ARTICLE

Ocular Trauma Score as a predictor of final visual outcomes in traumatic cataract cases in pediatric patients

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PURPOSE: To validate the predictive value of the Ocular Trauma Score (OTS) in children with traumatic cataract.

DESIGN: Retrospective cohort study.

SETTING: Tertiary eye care center at nexus of Gujarat, Madhya Pradesh, and Rajasthan states, central Western India.

METHODS: After meeting inclusion criteria, eyes with traumatic cataract were enrolled and examined to review comorbidities caused by trauma. Surgery was performed for traumatic cataract, intraocular lenses were implanted, and patients were treated for amblyopia, as applicable. Patients were reexamined 6 weeks postoperatively. Based on ocular trauma described according to the Birmingham Eye Trauma Terminology System, the patients were divided into 2 traumatic cataract groups: open-globe injury and closed-globe injury. The relationship between final corrected distance visual acuity (CDVA) and demographic and clinical variables was analyzed. Visual outcomes were predicted using the OTS, and the predictions were compared with actual outcomes using statistical tests.

RESULTS: The study enrolled 354 children. Six weeks postoperatively, the CDVA was better than 20/200 in 181 eyes (63.0%) and 20/40 or better in 110 eyes (38.4%) in the open-globe group and better than 20/200 in 36 eyes (53%) and 20/40 or better in 15 eyes (22.4%) in the closed-globe group. The differences between the groups were not significant ($P = .143$). Of all eyes, 214 (61.3%) achieved a final CDVA of better than 20/200 and 123 eyes (35.3%), of 20/40 or better.

CONCLUSION: The OTS was a reliable predictor of the final visual outcome in cases of pediatric traumatic cataract.

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Trauma is a major cause of monocular blindness in the developed world, although few studies have addressed the problem of trauma in rural areas.[1] The etiology of ocular injury is likely to differ between urban areas and rural areas and is worthy of investigation.[2–4] The development of strategies to prevent injuries requires knowledge of the causes. In eye injuries, the victims, especially children in whom ocular injury has a poor prognosis, and society bear a large, potentially preventable burden.[3] More appropriate targeting of resources toward preventing eye injuries may reduce this burden.

One consequence of ocular trauma is cataract formation.[1] Methods for evaluating visual outcomes in eyes with cataract due to trauma or other causes have been established[5]; however, damage to surrounding ocular tissues may compromise the visual gain in eyes after surgery for traumatic cataract. Hence, the success rate may differ between eyes with traumatic cataract and eyes with nontraumatic cataract. Traumatic cataracts often lead to poor visual outcomes in children as a result of amblyopia and recurrent inflammation.

The introduction of the Birmingham Eye Trauma Terminology System (BETTS) has led to standardized

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definitions of ocular trauma,[5] making it possible to compare visual outcomes after surgery for traumatic cataract and to understand the determinants in predicting the outcomes. Studies[6,7] have reported visual outcomes of traumatic cataract; however, most had small samples or were case studies. Gradin et al.[6] and Morgan et al.[7] report a patient series, focusing on the primary management of traumatic cataract and perforating injuries.

Various models, including the Ocular Trauma Score (OTS) and the Classification and Regression Tree (CART), have been proposed for predicting the visual outcome based on an initial examination. Although both models have been shown to be effective in the general population, few studies have tried to validate prognostic models in children, and these report variable results. It is important to validate predictive methods in a larger patient series.

We assessed the value of the OTS for predicting visual outcomes after surgery in children with traumatic cataract. Our study was performed in a city located at the nexus of 3 states, Gujarat, Madhya Pradesh, and Rajasthan, in central Western India. Qualified ophthalmologists at our institute provide low-cost eye services, mainly to the poor among the tribal populations of 4.2 million people in the area.

PATIENTS AND METHODS

Approval for this study was obtained from the hospital administrators and a research committee. Written consent was obtained from the participants.

The study had a retrospective design. All patients were children (0 to 18 years old) who had been diagnosed with traumatic cataract in either eye between January 2003 and December 2009. Patients who had no other serious bodily injuries and who gave consent were enrolled. Historical medical data were retrieved from medical records and were collected using a pretested online form.

