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Visual Outcomes Following Traumatic Cataract Surgery in Children in Mongolia: Experience Over 2 Years at a Major Hospital

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Objective: To describe the demographics, nature of the injury and visual outcomes of pediatric patients presenting with traumatic cataract requiring surgery at the National Center for Maternal and Child Health in Mongolia and to compare the relevant literature on traumatic pediatric cataracts in other countries. **Methods:** The charts of individuals aged ≤ 18 years who underwent surgery for traumatic cataract over a two-year period at a pediatric hospital were reviewed. The data collected included: demographic information, mode and time of injury, intraocular lens type, surgeries pre- and post-operative best-corrected visual acuity, and surgical complications. **Results:** Over the 2-year study period, 27 children underwent cataract surgery for traumatic cataract. The mean age was 8.52 ± 4.7 years (range, 1-17 years). The type of primary insult was penetrating injury in over 80% of patients. The mean interval between injury and cataract surgery was 7 ± 6.5months. Pre-cataract surgery no patient had vision better than 20/40; after cataract surgery 36% had 20/50. **Conclusion:** A better understanding of the causes of eye injuries and the environments in which they occur can provide informed educated strategies for parents, caregivers, and teachers and can possibly reduce time to treatment.

Keywords: Cataract, Pediatrics, Surgery, Traumatic, Outcome

Introduction

Eye injury accounts for 8-14% of all types of injury in children [1]. Among boys, the incidence of eye trauma is significantly higher than among girls, which is the result of the greater exposure of boys to injuries in general and the higher incidence of violent activities among them. In all countries, young boys appear to be at greater risk for ocular injury [2].

An eye injury in a child can cause a visual disability that subsequently restricts the choice of profession or decreases

productivity and also negatively impacts an individual's self-confidence by affecting physical appearance [1]. Ocular trauma occurs in 3.45 per 100 000 population per year or 4.6 per 10 000 outpatient visits in Israel [3].

Injury can affect any eye structure. Lens injuries include partial or complete lens dislocation and partial or complete cataract. Eye trauma causes cataract in 65% of eye cases [4]. In a study from China, 19-24% of patients from 2 to 8 years old had traumatic cataract [5]. This study also reported that the main causes were sharp metal objects (40%), toys (16%), and wooden sticks (11%). Penetrating injuries accounted for 77% of all injuries.

Lens trauma also depends on the degree of the lens layer trauma. Unfortunately, there is yet no morphological standard for cataract caused by trauma [6]. Perucho-Martinez et al. reported that, over an 18-year period, 90% of patients with acquired cataract had cataract due to trauma [7]. In Enkhtuul and colleague's study in Mongolia, 38% of child eye trauma caused lens injury and resulted in impaired vision and vision loss [8]. Shah et al. reported that an intraocular lens (IOL) was implanted in 82% of traumatic cases in their study conducted in three states in western India [9]. According to Singh and co-worker's study in Nepal, best-corrected visual acuity (BCVA) post-operative (6/6-6/60) accounted for a majority of 81% and the major post-operative complication was anterior uveitis in 19% [10]. In most cases, the traumatic cataract interferes with the visual axis and requires cataract surgery but in some cases, a minor injury to the lens may result in a localized non-progressive lens opacity that does not require surgery [11]. We implanted an interocular lens [IOL] in 95% of open-globe and 100% of closed-globe traumatic cataract cases which was higher compared to the study made in India and China [12]. While the BCVA of 65% of the total cases included in the study had 20/100 and more, it is lower compared to the study conducted in Nepal [10]. Depending on the specifics of the country, mode of injury is different, for example, according to a study in India [13], children are more likely to be injured by fireworks, but we have not had such injuries. In a study from Nepal [10], the most common injury was closed-globe, and in our study, it was open-globe injury.

