Original Article

Anaesthesia for children with ocular injuries in a tertiary hospital

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Abstract

Background: Eye injuries in childhood are common and an important cause of non-congenital unilateral blindness. The anaesthetic management of paediatric ocular trauma deserves the special skills of the anaesthetist to improve safety. This study determined the nature of ocular trauma and the perioperative anaesthetic management of the peculiarities of the paediatric patient with eye injury.

Methods: Ophthalmic theatre registry records of surgical procedures done in the paediatric ophthalmology unit from January 1, 2017, to December 31, 2023 were reviewed. The nurses' records, case notes, and patients' anaesthetic records were examined for demographic features, nature of ocular trauma, surgical procedures, type of surgery, and others for each patient.

Results: A total of 426 children presented to the unit and 139 (32.6%) had traumatic eye injury; 40 females (28.8%) and 99 males (71.2 %). Male children were over twofold more likely to suffer eye injury (p = 0.0001, OR 2.5, 95%CI = 1.65 – 3.92). The injuries were open globe (n = 97, 69.8%) or close globe (n = 23, 16.5%) and others (n=19, 13.7%). Most of the surgeries were performed under general anaesthesia (84.9%). Tracheal intubation was achieved using succinylcholine (63.6%) or non-depolarising muscle relaxants (36.4%). Few children received premedication (18.7%) and senior registrars and consultants provided care.

Conclusion: Anaesthesia for paediatric ocular trauma should be conducted as specialized care by senior anaesthetists. The dilemma of a full stomach in a child with ocular trauma and the use of succinylcholine for tracheal intubation should be attended to with clinical prudence.

Keywords: Children, eye injury, penetrating eye injury, anaesthesia, trauma

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INTRODUCTION

Blindness in children could be a burden on society due to the critical relevance of the child's psychosocial development. Besides cataracts, ocular trauma has been implicated in the scourge of blindness in children. Several studies have reported the problems of ocular trauma in paediatric practice.[1, 2] Onakpoya and colleagues[1] observed that ocular trauma was commoner in males, aged 6 -10 years and were mainly of the closed globe injury. In contrast, Ukponmwan and Momoh[2] showed that only 10% had closed injuries and 90% had open-globe injuries in their patients following broomstick injuries in children less than 14 years. However, there was a preponderance of

males over females in the distribution of the trauma.[1,2]

The anaesthetic management of a child with ocular trauma could be challenging to the anaesthetist, especially if penetrating in nature. The anatomical peculiarities of the child notwithstanding, the ocular trauma, particularly the open globe, could be a threat to the vision and survival of the child perioperatively. Paediatric ocular trauma indicates that about a fifth of the injuries occur when the child is at play,[3] which may provoke emergency care and the prospect of general anaesthesia. Indeed, ocular trauma was almost an absolute indication for general anaesthesia especially in the paediatric age group in a study.[4] For general anaesthesia, there could be issues with the residual gastric volume and the risk of aspiration. The problem of how to treat acute ocular injuries in a child who has not been fasted is frequent. Many centres steer clear of the matter by forgoing emergency surgery as there is no proof waiting for the child to be starved affects the surgical outcome.[5] It is important to note that a frightened child's stomach may not be empty after six hours of fasting. Still, the interval between feeding and the traumatic event is more relevant in estimating the residual gastric volume.[6] The administration of antacid prophylaxis may improve the acidity of the residual gastric contents. What constitutes the most appropriate airway control is debatable. However, avoiding suxamethonium when the eye is open is imperative since the increase in intraocular pressure can cause the loss of ocular content.

Consequently, the anaesthetist is often at a cross-purpose on the need to secure the airway by tracheal intubation and protect against the aspiration of gastric content without loss of vitreous following acute elevations in the intraocular pressure (IOP). Despite these challenges, most reports on paediatric ocular trauma in Nigeria are often limited to epidemiologic parameters;[1-3] and hardly interrogate the effects of anaesthesia on the outcome. It is crucial that the role of anaesthesia, in general, and specifically, is determined based on the result of open or closed-globe injuries. An understanding of the effects of anaesthesia on open globe injury, for instance, could be a factor in preventing blindness and other morbidities during the perioperative care of the paediatric patient. In addition, it may help policy formulations on the development of emerging paediatric ophthalmology services, especially with the involvement of anaesthesia personnel. Therefore, this study determined the nature of ocular trauma and the perioperative anaesthetic management of the peculiarities of the paediatric patient with eye injury.

