

Pediatric Traumatic Cataracts : 10 Year-experience of a Tertiary Referral Center

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Abstract

Background: To evaluate the factors influencing final visual acuity in pediatric traumatic cataracts.

Methods: Data of patients who presented with traumatic cataracts were reviewed retrospectively. We evaluated sex; age at trauma; trauma type, cause, and zone; duration between the time of trauma and cataract surgery; surgical method used; time, location, and type of intraocular lens (IOL) implantation; initial and final corrected distance visual acuity (CDVA); amblyopia rate and complications.

Results: In all, 61 eyes of 59 patients with cataracts after trauma, under 16 years of age, were included. The mean age of the children was 7.2 ± 3.9 years. Primary IOL implantation was performed in 70.9% of eyes. The CDVA was 0.7 LogMAR or better in 16.3% of the 49 eyes where the visual acuity could be measured at the time of trauma and in 69.1% of 55 eyes in which it could be measured after treatment. The evaluation of factors potentially influencing the final visual acuity revealed that eyes that had undergone posterior capsulotomy (PC) and anterior vitrectomy (AV) during cataract surgery had significantly better final vision compared to eyes that did not undergo these procedures.

Conclusion: Good visual results can be obtained in children with traumatic cataracts using PC and AV together with lens aspiration and IOL implantation, followed by effective amblyopia treatment and close monitoring.

Background

Ocular trauma in childhood is one of the most important causes of preventable vision loss, and traumatic cataracts make up 12–46% of all pediatric cataracts [1,2]. The management of traumatic cataracts in the pediatric population is particularly challenging due to the ongoing growth of the eye, the risk for amblyopia, and a long life expectancy [3].

Therefore, there could be many factors that influence the final visual acuity in pediatric cataracts, including the age of the child at the time of trauma, the type and cause of the trauma, the surgical procedure, and the initial visual acuity [4–6]. Recognizing these factors would help the development of an appropriate treatment approach to pediatric traumatic cataracts. In this study, we investigated the epidemiologic features of pediatric traumatic cataracts and evaluated the factors influencing final visual acuity.

Methods

In this retrospective study, medical records of children < 16 years analyzed who had presented as an emergency to the XXX City Hospital eye clinic with ocular trauma between January 2009 and January 2019, and who developed a traumatic cataract later on. We included children who developed traumatic cataracts after a penetrating or blunt injury and who had been followed up for at least 1 year. Children with an eye injury from an intraocular foreign body and those whose lens capsules were not intact in

primary closure surgery and who therefore underwent lens aspiration (LA) were excluded. All penetrating injury cases underwent primary corneal surgery, followed by secondary cataract surgery. The study was conducted according to the ethical principles of the Declaration of Helsinki after permission was acquired from the ethics committee of our hospital.

A detailed medical history was obtained from the patients or parents during the first examination. Cataract surgery was planned after the primary sutures were removed, once a suitable period had passed for the inflammation to subside. All surgeries were performed by a single experienced surgeon (YO). Children younger than 2 years routinely underwent LA with posterior capsulotomy (PC) and anterior vitrectomy (AV), and a secondary intraocular lens (IOL) implantation was performed after 2 years of age. Posterior capsulotomy and anterior vitrectomy were always performed with LA in children aged 8 years or younger [7].

The demographic features of the children, age at the time of trauma, follow-up duration, type and cause of the trauma, surgical interventions, whether PC was performed with AV or not, IOL implantation time (primary or secondary), visual acuity, and complications were recorded.

All clinical examination steps including corrected distance visual acuity (CDVA) measurement, slit lamp biomicroscopy, intraocular pressure measurement with the Tono-Pen XL (Mentor Ophthalmics, Inc, Norwell, MA, USA), and fundus examination by indirect ophthalmoscopy (or B-scan ultrasonography) were performed at every follow-up examination. The approach to the cataract surgery, whether IOL implantation was performed or not, IOL type, and IOL position were noted. The IOL power was determined according to the SRK-T formula before surgery. The intended target refraction was approximately +3.0 diopters (D) for the 2–4 years age group, +2.0 D for the 4–6 years age group, +1.0 D for the 6–8 years age group, and a plano lens for children older than 8 years of age.