For each patient enrolled in the study, a detailed history of the injury as well as the treatment and surgery performed to manage the ocular trauma were obtained. Data for the initial and follow-up reports were collected using the online BETTS format of the International Society of Ocular Trauma (ISOT).[A] Details of the surgery were also collected using a pretested online form.

The cases of traumatic cataract were divided into 2 groups: open-globe injury and closed-globe injury. Open-globe injuries were further categorized into laceration and rupture groups. Lacerations of the globe were subcategorized as perforating injury, penetrating injury, and injury involving an intraocular foreign body. The closed-globe group was divided into lamellar laceration and contusion groups.

Demographic details included patient characteristics, residence, activity at the time of injury, cause of injury, and previous examinations and treatments. After enrollment, all patients were examined using a standard method. Visual acuity was checked according to age using the guidelines of the American Academy of Ophthalmology (AAO). The anterior segment was examined using a slitlamp.

Cataracts were classified based on lenticular opacity. Cataracts with no clear lens matter between the capsule and nucleus were classified as total. Those in which the capsule and organized matter were fused to form a membrane of varying density were classified as membranous. When loose cortical material was observed in the anterior chamber together with a ruptured lens capsule, the cataract was classified as white soft with ruptured capsule. Rosette-type cataracts were those in which the lens had a rosette pattern of opacity. All cataract cases fit within this classification. The morphology was influenced mainly by the type, force, and cause of injury and the time between injury and examination.

For a partially opaque lens, a posterior segment examination was performed with an indirect ophthalmoscope and a +20.0 diopter (D) lens. When the optical medium was not clear, a B-scan ultrasound was performed to evaluate the posterior segment.

The surgical technique was selected according to the morphology and the condition of the surrounding tissues other than the lens. Extraction of cataracts with a hard large nucleus was by phacoemulsification. Unimanual or bimanual aspiration was used for a lens with a white soft or rosette cataract. Membranectomy and anterior vitrectomy using an anterior or pars plana approach were performed for membranous cataracts.

In patients having corneal wound repair, the traumatic cataract was managed using a second procedure. Recurrent inflammation was more prominent in patients who had previous surgery for trauma.[8,9] When the ocular medium appeared hazy due to inflammation of the anterior vitreous, a capsulectomy and vitrectomy were performed via an anterior–pars plana route.

In children younger than 2 years, a lensectomy and vitrectomy were performed via the pars plana route, leaving a rim of the anterior capsule for the secondary intraocular lens (IOL). The same surgical procedures were used to manage traumatic cataracts. Intraocular lens implantation as part of the primary procedure was avoided in all children younger than 2 years; these children were rehabilitated with optical correction, and secondary IOL implantation was performed after 2 years. All children were treated by a qualified pediatric orthoptist for supportive amblyopia therapy and by a pediatric ophthalmologist for strabismus therapy.

All patients with injuries and without infection were treated with topical and systemic corticosteroid and cycloplegic agents. The duration of medical treatment depended on the degree of inflammation in the anterior and posterior segments of the operated eye. Postoperatively, patients were reexamined after 24 hours, 3 days, and 1, 2, and 6 weeks to enable refractive correction. Follow-up was scheduled for 3 days, weekly for 6 weeks, monthly for 3 months, and then every 3 months for 1 year.

At every follow-up examination, visual acuity was tested according to age using the AAO guidelines. The anterior

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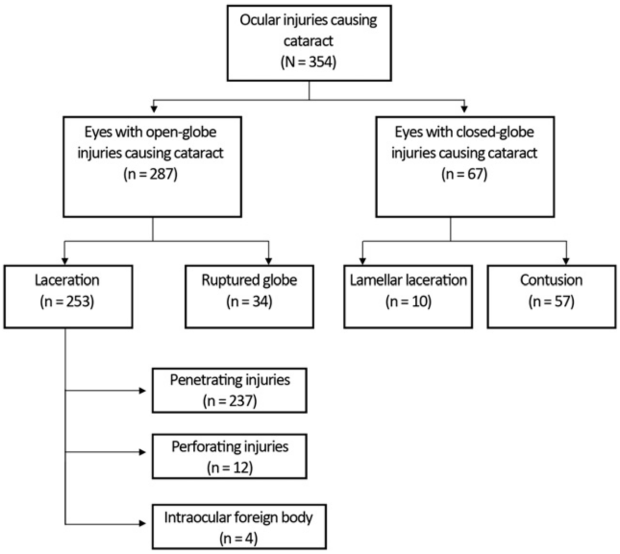

Figure 1. Distribution of cataracts based on ocular injury according to the BETTS classification.

segment was examined with a slitlamp, and the posterior segment was examined with an indirect ophthalmoscope. Eyes with corrected distance visual acuity (CDVA) better than 20/60 at the 6-week follow-up were defined as having a satisfactory grade of vision.