Previous studies in Mongolia have assessed the prevalence and some causes of traumatic cataracts. In this study, we evaluated the detailed causes of traumatic cataracts, the types, and the effectiveness of surgical treatment. The Orbis National Center for Maternal and Child Health of Mongolia (NCMCH) recently introduced new technology for performing lens surgery. Therefore, this study is the first basic study to evaluate the outcome of pediatric traumatic cataract surgery in Mongolia. We also evaluated the visual outcome pre- and post-surgery retrospectively This study will identify the causes and types of traumatic cataracts in Mongolian children, assess the extent to which the type of injury affects the outcome of the surgery and make up for the knowledge gap.

We aimed to describe the demographics, nature of the injury and visual outcomes among pediatric patients with traumatic cataract at the NCMCH in Mongolia and compare with the relevant literature on traumatic pediatric cataracts in other countries.

Materials and Methods

Study design

National Center for Maternal and Child Health (NCMCH) is a tertiary referral care center for Mongolia, which has an estimated population of 3 million people, nearly one-third of whom are children younger than 18 years old. From January 1, 2018 to December 31, 2019, 126 children were hospitalized at NCMCH due to ocular trauma. From a total of 126 cases, 34 involved traumatic cataract and five children did not return for surgery. There were no cases of bilateral traumatic cataract. Retrospective analyses of traumatic cataract children's visual outcomes were performed pre- and post-surgery. All participants were assessed for visual acuity and demographic causes and types of traumatic cataracts pre-surgery. We followed all participants. These children were also evaluated for postoperative visual acuity.

Participants

All pediatric patients with traumatic cataract who required lens surgery at NCMCH were identified and included in our study. The exclusion criteria were as follows: pre-existing ocular diseases such as amblyopia, refractive error, corneal opacity, posterior segment disorder, atraumatic retinal detachment that affected visual acuity, and a history of previous ocular surgery. Twenty-seven were included in the analysis and completed at least a 3-month follow-up at the single center at the pediatric ophthalmology department of NCMCH, Ulaanbaatar, Mongolia.

Methods

We retrospectively reviewed the medical records of all children hospitalized due to ocular trauma. The data collected was comprised of: demographic information, mode of injury, time of injury, IOL type and power, the interval between injury and first visit to a doctor, surgeries, pre-operative and post-operative best corrected visual acuity (BCVA) and surgical complications.

Main outcome

Visual acuity was graded according to the classification proposed by Pieramici [12]: grade 1, ≥ 20/40 grade 2, ≥ 20/100 - < 20/40 grade 3, ≥ 20/400 - < 20/100, grade 4, ≥ light perception (LP) - < 20/400, grade 5 no light perception (NLP).

The children underwent a complete ocular examination: visual acuity estimation, slit lamp examination, orthoptic evaluation, and fundoscopy. Visual acuity was measured by the Snellen's chart. Lea charts were used for children ≤ 5 years of age. Intraocular pressure (IOP) was measured using a ICARE FI-01510 Vantaa, Finland and Clement-Clarke Perkins MK2 Handheld Tonometer.

Lens removal was performed either during the wound repair after the ocular injury or as a second procedure after the penetrating wound was sutured. All the surgical cases were done by the scleral tunnel approach. Capsulotomy was done by either pediatric capsulorhexis forceps or 23-gauge vitrector. Irrigation aspiration was done using an Alcon Laureate phacoemulsifier to clear the cortical matter and vitrectomy.

IOLs were implanted in the capsular bag or the sulcus. Anterior vitrectomy was performed in children with posterior capsular tear and under 7 years old. One patient without any capsular support was left aphakic and prescribed spectacles. Patients spent 1 week in the hospital and then subsequently were followed up at 1 month, 3 months, and 6 months post-operatively. Uncooperative patients underwent an examination under anesthesia. At each follow-up visit, the patient's visual acuities were recorded. Final BCVA was noted. The patients were divided into two groups based on the type of injury: closed-globe or open-globe. Either a foldable hydrophobic acrylic or polymethylmethacrylate IOL was implanted according to the formula SRK/T.