The patients were divided into three groups according to age: Group A, 0–5 years; Group B, 6–10 years; and Group C, 11–16 years. The zone of trauma was defined according to the Ocular Trauma Classification. The patients were accordingly classified as zone 1 (corneal), zone 2 (corneoscleral), or zone 3 (scleral) [8].

The CDVA was evaluated using the Snellen visual acuity chart and Lea symbols as appropriate. All measured visual acuities were converted into logMAR and recorded. The visual acuities were classified into four groups as suggested by Pieramici *et al.* [8]: Grade 1, 0.3 logMAR (Snellen equivalent 20/40) or better; Grade 2, 0.7 to 0.3 logMAR (20/40 to <20/100); Grade 3, 1.3 to 0.7 logMAR (20/400 to <20/100); and Grade 4, 1.3 logMAR to light perception (20/400 to <LP). The CDVA at the final follow-up and potential influencing factors were investigated. The ratio of those with a final visual acuity of 20/60 or better was also calculated so that we could compare the relevant results to other studies. The relationship between the injury type and the surgical procedure used, in addition to cataract surgery, was also examined in our statistical analyses.

The rates of amblyopia and strabismus and the optic rehabilitation options were also analyzed in the study group. Patients who had amblyopia were regularly followed-up with patching. Patching was prescribed starting at the second week after cataract surgery. Caregivers were instructed to have the child wear an adhesive occlusive patch over the fellow eye 1 h daily per month of age until the child was eight months old. Thereafter, caregivers were told to patch their child 50% of the waking hours, as suggested by the Infant Aphakia Treatment Study Group [9].

Statistical Analyses

Statistical analyses were performed with SPSS for Windows (version 22.0; IBM Corp., Armonk, NY, USA). The Mann–Whitney U-test and Kruskal–Wallis test were used for comparison of the independent predictors related to the final CDVA. The chi-square test was used to evaluate the relationship between categorical nominal variables, e.g., PCO and PC+AV, injury age range and amblyopia, and injury type and additional surgery. Correlation analyses were made between initial and final CDVA readings using Spearman's correlation coefficient test. A p-value of less than 0.05 was considered statistically significant.

Results

Data from 61 eyes of 59 patients were recorded to have undergone cataract surgery for traumatic cataract in the study period. Boys were the more commonly affected of all types of trauma. The age group with the highest rate of traumatic cataracts was Group B (6–10 years old). Demographic characteristics of patients are provided in Table 1. There was no significant effect with respect to sex ($p = 0.25$) or age range ($p = 0.89$) on final vision as shown in Table 2.

The cataract had developed due to penetrating trauma in 49 eyes (80.4%) and blunt trauma in 12 eyes (19.6%). There was no statistically significant effect regarding trauma type on the final CDVA ($p = 0.295$) (Table 2). The most common cause of trauma was penetrating injury with a sharp object (27.6) as shown in Figure 1. Only the lens was affected in 8 of 12 eyes with blunt trauma, whereas 4 eyes had trauma of other tissues besides the cataract. There was no statistically significant relationship between the cause of trauma and the final CDVA ($p = 0.601$) (Table 2).

The zone of traumatic injury was zone 1 in 31 eyes (50.8%), zone 2 in 13 eyes (21.3%), and zone 3 in 5 eyes (8.2%). The effects of the trauma site on CDVA were not statistically significant ($p = 0.065$) (Table 2).

Overall, 6 of the 61 eyes were followed up without cataract surgery, as the initial CDVA was better than 0.3 logMAR, and they were in an age group (10–15 years) with a low risk for amblyopia. Cataract surgery was performed on 55 eyes (90%). In children undergoing cataract surgery, the mean duration between the time of primary injury and cataract surgery was 9.7 ± 15.9 months (0.3–84 months; median, 3 months). There was no statistically significant correlation between this duration and the final CDVA ($r = -0.023$, $p = 0.878$) as shown in Figure 2.