METHODOLOGY

Ophthalmic procedures conducted from January 1, 2017, to December 31, 2023, at the University of Benin Teaching Hospital were analyzed. An analysis of the ocular theatre registry was conducted to ascertain the pattern of surgical procedures executed in the paediatric ophthalmology unit. The nurses' records, case notes, and patients' anaesthetic records were examined for demographic features, surgical procedures, type of surgery (elective or emergency), anaesthetic technique, and the qualifications of the attending anesthesiologist and surgeon for each consecutive patient. Children were defined as individuals younger than 18 years of age following the United Nations Committee on the Rights of the Child.[7] Patient scheduling was determined by elective or emergency operations. An elective procedure is described as one scheduled on the daily published operating list of the pediatric ophthalmic unit, whereas an emergency procedure is characterized as one requiring immediate operation on the same day a patient present.

The age at presentation, sex, and nature of ocular trauma were determined. The type of ocular truama was grouped as appropriate; open globe or closed globe. ‘Open’ globe injuries are where the trauma has breached the full thickness of the sclera, the cornea, or both.[8] Patients were grouped by age into a preschool (0–6 years), school-age (>6–12 years) or older children (>12–18 years) group.

Data analysis was conducted using Instat GraphPad Prism (version 8.4.3) (GraphPad software Inc, Boston, Massachusetts, United State America). All tests were two-way with a type I error rate of 5%. Continuous variables

were summarized utilizing means and standard deviations (SD). Dichotomous variables were displayed as frequencies. The correlation between the patient's age, the conditions of the surgical operation, and the anaesthesia method was analyzed using the Chi-square test with Yates correction.

RESULTS

A total of 426 children presented to the Paediatric Opthalmology Surgical Unit and 139 (32.6%) of them had traumatic eye injury within the study period; forty females (28.8%) and ninety-nine males (71.2 %). Male children were over twofold as likely to suffer an eye injury as females (p = 0.0001, OR 2.5, 95%CI = 1.65 – 3.92). The age ranged from one month to eighteen years and the mean age was 7.5 ± 4.7 years giving a male-female ratio of 2.5:1.0 (Table 1). About half of the patients were under 6 years and the least number of patients were less than a year (n=9, 6.5%).

Table 2 shows the various traumatic ophthalmic surgical diagnoses including corneal injury, foreign body injury, and ruptured globe. The injuries were open globe (n = 97, 69.8%), close globe (n = 23, 16.5%) and others (n=19, 13.7%). Most surgeries were performed under general anaesthesia (84.9%), as opposed to local anaesthesia, which was mainly for older children (15.1%).

Table 3 shows that general anaesthesia was the preferred technique whether elective (64.4%) or emergency (35.6%) while LA was mostly utilized for elective ophthalmic procedures than emergency especially in the older paediatric age group (71.4%).

A total of 26 children received premedication (18.7%) before anaesthesia/surgery; antacid (14.3%) anti-vagal (4.3%) but no patient received antiemetic prophylaxis. General anaesthesia was the technique of choice in 118 out of 139 (84.9%) patients. Tracheal intubation was the main method of protecting the airway in all patients who received general anaesthesia (100%). A laryngeal mask airway or face mask was not used to provide general anaesthesia. Succinylcholine was used to facilitate tracheal intubation in 75 patients (63.6%), non-depolarising muscle relaxants in 43 patients (36.4%), and all intubated patients had awake tracheal extubation as shown in Table 4.

Table 5 indicates that the senior registrar anaesthetists provided care for most patients (66.2%), and consultant anaesthetists (24.5%) while the ophthalmologists performed some local blocks (9.3%) for superficial traumatic paediatric ophthalmic surgeries. Consultant ophthalmologists performed most of the procedures (71.9%) and about one-third of the surgeries were carried out by Senior Registrars (28.1%).