The posttreatment visual outcome was predicted from the OTS by calculating the raw score based on the presenting vision and condition. This prediction was compared with the actual visual outcome using statistical analysis.

During the examination, data were entered online using a pretested format designed by ISOT (initial and follow-up forms) and exported into an Excel spreadsheet (Microsoft Corp.). Data were audited periodically to ensure complete data collection. SPSS software (version 17, SPSS, Inc.) was used to analyze the data. Descriptive statistics and cross-tabulation were used to compare the cause and effect of different variables. The dependent variable was CDVA better than 20/60 at the 6-week follow-up after cataract surgery. The independent variables were age, sex, residence, time between injury and cataract surgery, primary posterior capsulectomy and vitrectomy procedure, and type of ocular injury. All variables were analyzed in the open-globe group and the closed-globe group and were also compared between the 2 groups.

RESULTS

The enrolled patient group consisted of 354 patients with traumatic cataract (Figure 1). The mean age of the 252 boys (71.1%) and 102 girls (28.8%) was 10.6 years ± 4.3 (SD) (Table 1). Of the eyes, 287 (82.6%) had open-globe ocular injuries and 67 (17.3%) had closed-globe injuries. According to cross tabulation and statistical analysis, the demographic factors analyzed, including socioeconomic status (264 [74.5%] were of lower socioeconomic status) and residence (327 [92%] were from rural areas), had no significant relationship to final visual acuity.

Table 1. Age and sex distribution of the patients.

Age (Y)	Sex (n) Female	Male
0 to 2	2	2
3 to 5	12	33
6 to 10	44	88
11 to 18	44	129

Table 2. Interval between injury and intervention.

Days	Frequency (n)	Percentage
0 to 2	109	30.8
3 to 7	47	13.3
8 to 30	78	22.0
Longer	120	33.9

With regard to patient entry, 33 patients (9.2%) had received primary treatment before reaching the center, and this was associated with a significant difference in the final visual outcome ($P = .02$). Of the total patients enrolled, 103 (26.4%) entered via an outreach department and 251 (71%) were self-referred.

Of the injuries, 106 (30%) were reported within the first 24 hours, 106 (30%) were reported within 3 days, and 120 (33.9%) were reported within 1 month (Table 2). Table 3 shows the object causing the eye injury. A wooden stick was the most common cause. Neither the injury-causing object (Table 3) nor the activity at the time of injury (Table 4) was significantly associated with the final visual acuity (both $P = .3$).

The improvement in CDVA from preoperatively to postoperatively was statistically significant ($P = .000$, Pearson's chi-square and analysis of variance) (Table 5). An IOL was implanted in 219 cases

Table 3. Object causing eye injury.

Object	Frequency (n)	Percentage
Ball	5	1.4
Cattle horn	6	1.7
Cattle tail	1	0.3
Chemical	2	0.6
Firecrackers	10	2.8
Electricity	3	0.8
Finger	3	0.8
Glass	4	1.1
Other	26	7.3
Sharp object	31	8.8
Stone	38	10.7
Thorn	12	3.4
Unknown	31	8.8
Wooden stick	182	51.4

Table 4. Activity at time of injury.

Activity	Frequency (n)	Percentage
Firecrackers	10	2.8
Fall	6	1.7
Housework	58	16.4
Employment	20	5.6
Other	45	12.7
Walking	4	1.1
Playing	195	55.1
Travel	12	3.4
Unknown	4	1.1

(80.2%). Aspiration was performed using 1 or 2 ports in 172 patients (48.6%) in the open-globe group and was significantly associated with improved visual acuity ($P = .000$).

A comparison of these variables among the open-globe subgroup and closed-globe subgroup found no significant differences in the subcategories of traumatic cataract caused by penetrating injuries ($P = .002$).