Of the 55 eyes that underwent cataract surgery, 13 (23.6%) were treated with LA only; 42 (76.4%) eyes underwent PC+AV together with LA. Posterior capsule opacification (PCO) was seen during follow-up in all (100%) of the 13 cases that had undergone LA without PC+AV and all of these patients underwent YAG laser capsulotomy. There was a statistically significant relationship between not performing PC+AV and PCO development ($p = 0.001$). The final CDVA was significantly better in eyes that had undergone PC+AV, compared to those that had not, and the results were significant ($p = 0.048$)(Table 2).

Of the 55 eyes that underwent cataract surgery and 5 eyes (9.1%) of three patients were followed-up as aphakic. A visual acuity of 0.4 logMAR or above was achieved in these five eyes, using aphakic glasses in three eyes (aphakic glasses were needed in one eye because of high myopia) and aphakic contact lenses in two eyes. We did not find any statistically significant relationship between the time of implantation (whether primary or secondary) and the final CDVA ($p = 0.513$)(Table 2). The IOL was placed into the bag in 19 and into the sulcus in 21 of the 50 eyes; IOL implantation with trans-scleral fixation (TSF) was performed in 10 eyes due to insufficient posterior capsule support. The mean age of these patients was 6.7 years (range, 4–9 years). Six of these cases were sutureless and four had trans-scleral fixation sutures using a three-piece foldable hydrophobic acrylic IOL. The type of IOL implanted was the three-piece foldable hydrophobic acrylic in 31 eyes (62%) and the single-piece foldable hydrophobic acrylic IOL in 19 eyes (38%). The IOL implantation location ($p = 0.335$) and IOL type ($p = 0.467$) also had no statistically significant effect on the final CDVA. A statistically significant relationship was found between the type of trauma (blunt or penetrating) and the additional surgical interventions used ($p = 0.001$). Anterior segment interventions such as membranectomy and pupilloplasty were required more often in penetrating cases, whereas retinal surgery was required more frequently for blunt injuries.

The initial CDVA was 0.7 logMAR or better in 8 (16.1%) of the 49 patients with a pretreatment visual acuity measurement and in 38 (69.1%) patients at the final follow-up after treatment. Those with a final visual acuity of 20/60 (0.5 logMAR) or better made up 61.1% of the group. The mean CDVA increased from 1.8 ± 0.42 logMAR before treatment to 0.61 ± 0.56 logMAR after treatment, and the percentage of those seeing between \geq LP to 1.3 decreased from 83.6% to 3.6% during the same period (Table 3). Spearman rank correlation analyses showed no significant correlation between the initial visual acuity and the final visual acuity ($r = 0.132$, $p = 0.365$)(Figure 2).

Amblyopia was present in 34 (57.6%) patients and strabismus was observed in 13 (22%) patients. Amblyopia was found in 83.3% of those with strabismus. A statistically significant relationship was found between the age range at injury and the presence of amblyopia ($p = 0.001$) (Table 4), whereas no such relationship was evident with the presence of strabismus ($p = 0.162$). A comparison of the final CDVA in patients with and without strabismus also did not show any statistically significant relationship between strabismus and final vision ($p = 0.067$).

Postoperative optic rehabilitation was provided with glasses in 49 patients and contact lenses in 5 patients (2 for aphakia and 3 for refractive correction), while 1 case did not need optic rehabilitation. Patients who had amblyopia were regularly followed-up with patching.

Complication analyses revealed that the most common finding was pupil irregularity in 23 eyes (41.8%). Anterior and/or posterior synechiae were present in 12 eyes (21.8%), membrane formation in 11 eyes (20%), high intraocular pressure that could be controlled with medical treatment in 4 eyes (7.2%), and retinal detachment (RD) in 4 eyes (7.2%) (3 secondary to blunt trauma and 1 to penetrating trauma). All RD patients underwent vitreoretinal surgery. One patient with RD was mentally retarded and had suffered bilateral RD due to blunt trauma. This patient developed RD bilaterally again, due to recurrent trauma after the surgery. Degenerative myopia was present in the other patient that developed RD. Penetrating keratoplasty was performed in three eyes (5.45%) that had a large corneal scar developing secondary to penetrating trauma. There was also IOL decentralization in two eyes (3.63%), intravitreal hemorrhage in one eye (1.81%), and iris atrophy in one eye (1.81%).