Table 1: Sociodemographic characteristics of patients

Features	Frequency	Percentage
• **Age**		
<1	9	6.5
1-6	55	39.5
>6-12	49	35.3
>12-18	26	18.7
• **Sex**		
Male	99	71.2
Female	40	28.8
Total	139	100.0

Table 3: Nature of procedure and type of anaesthesia

Nature of Surgery	General Anaesthesia		Local Anaesthesia	
	(n)	%	(n)	%
Elective	76	64.4	15	71.4
Emergency	42	35.6	6	28.6
Total	118	100.0	21	100.0

Table 2: Diagnosis and technique of anaesthesia

Procedures	Frequency (%)	General Anaesthesia	Local Anaesthesia
Open Globe Injury	97/139 (69.8)		
• Corneal injury	89	81	8
• Foreign body	4	3	1
• Ruptured globe	4	4	0
Closed Globe injury	23/139 (16.5)		
• Blunt eye injury	23	16	7
Others	19/139 (13.7)		
• Traumatic Cataract extraction	11	9	2
• Lid injury	8	5	3
Total	**139 (100.0)**	**118 (84.9%)**	**21 (15.1%)**

Table 4: Conduct of anaesthesia for ocular trauma

Features	Yes	No
Antivagal premedication	6	-
Anti-acid premedication	20	-
POV prophylaxis	-	-
General Anaesthesia		
• Tracheal intubation	118	
• LMA	-	
• Face Mask	-	
Neuromuscular Blocker		
• Succinylcholine	75	-
• Non-Depolarisers	43	-
Tracheal extubation		
• Awake	118	-
• Asleep	--	-
Local Anaesthesia	21	-
Total		

Table 5: Cadre of service providers

Cadre	Frequency (n)	Percentage (%)
Anaesthetists		
• Senior Registrar	92	66.2
• Consultant	34	24.5
• Regional by Ophthalmologists	13	9.3
Ophthalmologist		
• Senior Registrar	39	28.1
• Consultant	100	71.9
Total	**139**	**100.0**

DISCUSSION

This study shows that 32.6% of children attending the paediatric ophthalmology Clinic had ocular trauma, with male preponderance, and children aged below 6years. The males were twice as likely to sustain an eye injury than females. The ocular injuries were open globe (69.8%), closed globe (16.5%) and others (13.7%) but most surgeries were performed under general anaesthesia (84.9%). Tracheal intubation was the preferred method for airway control in all patients who received general anaesthesia. Succinylcholine (63.6%) or non-depolarising muscle relaxants (36.4%) was used to facilitate the tracheal intubation. Few children received premedication before anaesthesia and surgery for the ocular trauma. The senior registrar or consultant anaesthetists provided the anaesthetic care while the ophthalmologists conducted the local ocular block.

There is a plethora of evidence implicating trauma as a major cause of visual impairment or blindness in children. Paediatric ocular trauma was reported by Isawumi[9] to be responsible for blindness (8.1%), severe visual impairment (12.5%), and moderate visual impairment (9.8%) among children in a rural Nigerian population. Indeed, a recent systematic review showed trauma to be one of the leading causes of visual impairment or blindness in Nigerian children.[10] The role of traumatic injury in childhood blindness has assumed public health importance. With a clear understanding of the mechanisms of the trauma, ophthalmologic care could ameliorate

the morbidity of visual impairment and improve the lifelong burden of blindness.

The male gender as a risk factor for ocular trauma in children, as seen in this study, is in keeping with extant literature on demographic characteristics of paediatric ocular trauma.[1, 2, 11, 12] The increased risk of males especially children of school age has been attributed to the proclivity of males to increased activity. These activities are varied and include playing,[3, 12] chores at home, [12, 13] farming,[3] or sporting activities at school.[14] However, Mowatt and colleagues[15] demonstrated female preponderance especially when the injury occurs at home (50% vs. 47.5%). Ukponmwan and Momoh showed that broomstick injuries were the most common among male children involved in tough plays,[2] while other common mechanisms for injury included stones, slingshots, belts, knives and others. These form the objects of play or items worn by children.