Six weeks after surgery, the CDVA in the open-globe group was better than 20/200 in 181 eyes (63.0%) and 20/40 or better in 110 eyes (38.4%). In the closed-globe group, the CDVA was better than 20/200 in 36 eyes (53%) and 20/40 or better in 15 eyes (22.4%). The difference between the groups was not significant ($P = .143$). In total, 123 eyes (35.3%) had a final visual acuity of 20/40 or better and 214 eyes (61.3%) had a final visual acuity better than 20/200 (Tables 5 and 6).

An IOL was implanted in 290 cases (82%), and 106 cases (30%) required more than 1 operation. The mean follow-up was 71.8 days (range 45 to 1076 days). An overall significant difference in final CDVA was observed between the OTS groups ($P = .000$) (Table 7).

Table 5. Comparison of preoperative and postoperative CDVA.*

	Preop CDVA					
Postop CDVA	UC	NLP	HM to LP	1/200 to 19/200	20/200 to 20/50	≥20/40
UC	7	0	1	0	0	0
NLP	0	8	2	0	0	0
HM to LP	0	4	48	1	0	0
1/200 to 19/200	0	1	48	16	0	1
20/200 to 20/50	1	3	64	22	4	0
≥20/40	2	0	83	32	6	0

CDVA = corrected distance visual acuity; HM = hand movement; LP = light perception; NLP = no light perception; UC = uncooperative
*Values are number of cases.

Figures 2 to 5 show the final CDVA according to the OTS predictions in children with traumatic cataract (OTS 1, $P = .265$; OTS 2, $P = .22$; OTS 3, $P = .22$; OTS 4, $P = .172$).

DISCUSSION

Visual gain after surgery for traumatic cataract is a complex issue. Electrophysiological[9] and radio imaging[10–12] studies are important tools for assessing comorbidities associated with an opaque lens.

In the present study, a satisfactory grade of vision after the management of traumatic cataracts was achieved significantly more often after open-globe injuries than after closed-globe injuries. Many studies document visual outcomes in children with traumatic cataract. Shah et al.[4] report that 56% of patients obtained a CDVA of better than 20/60, Krishnamachary et al.[12] found a CDVA of better than 20/60 in 74% of cases, and Kumar et al.[13] of better than 6/18 in 50% of cases. Staffieri et al.[14] report a CDVA of better than

Table 6. Visual outcome according to type of injury.

	Type of Injury	
CDVA	Closed Globe	Open Globe
UC	3	5
NLP	3	7
HM to LP	10	43
1/200 to 19/200	15	51
20/200 to 20/50	21	73
≥20/40	15	108

CDVA = corrected distance visual acuity; HM = hand movement; LP = light perception; NLP = no light perception; UC = uncooperative

Table 7. Comparison of OTS.*

	OTS				
Final CDVA	1	2	3	4	5
UC	1	1	5	0	0
NLP	3	7	0	0	0
HM to PL	1	14	38	0	0
1/200 to 19/200	0	8	59	0	0
20/200 to 20/50	0	21	71	2	0
≥20/40	0	5	115	2	1

CDVA = corrected distance visual acuity; HM = hand movement; LP = light perception; NLP = no light perception; OTS = Ocular Trauma Score; UC = uncooperative
*Values are number of cases.

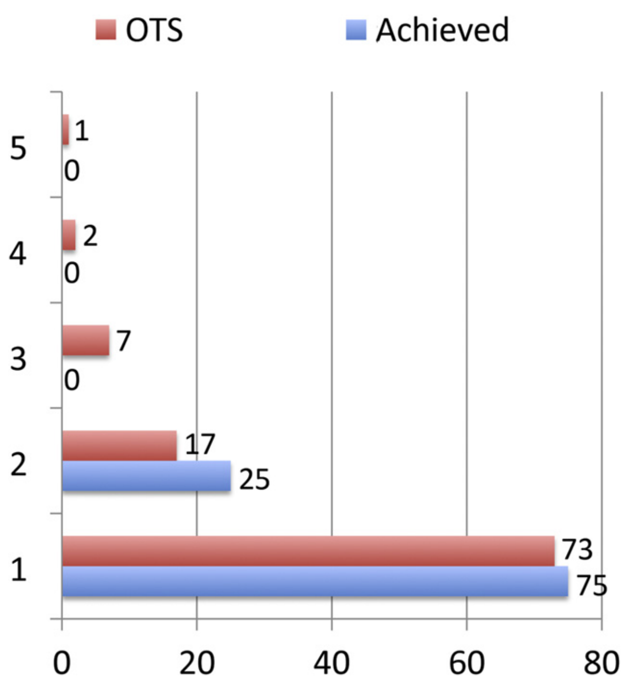

Figure 2. Comparison of OTS and achieved results in OTS-1 score category; percentage of cases (1 = 0; 2 = 0; 3 = 0; 4 = 3; 5 = 1; OTS = Ocular Trauma Score).