Discussion

Pediatric traumatic cataracts can result in amblyopia and strabismus by disturbing binocular vision, possibly resulting in lifelong poor vision if not treated properly. Many studies have attempted to determine which factors have the most influence on final vision; however, some uncertainties still exist [5,6,10].

Analyses of the demographic features that influence traumatic cataract development and the results of treatment show that traumatic cataracts are more common in boys than in girls [6,10-12]. Similarly, 71.2% of the patients in our study were male. This may be due to boys being more prone to experiencing trauma due to their activity level and tendencies toward outdoor play [11]. Injury was most common between the ages of 6 and 10 years, i.e., during the active play and school period, as reported by other studies [12,13]. A statistically significant relationship between the age range and final visual acuity was not found in this study, in line with previous reports [11,14,15]. However, some studies have reported age and sex as significant variables with respect to the final visual acuity [11,13].

As previously reported, penetrating trauma was more common than blunt trauma in our study [4,13,16,17]. By contrast, Shah *et al.* indicated that blunt trauma was more common than penetrating trauma [18]. Some studies that have investigated the effects of trauma type on the final visual acuity have revealed that blunt traumas have a better prognosis than penetrating traumas [10,14,17-19]. A statistically significant relationship was not found between the type of trauma and the final visual acuity in the current study, similar to two previous studies [4,16]. With both trauma types, the presence of ocular pathologies besides cataracts, as well as other factors that could influence the final vision, may explain the different results reported in various studies.

Although the causes of ocular trauma vary globally due to different socioeconomic conditions and lifestyles, the most common cause of traumatic cataracts in our study was injury with a sharp object, similar to previous works [20-23]. We did not find a statistically significant effect of the cause of trauma on the final CDVA, as in Shah *et al.* [13].

The most commonly involved area in our study was zone 1 (corneal) as in many pediatric trauma series [20-22,24]. Although zone 3 injuries may indicate a poor prognosis [24,25], we did not find a statistically significant effect of the injury site on final visual acuity. The reason for this could be the prompt primary repair of the injury to prevent complications and early interventions for any complications that might develop afterwards in our clinic. The low number of zone 2 and zone 3 injuries may also support our results.

The mean duration between the time of primary injury and cataract surgery was 9.7 ± 15.9 months (median, 3 months), and there was no statistically significant relationship between the time from the trauma to cataract surgery and the final CDVA, in accordance with previous studies [10,13,22]. PCO is more common in pediatric traumatic cataracts, which have more significant inflammation than in non-traumatic cataracts [26,27]. We observed PCO in all of the 13 cases over 9 years of age that did not undergo PC+AV, as in a previous study [15]. According to statistical analyses, the final CDVA was significantly better in patients that had undergone PC+AV compared to those that did not undergo this procedure [5,16,19]. Therefore, the use of posterior capsulotomy and anterior vitrectomy for traumatic pediatric cataract surgery will help to avoid a high postoperative PCO rate (100% in our cases) and the complications that could develop due to YAG capsulotomy or surgical interventions to treat PCO in older children as well.

Another factor that could influence visual prognosis in pediatric traumatic cataracts is the time of IOL implantation. Many authors have reported the comparative advantages of primary or secondary IOL implantation [28-30]. The IOL implantation was primary in 70.9% and secondary in 20%, whereas no IOL was used in the remaining 9.1% in this study. The time of IOL implantation had no statistically significant effect on the final CDVA. Similarly, Rumelt *et al.* did not find a statistically significant relationship between the time of implantation and a good CDVA [31]. The time of IOL implantation can be determined according to the child's age and the degree of trauma. Good visual acuity may be obtained with proper indication, regular follow-up, and appropriate optic rehabilitation. The time of IOL implantation by itself may not be a statistically significant variable for final vision in this aspect. The IOL type and the IOL insertion location during surgery differed according to the location and type of trauma and the capsular and zonular integrity of the lens. A statistically significant effect of whether the IOL was placed into the sulcus or the capsular bag on the final CDVA was not found in this study, as in a previous series [32].