Statistical analysis

Demographic variables were expressed in numbers and percentages. The confidence interval of the calculation is defined as 95.0%. Comparison of category variables used Freeman-Halton's statistics, an extended method of the Fisher test. The extension of Fisher's exact treatment for 2 × 2 contingency tables was proposed by Freeman and Halton (1951). This method, proposed by Freeman and Halton (1951), is a statistical test that can be used in many groups of category variables. Post-operative complications are multiple-choice questions and were analyzed as binary variables for each complication. A McNemar Bowker test was used to determine the difference in visual acuity pre- and post- surgery. Because the dependent variable was multinomial category variables, the independent variable measure was repeated two times, and table was symmetrical (Tests for Multiple Correlated Proportions, NCSS). The analysis determined whether the preoperative and postoperative BCVA differed by type of injury. The results of the above hypothesis test were considered to be statistically significant if the p value was less than 0.05. The Generalized Estimation Equation Model (GEE) (Liang and Zeger, 1986) was used to determine the interaction effect of injury type on postoperative BCVA improvement pre- to post-operative. The dependent variable was an ordinal number with two repeated measurements and had a non-parametric distribution. The Generalized estimation Equation is an extended version of the GML for re-measurement of prospective research. In contrast to the ANOVA and Mixed regression of the repeat measurements, it was consistent with our data to allow a small sample size that did not require normal distribution and variation of the same. We analyzed using SPSS version 26.0 (IBM).

Ethical statement

The ethical approval for this study was obtained from the Research Ethics Committee of Mongolian National University of Medical Sciences (22 February 2019, No. 2019/3-02), National Center for Maternal and Child Health (18 January 2019, No. 82)

Results

A total of 29 children were admitted with traumatic cataract over the study period. One patient who had a traumatic retinal detachment that confirmed by B scan and another who underwent vitreoretinal surgery for endophthalmitis elsewhere were excluded. Three of 27 children had secondary IOL, 23 underwent lens aspiration and had IOL implantation after

wound repair and one child was left aphakic after lens aspiration because of not having capsular support.

There were 21 males and 6 females (male-to-female ratio 3.5: 1; Table 1). The age range was 1-17 years (mean age 8.52 ± 4.75years) and the majority of the patients (52%) were under 6 years of age. Laterality was more common in the left rather

Table 1. Demographics and characteristics of patients with traumatic cataract.

Variables		N	%	95% CI Lower	Upper
Gender					
	Male	21	77.8	59.8	90.2
	Female	6	22.2	9.8	40.2
Place					
	Urban	6	22.2	9.8	40.2
	Rural	21	77.8	59.8	90.2
Laterality					
	Right	11	40.7	23.9	59.4
	Left	16	59.3	40.6	76.1
Type of injury					
	Open-globe	22	81.5	64.1	92.6
	Closed-globe	5	18.5	7.4	35.9
Place of injury					
	Home	14	51.9	33.6	69.7
	Street	12	44.4	27.1	62.9
	Unknown	1	3.7	0.4	16.0
Age at time of trauma (years)					
	0-3	4	14.8	5.2	31.5
	4-6	10	37.0	20.9	55.8
	7-9	4	14.8	5.2	31.5
	10-12	4	14.8	5.2	31.5
	13-15	5	18.5	7.4	35.9
Injury cause					
	Self-injured	16	59.3	42.4	68.0
	Sibling	3	11.1	3.4	27.7
	Friends	6	23.0	21.0	27.7
	Unknown	1	3.7	1.5	4.8
	Thunder	1	3.7	1.5	4.8
Type IOL					
	Foldable	7	25.9	12.9	45.7
	PMMA	20	74.1	54.3	87.1
IOL implantation					
	In sulcus	11	40.8	23.9	59.4
	In bag	15	55.5	45.0	62.9
	Without IOL	1	3.7	0.4	5.3
Visit emergency					
	<24h	9	33.3	17.9	52.1
	24-72h	2	7.4	1.6	21.7
	73h<	16	59.3	40.6	66.1