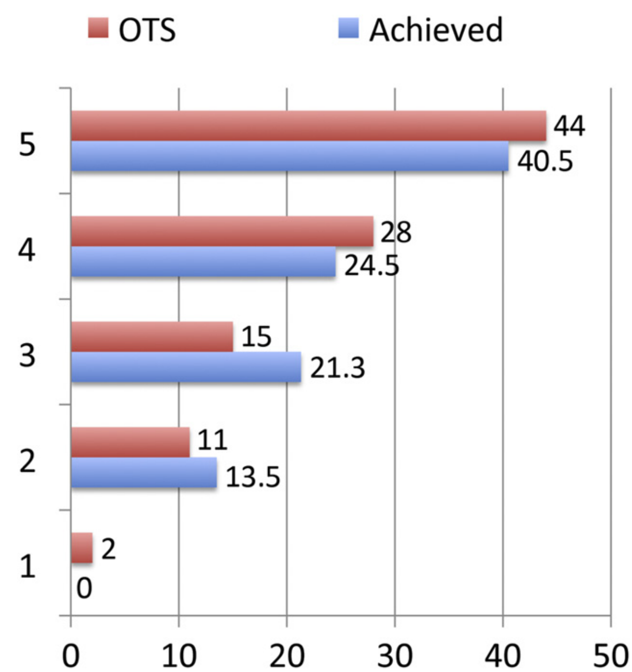

Figure 3. Comparison of OTS and achieved results in OTS-2 score category; percentage of cases (1 = 2; 2 = 19; 3 = 7; 4 = 13; 5 = 8; OTS = Ocular Trauma Score).

6/12 in 35% of cases, Bekibele and Fasina[15] of better than 6/18 in 35.6% of cases, and Gradin and Yorston[6] of better than 20/60 in 64.7% of cases. Brar et al.[16] report a CDVA of better than 0.2 in 62% of cases, Cheema and Lukaris[17] of better than 6/18 in 68% of cases, Karim et al.[18] of better than 0.2 in 62% of cases, and Knight-Nanan et al.[19] of better than 20/60 in 64% of cases. Bienfait et al.[20] found a CDVA of

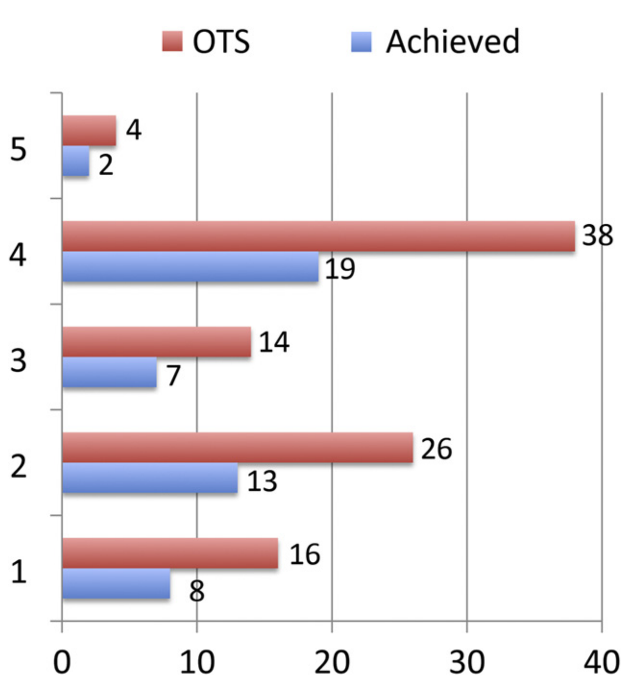

Figure 4. Comparison of OTS and achieved results in OTS-3 score category; percentage of cases (1 = 143; 2 = 87; 3 = 75; 4 = 48; 5 = 0; OTS = Ocular Trauma Score).