The ratio of children with a visual acuity of 20/60 or better following traumatic cataract has been reported to be 46.1% and 64.7% [11,29]. The ratio of those with a final visual acuity of 20/60 (0.5 logMAR) or better was 61.1% in this series and a statistically significant correlation was not observed between the initial visual acuity and the final visual acuity. This result differs from those of many studies that consider the initial visual acuity in traumatic pediatric cataracts as a prognostic factor for the final visual acuity [3,10,24,33]. We believe that this result was influenced by our study being based on data obtained over a 10-year period, the complications seen during follow-up being managed promptly and correctly, amblyopia being prevented as much as possible, and the follow-ups being performed by the same ophthalmologist over many years. Gogate *et al.* [11] and Jinagal *et al.* [16] also did not find a

significant correlation between preoperative vision and final vision in their studies covering a long time period.

Optic rehabilitation and amblyopia treatment must be started as soon as possible with regular follow-up and the close cooperation of the family in the pediatric age group with a traumatic cataract where an amblyopia risk exists. The presence of amblyopia and the success of treatment are important factors regarding the visual prognosis in these children [1,3,16,31]. We believe that the results were better with appropriate optic rehabilitation, effective patching, and close follow-up for amblyopic eyes observed in this study. The lack of a statistically significant relationship between the presence of strabismus and both the age group and final vision could be related to the development of binocular vision before the trauma in most patients [34].

The limitations of this study were its retrospective nature and the relatively high rate of complicated cases in the series, as it was conducted at a tertiary referral center. A strong aspect is that the medical and surgical treatment and the follow-up of children who presented with ocular trauma over a 10-year period were conducted at a single center and by the same physician from the time of their first presentation. Standardization of the data obtained was ensured in this manner and the reliability was increased.

In this study, good visual results were achieved, regardless of the child's age, sex, initial visual acuity, type, cause and zone of injury, and the time of IOL implantation by the authors' 10-year experience with pediatric traumatic cataracts. This result is different from the literature, in that it is both a long-term experience and reveals that visual acuity is not affected by any factors other than PC+AV in pediatric traumatic cataracts.

In conclusion, satisfactory visual outcomes in the majority of children can be achieved using PC+AV combined with LA with or without IOL implantation, along with prompt initiation and maintenance of regular amblyopia treatment.

Declarations

Ethics approval and consent to participate

The Institutional Review Board and Ethics Committee of Dr. Lutfi Kirdar Kartal City Hospital Department of Ophthalmology, University of Health Sciences Istanbul approved the initiation of the study (IRB No: 2020/514/169/7). Informed written consent was obtained statement from parents/guardians of all participants.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analysed during this study are included in this published article [and its supplementary information files].

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

NTG designed the study, collected data and wrote the manuscript. AYO performed the data analysis and revised the manuscript; NTG performed the statistical analysis. Both of the authors

contributed to this study read and approved the final manuscript.

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- This study was performed in the Dr.Lütfi Kırdar Kartal City Hospital Department of Ophthalmology, University of Health Sciences, Istanbul, 34100 Turkey.

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Tables

Table 1: Patient demographics

Variables		Mean±SD	Min-max
Injury age (years)		7.2±3.9	0-15
Follow-up duration (years)		3.2±2.1	1-9
		<i>n</i>	%
Gender	Female	17	28.8
	Male	42	71.2
	Total	59	100
Age groups (years)	6-10	29	49.2
	0-5	19	32.2
	11-16	11	18.6
	Total	59	100
Eye	Right	30	49.2
	Left	31	50.8
	Total	61	100

Table 2: Factors affecting visual acuity after traumatic cataract surgery.