IOL-intraocular lens, PMMA-polymethylmethacrylate

than the right eye (59% versus 41%, respectively) and 22 (82%) had open-globe injuries compared to 5 (18%) closed-globe injuries. Most of the children were from rural areas: 21 (78 %) compared to 6 (22%) from urban areas. In 15 cases (55%), the IOL was implanted in the bag, 11 cases (41%) required sulcus implantation and 1 case (4%) was left aphakic due to poor capsular support. The type of IOL implanted was PMMA in 7 cases (27%) and foldable hydrophobic acrylic IOL in 19 eyes (73%). 9 of them (34%) visited a doctor within the first 24 hours after injury, 2 (7%) visited within 24-72 hours and 16 (59%) visited after 73 hours (Table 1).

The most common mode of injury was sharp objects (9, 33%), including scissors, iron wire, syringe needles, knife and nails, followed by fall from height (6, 22%), wooden stick (5, 19%), and toy guns (2, 7%). In open-globe injuries, the most common cause was a sharp object (33%); in closed-globe injury, falling from a height was the most common (60%). The mode of injury is a statistically significant difference between closed and

Table 2. Mode of injury in pediatric traumatic cataract.

Objects	Open-globe N (%)	Closed-globe N (%)	Total	p-value[a]
Sharp objects	9 (40.9)	0 (0.0)	9 (33)	0.010
Fall from height	1 (4.6)	3 (60.0)	4 (15)	
Wooden stick	4 (18.2)	1 (20.0)	5 (18)	
Stone	2 (9.1)	0 (0.0)	2 (7.4)	
Ceramic	1 (4.6)	0 (0.0)	1(3.7)	
Toy gun	2 (9.1)	0 (0.0)	2 (7.4)	
Electric shock	0 (0.0)	1 (20.0)	1(3.7)	
Glass	1 (4.6)	0 (0.0)	1(3.7)	
Eruption	1 (4.6)	0 (0.0)	1(3.7)	
Unknown	1 (4.6)	0 (0.0)	1(3.7)	
Total	22 (100.0)	5 (100.0)	27 (100)	

[a]Freeman-Halton's method, N – Number, % - percentage

Table 3. Type of cataract surgery and post-operative complications.

Variables	Open-globe N (%)	Closed-globe N (%)	Total N (%)	p-value
Type of surgery LA+PCIOL	3 (13.6)	3 (60.0)	6 (22.2)	
LA+PCIOL+synechealysis	4 (18.2)	0 (0.0)	4 (14.8)	
LA+PCIOL+PPC+AV	2 (9.0)	2 (40.0)	4 (14.8)	
LA+PCIOL+PPC+AV+synechealysis	8 (36.3)	0 (0.0)	8 (29.6)	0.114[a]
LA+PCIOL+PPC+AV+pupiloplasty	1 (4.6)	0 (0.0)	1 (3.7)	
LA+synechealysis	1 (4.6)	0 (0.0)	1 (3.7)	
Secondary implant	3 (13.6)	0 (0.0)	3 (11.1)	
Post-operative complications				
Non complications	12 (54.5)	3 (60.0)	15 (55.6)	0.023
Endophthalmitis	0 (0.0)	1 (20.0)	1 (3.7)	0.124
Inflammation	5 (22.7)	1 (20.0)	6 (22.2)	0.783
IOL-pigmentation	4 (18.2)	0 (0.0)	4 (14.8)	0.023
High IOP (temporary)	1 (4.5)	1 (20.0)	2 (7.4)	0.026
Thick membrane over the IOL	2 (9.1)	0 (0.0)	2 (7.4)	0.069
Corneal edema	1 (4.5)	0 (0.0)	1 (3.7)	0.085
Total	22 (100.0)	5 (100.0)	27 (100.0)	

LA-Lens aspiration, PCIOL-Posterior chamber intraocular lens, PPC-Primary posterior capsulotomy, AV-Anterior vitrectomy, [a]Freeman-Halton's method

open-globe (p = 0.016) (Table 2).

