9000241012
Email: drgitanath@hotmail.com

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repair of open eye injuries and major oculoplastic/reconstructive surgery where ETI may be required because of the length and complexity of the surgical procedure.

Keywords : Supraglottic airway device, endotracheal intubation, ophthalmic anaesthesia, paediatric

Airway management during eye surgery is always a matter of concern, both in adults as well as children. Even under local anaesthesia, the face is covered with drapes, and may cause the patient to feel claustrophobic and breathless. If sedation is given, monitoring the ventilation is a challenge – the latest practice guidelines for procedural sedation recommend the continual use of capnography to monitor the ventilation.[1] In children, eye surgery is usually done under sedation or general anaesthesia (GA), since most children do not tolerate local anaesthetic techniques in this situation. During GA, an airway device is mandatory to ensure a patent airway, as immediate access to the airway is difficult due to the nature of surgery. In this narrative review, the various factors determining the choice of airway device will be reviewed.

Anaesthetic requirements during eye surgery:

Anaesthetic goals during eye surgery are to provide a smooth anaesthetic, with an immobile eye, avoiding/treating the oculocardiac reflex, maintaining a low-normal intraocular pressure (IOP) and planning for intra- and post-operative analgesia.

Management of the IOP is crucial for successful eye surgery. A high IOP compromises intraocular perfusion and may also lead to extrusion of ocular contents, whereas a sudden or excessive decrease in IOP predisposes to a high ocular perfusion pressure and may lead to choroidal haemorrhage.[2] Several physiological factors cause increased IOP, such as raised venous pressure due to coughing or straining, increased arterial pressure, hypoxia or hypercarbia, some anaesthetic agents such as ketamine and suxamethonium; and pressure on the eyeball with the face mask. Most anaesthetic agents lower IOP, as also head-up tilt, decreased venous and arterial pressure, muscle relaxants, acetazolamide which decreases production of aqueous humour and mannitol which decreases vitreous volume.[3,4]

Airway Management

It is important to avoid manipulation or adjustment of the of the airway device during surgery so that the procedure is not disrupted. The gold standard for maintaining a secure airway is endotracheal intubation (ETI), but both intubation and extubation are associated with coughing along with tachycardia and hypertension.[2] A retrospective analysis of over 300,000 airway management procedure over 16 years found that supraglottic airway device (SAD) use increased from 10% in 2005 to 27% in 2020, while ETI decreased from 75% to 53% over the same period.

Comparing the different specialties, ophthalmology showed the highest odds ratio for SAD use, with a predicted increase of 26.4/year. Of the SADs, proportion of second-generation SADs increased from 9% to 82%. This was thought to be because of an improved seal and better identification of malpositions.[5]

Post-operative respiratory complications such as desaturation, laryngospasm, cough and breath-holding were all decreased by the use of SADs, according to a meta-analysis comparing SAD versus ETI in children. There was however, no difference in the incidence of sore throat, bronchospasm or aspiration.[6]

The specific SAD used can also impact anaesthetic and surgical outcome. Despite the advantages of second-generation SADs, they are stiffer and have greater vertical projection, and may encroach more into the surgical field. A more flexible SAD such as the Proseal LMA or flexible LMA can be fixed to the chin and cause less interference with surgical manoeuvres.[7]

Endotracheal Intubation In Eye Surgery

Several studies have demonstrated the catecholamine and haemodynamic responses of direct laryngoscopy, with or without ETI.[8] These changes are associated with increase in the IOP, which are even greater in glaucomatous eyes.[9] Direct laryngoscopy was found to double the IOP on the first attempt with an additional 30% increase with the second laryngoscopy attempt.[10]

But despite the haemodynamic effects of laryngoscopy and intubation, the overall effect of GA is to decrease the IOP because of the effect of the anaesthetic agents as well as relaxation of the ocular muscles.[2] Various measures can be taken to prevent this haemodynamic response, including opiates, IV lignocaine, beta-blockers and so on. Therefore, increase in IOP alone need not be taken as a contraindication, when intubation is deemed necessary for the procedure. Different types of video laryngoscopes seem to perform better regarding IOP compared to direct laryngoscopy.[11,12,13]

One of the earliest papers comparing ETI and LMA by Lamb et al showed that the IOP and stress response was significantly less in the LMA group.[14] Subsequently, several studies have compared ETI with SADs for eye surgeries. (Table 1)

Choice Of Airway Device In Different Situations

Examination under anaesthesia (EUA): These are short examination and may require IV sedation or can be done with face mak or SAD for airway management. Measurement of IOP, retinoblastoma evaluation, refraction, suture removal, laser are common indications for EUA.[20,21]