CDVA: Corrected distance visual acuity, **LA:** Lens aspiration, **AV:** Anterior vitrectomy, **PPC:** Primary posterior vitrectomy, **PCIOL:** Posterior chamber intra-ocular lens, **TSF:** Transscleral fixated

	Final CDVA (logMAR)			Final Corec
	n	Mean±SD	Median (Min-Max)	p
Sex (n:59)				0.258
Female	17	0,84 ± 0,68	0,5 (0,22 -2)	
Male	42	0,6 ± 0,5	0,4 (0 -2)	
Age at injury range (n:59)				0.896
0-5 years	19	0,69 ± 0,53	0,5 (0 -2)	
6-10 years	29	0,68 ± 0,61	0,4 (0 -2)	
11-16 years	11	0,59 ± 0,48	0,5 (0 -1,3)	
Cause of truma (n:61)				0.601
Glass	11	0,57 ± 0,32	0,45 (0,22 -1,3)	
Sharp metals	17	0,36 ± 0,13	0,36 (0 - 0,4)	
Wooden objects	12	0,51 ± 0,34	0,45 (0 -1,3)	
Stones	2	0,5 ± 0,42	0,5 (0,2 -0,8)	
Firecracker	3	1,03 ± 0,87	0,8 (0,3 -2)	
Fingernail	2	0,58 ± 0,29	0,5 (0,4- 0,6)	
Blunt trauma	12	0,44 ± 0,41	0,26 (0 -1,3)	
Not known	2	1 ± 0	1 (1 -1)	
Type of injury (n:61)				0.295
Open globe	49	0,69 ± 0,55	0,45 (0 -2)	
Closed globe	12	0,58 ± 0,61	0,3 (0 -2)	
Zone of injury (n:61)				0.065

Zon 1	31	0,62 ± 0,56	0,4 (0 -2)	
Zon 2	13	0,9 ± 0,59	0,7 (0,3 -2)	
Zon 3	5	0,49 ± 0,45	0,3 (0 -1,3)	
Type of surgery (n:55)				0.124
LA	13	0,37 ± 0,36	0,31 (0 -1)	
LA+ PCIOL	26	0,66 ± 0,58	0,4 (0 -2)	
LA + PPV	5	0,86 ± 0,66	0,7 (0,4 -2)	
LA+membranectomy+pupilloplasty	11	1,03 ± 0,59	1,15 (0,22 -2)	
LA+AV (n:55)				0.048
Performed	42	0,59 ± 0,46	0,4 (0 -2)	
Not performed	13	0,77 ± 0,63	0,5 (0,2 -2)	
Time of IOL implantation (n:55)				0.513
				0.513
Aphakia	5	0,52 ± 0,59	0,22 (0 -1,3)	
Primer	39	0,72 ± 0,57	0,5 (0 -2)	
Secunder	11	0,76 ± 0,72	0,4 (0,22 -2)	
IOL implantation location (n:55)				0.335
				0.335
Aphakia	5	0,52 ± 0,59	0,22 (0 -1,3)	
Bag	19	0,56 ± 0,45	0,4 (0 - 1,3)	
Sulcus	21	0,83 ± 0,61	0,7(0,22 -2)	
TSF	10	0,9 ± 0,79	0,4 (0,2 -2)	
IOL type (n:50)				0.467
				0.467
Single - piece Foldable IOL	31	0,58 ± 0,41	0,5 (0 - 1,3)	
Three - piece Foldable IOL	19	0,88 ± 0,67	0,8 (0,22 -2)	

Table 3: Initial vs. final Corrected Distance Visual Acuity (CDVA)

		Mean±SD	Min-max
Initial CDVA		1.8±0.4	0.4-2
Final CDVA		0.63±0.56	0-2
		<i>n</i>	%
CDVA (initial)	0.7 to < 0.3 (20/100 to < 20/40)	3	5.9
	1.3 to < 0.7 (20/400 to < 20/100)	5	10.2
	≥LP to 1.3 (LP to < 20/400)	41	83.6
	Total	49	100
	CDVA (final)	> 0.3 (20/40)	20
	0.7 to < 0.3 (20/100 to < 20/40)	18	32.7
	1.3 to < 0.7 (20/400 to < 20/100)	15	27.3
	≥LP to 1.3 (LP to < 20/400)	2	3.6
	Total	55	100.0

Table 4: Relationship between the injury age range and amblyopia presence.