A significant portion of males and young children aged 1 to 6 years (39.5%) had anaesthesia for surgeries for eye injuries. A comparable demographic pattern was observed by Mahmoud et al[16] in a sample of pediatric patients receiving ophthalmic examinations under anaesthesia. Specifically, two studies reported similar prevalence of 45%[1] or 50%[12] for the preschool age group (1 - 6years) who received treatment for ocular trauma. The urgency for prompt eye evaluations in young children, likely due to the critical role vision plays in learning and communication,[17] may explain the dominance of this age group in studies addressing anaesthesia for eye surgeries. Moreover, older children tend to be more capable of understanding and following the necessary instructions for sedation or local anaesthesia for eye procedures. Indeed, the trend favouring general anaesthesia in preschool age group has been documented in other studies on paediatric ophthalmologic procedures.[1, 2, 11, 12]

These common mechanisms of injury notwithstanding, most ocular trauma are classified as either open or closed globe. The rate of open globe trauma in this study is quite high (69.8%). Some authors report more closed-globe injuries[1,13] while others indicate open-globe injuries as preponderant.[2,12] Nevertheless, the anaesthetic management of these injuries is often obscured by the attempt to restore vision where feasible. The anaesthetic management of ocular injury is dependent on the nature of the injury, the time of injury and the potential for blindness or visual impairment. General anaesthesia is often deployed for the surgical care of children with or without ocular trauma, generally.[1,18] Whether the injury is open or closed, the implications of the fluctuations in intraocular pressure (IOP) could have consequences for the patient, ophthalmologist or anaesthetist. In an open globe injury, local anaesthetic solution through the peribulbar or retrobulbar routes is associated with increased intraocular pressure,[8] even if the child could tolerate regional eye block.

The use of general anaesthesia offers peculiar concerns with the perioperative care of the patient. In keeping with best practices, all patients must be reviewed and preliminary preparations deployed to achieve good postoperative outcomes. These concerns for the child with ocular trauma include issues of full stomach (increased gastric volume), oculocardiac reflex, or postoperative vomiting. The active child, perhaps who had just eaten and could be playing, is at risk of regurgitation and aspiration of gastric contents. The acceptable means to avoiding this mishap is airway protection by tracheal intubation facilitated by the administration of succinylcholine, a depolarising muscle relaxant. Succinylcholine may induce fasciculation, a rise in intraocular pressure and a possible loss of ocular contents especially in open-globe injuries. In addition, succinylcholine may interfere with the integrity of the lower oesophageal sphincter in a patient with a full stomach, resulting in vomiting. This dilemma of prompt airway control with a drug that may result in vomiting and raised intracranial pressure puts the anaesthetist in cross-purpose. Thus, using antacids, or antiemetics as premedication becomes essential. Notwithstanding the minimal use of antacids, there was no regurgitation or vomiting in this study.

The use of premedication is considered a personal preference by some anaesthetists as

most children presenting for surgery are healthy.[19] However, the risk of aspiration following the high tendency to full stomach in children with ocular trauma may indicate the need for antacid prophylaxis. The inherent risk of aspiration may have provoked the use of antacids in our patients, representing the highest premedication utilization. Furthermore, the next commonly utilized premedication is antivagal against bradycardia. Oculocardiac reflex (OCR) is considered problematic for the course of anaesthesia especially in children with ocular trauma. Oftentimes, OCR results in bradycardia but more worrying presentations include atrioventricular block, ventricular bigeminy, ventricular tachycardia, and asystole.[20] It is thought that premedication with antivagal agents like atropine may reduce the incidence of arrhythmias. Nevertheless, OCR could be self-limiting and terminates with the cessation of stimulation. The minimal use of antivagal premedication (4.3%) may indicate the lack of consensus on the need for anticholinergic prophylaxis in paediatric ocular trauma. Indeed, some authors argue against the routine use of antivagal prophylaxis in paediatric anaesthesia.[21] At the same time, some anaesthetists prefer to blunt or prevent the OCR by administering atropine or glycopyrrolate before surgical manipulations.[22] The protagonists of the selective use of antivagal agents insist that the oculocardiac reflex manifests as bradycardia before using atropine or glycopyrrolate.[23] In a study, Desalu et al[24] observed arrhythmias in 27.7% of children who received intravenous atropine (0.01mg/kg) at the induction of anaesthesia. Nevertheless, atropine should be used cautiously.