The mean interval between injury and cataract surgery was 7 ± 6.5 months. The interval between injury and cataract surgery was as early as 2 weeks in 2 (7%) cases and as late as 84 months in 1 case. (p = 0.364) (Figure1)

Out of 19 cases with open-globe injuries in patients who underwent lens aspiration, IOLs were primarily implanted in 18 (95%) and in 3 patients IOLs were implanted secondary (LA done during wound repair). IOLs were implanted in all 5 (100%) with closed globe injuries. Additional procedures were performed during lens aspiration and IOL implantation, including pupilloplasty (1 case) and anterior and posterior synechealysis. (13, 48%) (Table 3).

Following surgery, several complications were noted. Post-operative inflammation was a common complication in 5 cases (23%), significant anterior chamber reaction with a fibrinous membrane covering the IOL in 2 cases, pigment on the IOL surface in 3 cases (11%), IOL dislocation in 3 cases (11%), temporary increase in IOP in 2 cases (7%) and late-onset suture-related endophthalmitis in 1 case. The latter patient underwent vitreoretinal surgery and recovered vision. Postoperative complications are significantly less than open-globe when closed-globe surgery was done (p = 0.012) (Table 3).

The pre-operative and final BCVAs were examined in 25 cases. 1 case was uncooperative and 1 patient was left aphakic. The patient who was uncooperative had good fixation and good alignment. The patient who was left aphakic reportedly had anterior synechiae with a thick corneal scar, a large pupil and no capsular support. The vision was LP with high plus glasses counting finger at 1m. There was a significant improvement from pre- to post-operative BCVA (p = 0.000) (Figure 2).

In the subgroup analysis, pre-operative and post-operative BCVA was not significantly different in the case of open-globe and closed-globe trauma (pre = 0.13, post = 0.25) (Table 4). Post-operation, the best corrective visual acuity is expected to increase statistically (β = 1.35, se = 0.26, p < 0.000). However, the type of eye injury did not significantly correlate with postoperative visual acuity (β = 1.02, se = 0.78, p = 0.865).

Table 4. Pre-operative and post-operative BCVA by type injury (n = 25).

BCVA	Pre-operative N (%)	Postoperative N (%)	p-value[a]
Open - globe (n = 20)[c]			0.012
20/40<	0	7 (35)	
20/100-20/40	1 (5)	6 (30)	
20/400-20/100	3 (15)	4 (20)	
LP - 20/400	16 (80)	3 (15)	
Closed-globe (n = 5)			0.024
20/40<	0	2 (40)	
20/100-20/40	1 (20)	2 (40)	
20/400-20/100	1 (20)	1 (20)	
LP - 20/400	3 (60)	0	

BCVA=best corrective visual acuity, [a]McNemar bowker test, [c]Two missing value (One case was uncooperative and other one case was left aphakic in another patient).

Table 5. Estimated interaction effect of type of injure on the BCVA.

GEE (DV: BCVA)		
Effect	Time (pre-operative and post-operative)	Closed-globe injury (Ref: open-globe)
Parameter estimation (β)	1.35	1.02
Standard error	0.26	0.78
p-value	0.000	0.865

GEE – Generalized estimation Equations, DV – Dependent variables, ref- Reference group, β – GEE regression beta coefficient, BCVA – Best corrective visual acuity