		Amblyopia presence				
		Count	Column N %	Count	Column N %	p
Injury age range	0-5 years	13	38.2%	4	17.4%	0.001
	6-10 years	20	58.8%	9	39.1%	0.001
	11-16 years	1	2.9%	10	43.5%	reference

Figures

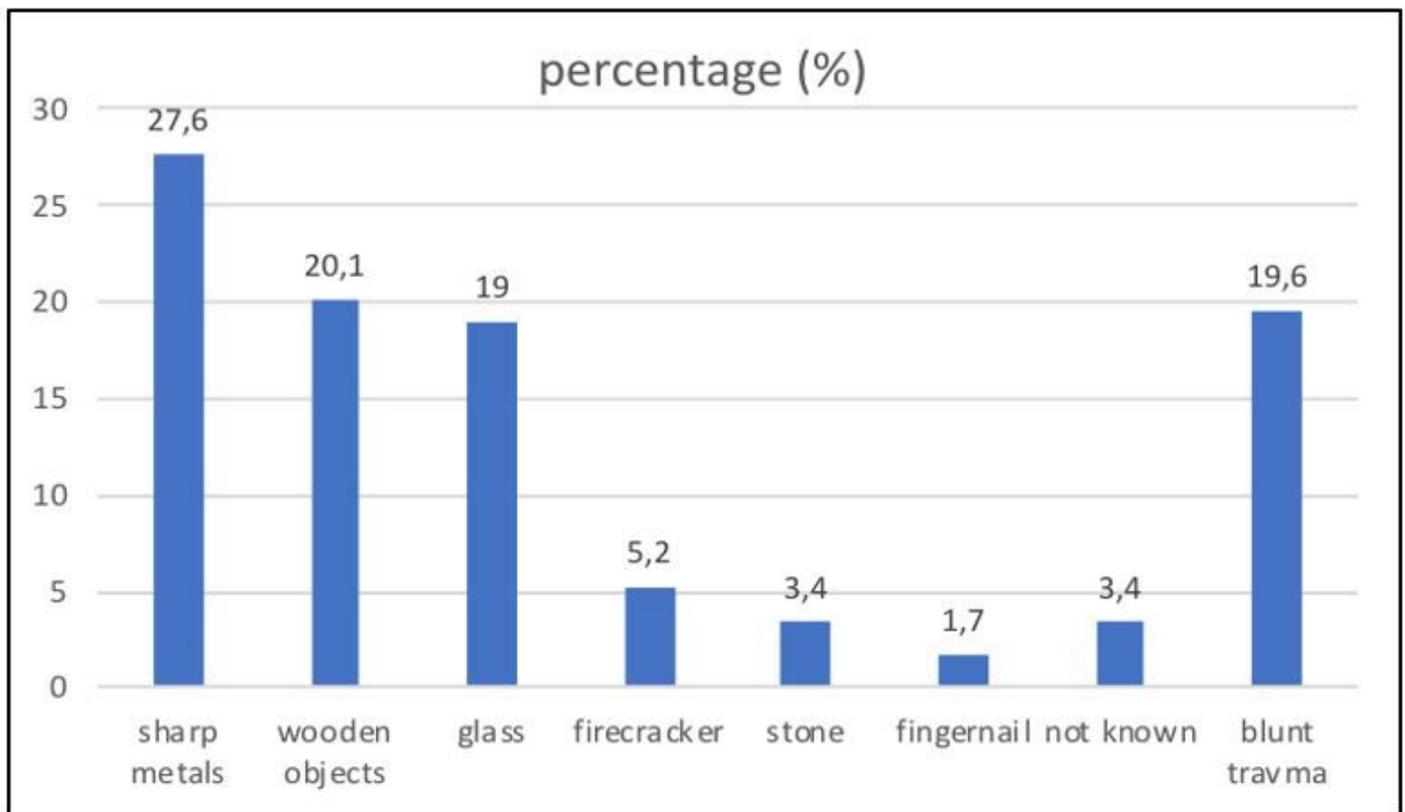


Figure 1