Strabismus surgery: As this is extraocular surgery, changes in the IOP are not a concern. Hypercarbia, hypoxia, light plane of anaesthesia, opioid and other sedative agents may potentiate OCR.[22]

Table 1. Studies comparing Supraglottic Airway Devices (SADs) and Endotracheal Intubation (ETI) on Intraocular pressure (IOP)

Study	Population	SADs	ETI
Lamb 1992[14]	Adult Intraocular Surgery	Smaller changes in pressor responses and catecholamine levels with airway manipulation	Higher IOP at all time points, peak at extubation
Watcha 1992[15]	Paediatric Ophthalmic	No change in IOP, HR or BP with LMA	Significant↑in IOP, HR and BP
Ghai 2001[16]	Adult Non-ocular	Significant IOP responses after airway instrumentation in both groups	Mean maximum increase of IOP was significantly higher after tracheal intubation.
Gulati 2004[17]	Paediatric Ophthalmic	No change on insertion of LMA but↑to 19.3±7.6 mmHg on removal	Intubation caused↑to 19.6±7.3 mmHg. Further↑to 24.6±10.4 on extubation
Ziyaeifard 2012[18]	Adult cataract Propofol + remifentanil	No significant differences in haemodynamics or IOP except at 5 minutes after intubation/LMA insertion	IOP: LMA 7.9 ± 2.3mmHg ETT 9.4 ± 2.5mmHg; (p = 0.030)
Obsa 2020[19]	Systematic review and meta-analysis	47 papers reviewed, 6 included in meta-analysis	LMA provides less IOP response compared to ETI

↑Increase; HR - Heart rate; BP - Blood pressure

Both SAD[23–25] and ETI[26,27] are acceptable for this surgery, but some authors recommend intubation in order to avoid hypercarbia which may lead to OCR.

Oculoplastic surgery: Syringing and probing for blocked nasolacrimal ducts is a simple procedure which can be managed with an SAD, taking care to suck out any fluid which enters the inferior meatus of the nose with a soft suction catheter. Dacrocystorhinostomy is a longer and more extensive procedure. ETI with throat pack is preferred with topical vasoconstrictors, and thorough oral suction prior to extubation.[29–31] Evisceration, enucleation, orbital and facio-maxillary reconstructive procedures are much longer, with limited access to the airway, and hence ETI is preferred.

Cataract and glaucoma surgery: These conditions require a motionless eye and avoidance of rise in IOP, especially during the procedure. If an SAD is chosen as the airway device, an adequate depth of anaesthesia should be ensured throughout the procedure to avoid sudden coughing or movement. Alternatively, muscle relaxation and ETI can be used to avoid these problems.[31,32]

Open eye injury: Danger of extrusion of ocular contents is the main concern due to breach in sclera or cornea with danger of extrusion of ocular contents. Since urgent surgery is necessary, in cases of inadequate fasting, risk of aspiration is always present.

Rapid sequence induction and ETI is preferred. Succinylcholine and rocuronium have been used for rapid sequence induction. A smooth extubation in a deep plane of anaesthesia prevents increase in IOP.[29,33]

Vitreo-retinal surgery: Both ETI and SADs have been used for this surgery. however many anaesthesiologist preferred ETI due to the length of surgery.[29]

Retinopathy of prematurity: The procedures done for this condition include cryotherapy, laser photocoagulation, intravitreal injections and vitreo-retinal surgery. Several studies have recommended ETI with controlled ventilation for these procedures[34,35] however for laser photocoagulation, a carefully selected anaesthetic plan with an SAD have been reported.[36]

Airway management in syndromic children for eye surgery: Numerous syndromes such as the mucopolysaccharidoses, craniosynostosis and craniofacial syndromes may be associated with eye pathology along with airway difficulties. Difficult airway guidelines should be followed with plan A, B, C and so on for airway management. Airway management with both SADs and ETI have been reported in syndromic children depending on mouth opening, availability of equipments, expertise of anaesthesiologist and surgical requirements.[37–39]

In summary, meticulous airway management is crucial for the success of eye surgery under GA, with focus on avoiding increase in the IOP, avoiding coughing and straining, maintaining an immobile eye and preventing/treating the OCR. SADs have been shown to reduce the stress response as well as increases in the IOP, and are increasingly used for eye surgery. However, there are specific procedures such as vitreo-retinal surgery, repair of open eye injuries and major oculoplastic/reconstructive surgery where ETI is preferred by many anaesthesiologist because of the length and complexity of the surgical procedure.

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Conflicts of interest

There are no conflicts of interest.

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