Another perioperative concern for the paediatric patient for ophthalmologic procedures is postoperative nausea or vomiting. Antiemetics against postoperative vomiting was not used for our patients. The risk of postoperative vomiting (POV) in paediatric anaesthesia is multifactorial. The type of surgery, duration of anaesthesia, and patient factors (eg age, history of motion sickness) are the identifiable risk factors for postoperative nausea and vomiting. Nausea, the subjective feeling of wanting to vomit, is only present in older children (over 3 years) while postoperative vomiting (the forceful expulsion of gastric contents through the mouth) is described across the paediatric age group. While strabismus surgery is notoriously associated with postoperative vomiting[21, 25] there is little or no association of POV with paediatric ocular trauma in a study.[21] This may have provided the rationale for the observed non-utilization of antiemetics in our study.

There are various options for maintaining the airway during general anaesthesia for children. Tracheal intubation was the main method of providing a safe airway in this study. The induction of general anaesthesia, laryngoscopy and tracheal intubation, should be devoid of coughing, straining or bucking which may cause a rise in intraocular pressure. Measures against fluctuations in intraocular pressure are critical to the outcome of ophthalmic surgery. A still, immobile eye offers the best operating condition for the ophthalmologist. With tracheal intubation, the many factors that affect intraocular pressure could be controlled especially hypocapnia following controlled ventilation. In contrast, the laryngeal mask airway (LMA) although not deployed in this study may increase perioperative hypercapnia in the spontaneously breathing patient. Nevertheless, evidence indicates that LMA may provide smooth induction and emergence from anaesthesia and could have minimal effects on IOP.[26] There is a body of evidence indicating that IOP did not change when endotracheal intubation was conducted by trainees with over three years of anaesthesiology training.[27] Thus, the experience of the anaesthetist performing the laryngoscopy and endotracheal intubation may affect IOP.

The conduct of tracheal intubation requires muscle relaxants. The best option for muscle relaxants is dependent on the circumstances of the repair of ocular trauma. Our observation indicates that succinylcholine was preponderant in providing muscle relaxation for the tracheal intubation. In situations of increased residual gastric volume (full stomach), rapid control of the airway with succinylcholine (rapid sequence induction) is critical for a good outcome. However, succinylcholine is associated with muscle fasciculations, increased IOP, and possible

loss of ocular contents.[28] In such a clinical dilemma, the surgical repair is either deferred for about 6 hours or a non-depolarising muscle relaxant such as rocuronium or atracurium could be handy.[29] It is unclear if about a third of our patients who received non-depolarizing muscle relaxants had their surgery delayed. Postponed surgery may allow the anaesthetist to use a non-depolarising muscle relaxant since the concern for the full stomach may have been contained. Nevertheless, delayed or postponement of surgery has not consistently removed the risk of a full stomach.[5] Perhaps, this lack of consistent results may have informed the high rate of succinylcholine in this study even with the concerns with increased IOP and risk of loss of ocular contents[30] Therefore, navigating the difficulty cross-purpose is essential for a healthy patient without worsening the vision.

There are some clear limitations to the interpretation of the findings in this study. First, it is a retrospective study and missing data may occur. The multiple sources of data collection were intended to ameliorate the impact of missing information. Second, it may have been necessary to determine the proportion of our patients whose surgery was delayed or postponed. A postponement of surgery allows for improved gastric emptying and minimizes the risk of aspiration at induction. The information on delayed surgery would have added value to the choices of muscle relaxants used by the anaesthetists. The observations on the conduct of the various aspects of anaesthesia and the choices of the anaesthetist on the technique of general anaesthesia, airway control, muscle relaxant for tracheal intubation, and evaluation of determinants of good outcome after anaesthesia underscores the strength of this study.

CONCLUSION

In conclusion, this retrospective study interrogated the anaesthesia for ocular trauma in children. The results indicated ocular trauma occurred in about a third of the children in paediatric ophthalmology, mainly males, less than 6 years, and more open globe than closed-globe injuries. The preferred choice of anaesthesia was general anaesthesia with tracheal intubation, facilitated with succinylcholine or non-depolarising muscle relaxants. The general anaesthesia was conducted by senior registrars and consultant anaesthetists only. Although premedication was sparingly used (18.7%), the emphasis was more on antacid prophylaxis. Therefore, it is important that anaesthesia for paediatric ocular trauma is specialized care and should be provided mainly by senior anaesthetists. In addition, the attending anaesthetist should conduct airway control in the paediatric patient with a full stomach with clinical prudence to achieve safety without compromising vision.

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Conflicts of interest

There are no conflicts of interest

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