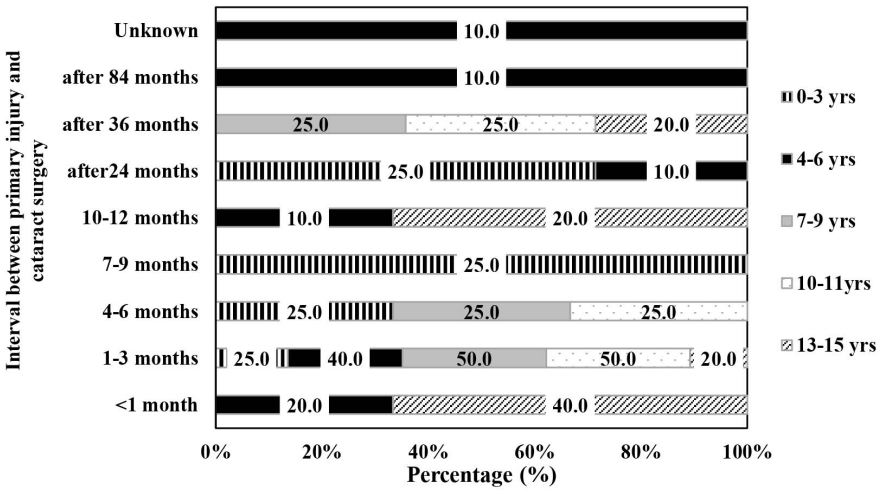

Figure 1. Interval between primary injury to cataract surgery, child age.

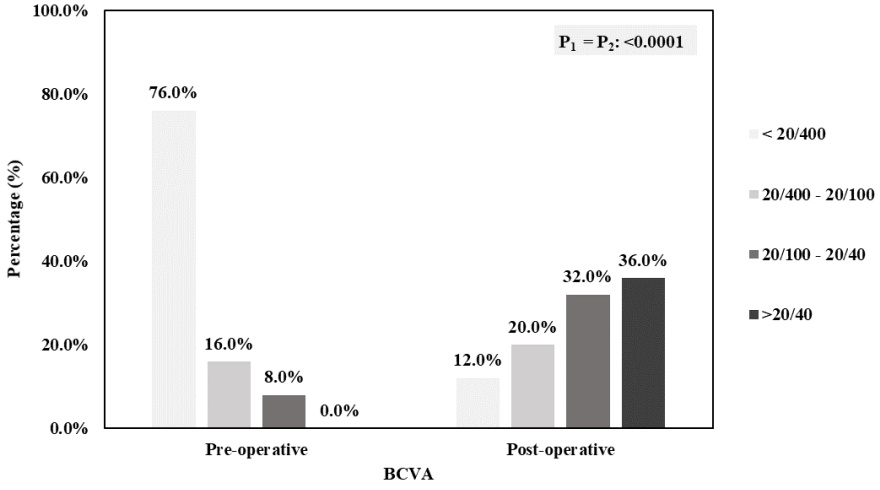

Figure 2. Best corrective visual acuity pre and post – operative, BCVA –best corrective visual acuity, P_1 – Pre operative, P_2 – Post-operative.

This result suggests that the type of eye injury does not have a significant interaction on changes in visual acuity pre- and post-operatively.

Discussion

This study included 27 cases of traumatic cataract in children (aged ≤18 years), who were managed in a tertiary referral care center at NCMCH in Mongolia. In line with previous studies conducted in other countries, more boys than girls suffered from traumatic cataract, likely reflecting the fact that males and females engage in different activities with different degrees of risk of ocular injury [10, 13, 14].

In our study, almost 80% of the injured children came from the countryside. 32% of the children came to the hospital within 24 hours after the injury and 60% of patients presented to the hospital 72 hours after the injury. 50% of those living in Ulaanbaatar city received urgent care in 24 hours compared to 28.5% of patients from rural areas. In a study from Eastern China [15], 83% of the children received urgent medical help within 24 hours whereas in a study from central-western India [9], 30 % of the children received medical urgent help within 24

hours, similar to our findings.

The most common mode of injury in our study was sharp objects, similar to reports from an urban center in the UK [15] and a mixed urban-rural population in Australia [16].