Causes of ocular trauma

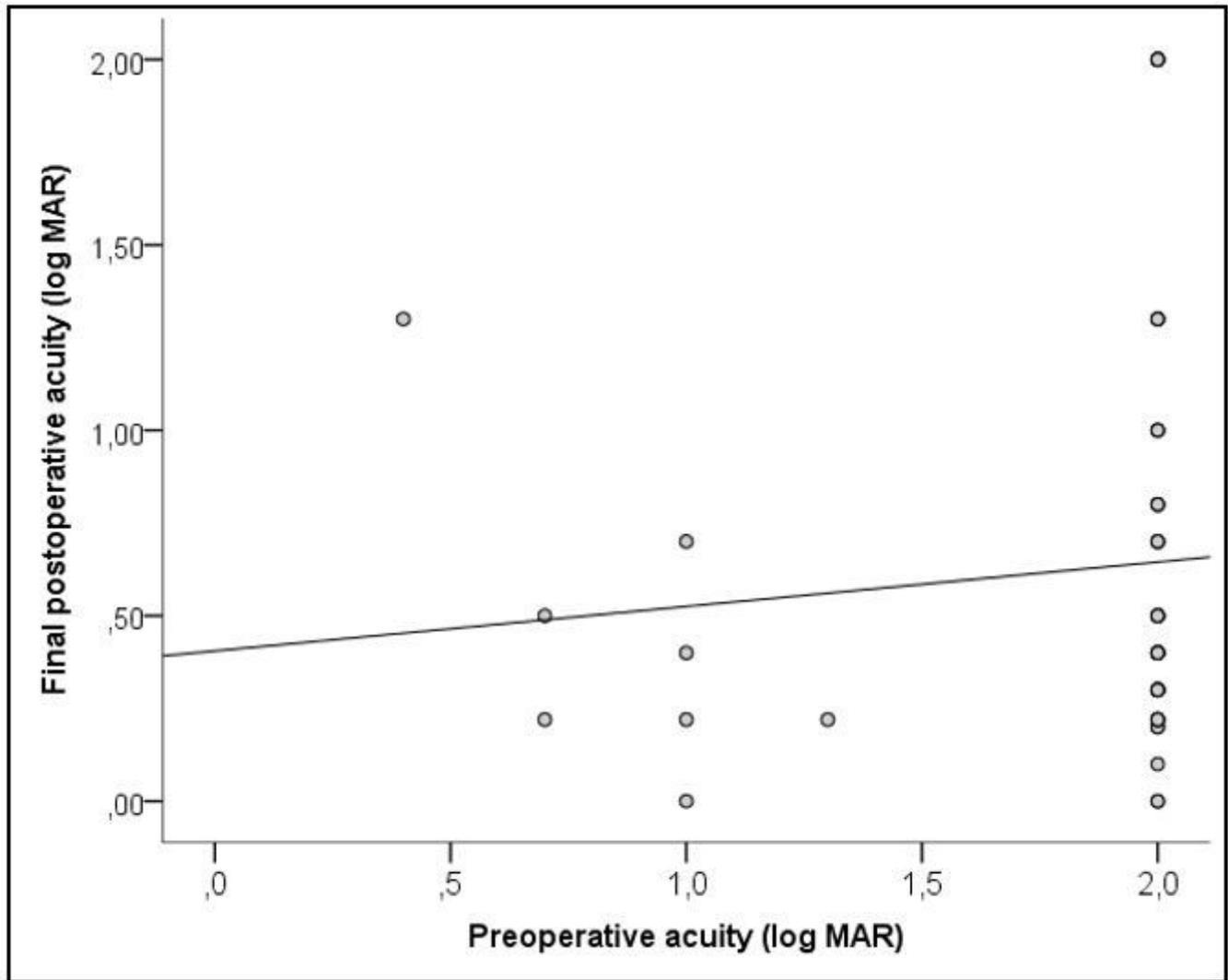


Figure 2

Spearman rank Correlation Analysis between the initial and the final visual acuity ($r=0.132$, $P=0.365$)

Supplementary Files

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