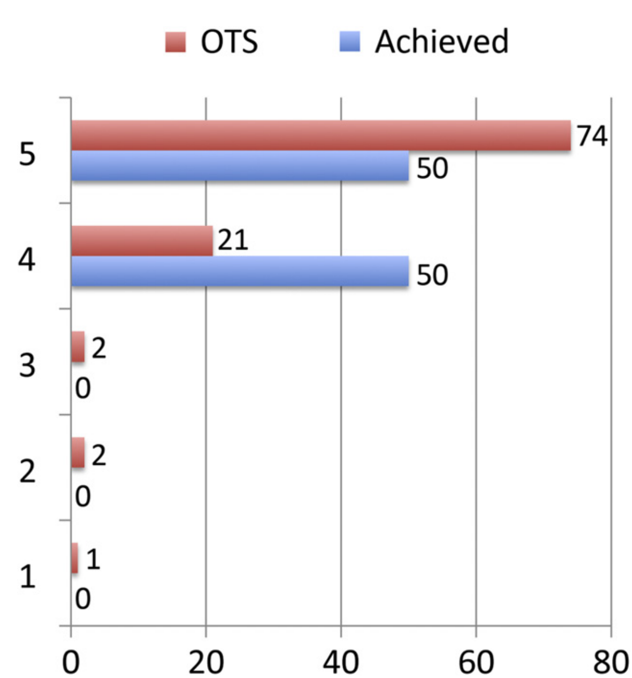

Figure 5. Comparison of OTS and achieved results in OTS-4 score category; percentage of cases (1 = 0; 2 = 0; 3 = 0; 4 = 177; 5 = 177; OTS = Ocular Trauma Score).

better than 0.7 in 27% of cases. Anwar et al.[21] report a CDVA of better than 20/40 in 73% of cases. Verma et al.[22] report the visual outcomes with poly(methyl methacrylate) IOLs, and their findings are similar to ours.

Eckstein et al.[23] and Gupta et al.[24] showed that an IOL can improve visual outcomes, again similar to the results in our study. Vajpayee et al.[25] and Zou et al.[26] suggest that primary insertion of an IOL for posterior capsule rupture is also important. The same trend was observed in our study. According to Shah et al.,[27] improved visual outcomes can be achieved when intervention is performed between 5 days and 30 days after injury in adults with traumatic cataract. Rumelt and Rehany[28] found no significant difference between primary implantation and secondary implantation, again supporting the results in our study. Staffieri et al.[14] report the use of a primary IOL in 62% of the cases, while a primary IOL was used in 80.2% of the cases in the present study.

We believe our study is the first to compare the final visual outcomes in children between open-globe injuries and closed-globe injuries classified by BETTS. Shah et al.[29] made this comparison in adults; however, we are not aware of any study that had a large cohort of successfully treated traumatic cataracts in children.

In our study, final visual outcomes were achieved according to the OTS[30] prediction in children with traumatic cataract. Although others report similar findings,[31–33] our study presents one of the largest reported databases of pediatric traumatic cataracts classified according to BETTS. Despite the long delay between injury and treatment in many cases in our study, the OTS was still relevant.

Lesniak et al.[31] report no significant differences between the final visual acuities and the visual acuities predicted by OTS in children. Sharma et al.[32] propose that the OTS calculated at the initial examination may be of prognostic value in children with penetrating eye injuries. However, Unver et al.[33] suggest that OTS calculations may have limited value as predictors of visual outcomes in a pediatric population. Lima-Gómez et al.[34] report estimates for a 6-month visual prognosis; however, some variables required evaluation by an ophthalmologist. Using the OTS, 98.9% of eyes in the general population could be graded in a trauma room. Knyazer et al.[35] report the prognostic value of the OTS in zone-3 open-globe injuries, and Man et al.[36] found that the OTS and the CART had equal prognostic effectiveness in the general population.

In conclusion, in this study, the OTS was a reliable predictor of the final visual outcome in cases of traumatic cataract in children.

WHAT WAS KNOWN

- The Ocular Trauma Score is an important tool to predict visual outcome after ocular injury in the general population.

WHAT THIS PAPER ADDS

- Results show the Ocular Trauma Score is also an important tool for evaluating children after ocular trauma.

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