In our study, 32% of those who were injured were between 4-6 years old. This peak age was also noted in Australia, with another peak between ages 13-15 [16]. In our study, 52% were up to 6 years old. The youngest children in our study were a 6-month-old girl who was accidentally struck with a dart and a 1-year-old boy who fell and hit the edge of a table. In the study from Finland, there was no trauma between ages 0-1 [17].

According to the study by Gogate' et al. [18], in rural India children received lens surgery 4 days to 6 years after the injury. The mean interval between primary injury and cataract surgery was 7 ± 6.5months in our study, compared to 4.62 ± 8.61months in a study conducted in Northern India which was higher interval in our study [13]. Another reason for delayed surgery is that lens surgery is expensive and patients must pay a proportion of it and also travel from a remote area.

We implanted an IOL in 96% of the children who had surgery. Also, all of the 5 closed-globe injuries were implanted with an IOL. We did not implant IOL in one of the open-globe injury cases because there was not enough lens support. In a Chinese study, IOLs were implanted in 68% of the children and they implanted IOL in all of the closed-globe injuries [19]. In our study, 76% of patients' pre-operative BCVA was less than 0.05 and 16% of patients' BCVA were more than 0.05. This is similar to study from Nepal, where 54% of patients' pre-operative BCVA was LP and 29% patients had visual acuity of only ≥ 5/60. The BCVA post-operatively was better than 20/200 in 63% of the patients; this is similar to a study from Nepal [10] in which the BCVA post-operatively was better than 6/60 in 80%. In our study, there was significant difference between the pre- and post-operative BCVA open-globe and closed-globe injuries ($p = 0.012$; 0.024). This is similar to a study from Eastern China [19]. Traumatic cataracts should be managed as soon as possible to avoid other complications, such as amblyopia. Children who were at the age for high risk of amblyopia had insufficient eye patching after the surgery. In our study, 23% of patients had anterior inflammation after the surgery, similar to other studies [10, 20] (19%, 25%). 2 patients had a very thick inflammatory membrane but after medical treatment, the inflammation resolved. 2 (16%) patients had pigment over the IOL surface, less than that reported by Jinagal et al. (26%) and similar to that reported Zia et al. [13, 21]. (18%). In 3 (11%) patients, the IOL dislocated from the center but it was stable. This is similar to a study in Pakistan (9%) but different from a study in India; IOL dislocation occurred in only 2% of cases in our study [9, 20]. Shah et al. reported that, after surgery, 1% developed secondary glaucoma [9]. In our study, 2 patients (8%) developed temporary ocular hypertension, which resolved with medication. 1 patient from a rural region had late-onset suture-related endophthalmitis and the suture was removed in an outpatient clinic. In contrast, Zia et al. reported endophthalmitis in 3 cases (9%) [21]. Whilet medical treatment was ineffective, the patient's vision returned to normal after vitrectomy was performed.

Eye injuries in children are preventable yet continue to cause loss of vision. Notably, children with eye injury were more commonly from rural areas and these children experienced a greater delay in receiving treatment. In Mongolia, there are few pediatric ophthalmologists outside the capital city. Parents, caregivers, and teachers in Mongolia require more information about how to prevent eye injuries and perform basic first-aid techniques as well as why urgent treatment is essential. The results of this study will be used to develop public health messages highlighting to parents, caregivers and teachers that it is important to maintain a safe environment for children to protect their eye health. The limitation of our study were a retrospective study, small sample, less follow-up time, and in our tertiary center most all simple and complicated cases come by referral, which may affect visual outcomes. Therefore, there is a need to increase the sample size, increase follow-up time, and perform prospective studies on surgical complications and outcomes in the future.

Conclusion

A better understanding of the causes of eye injuries and the environments in which they occur can provide informed educated strategies for parents, caregivers, and teachers and can possibly reduce time to treatment.

Conflict of interest

The authors declared no conflicts of interest.

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