ORIGINAL ARTICLE

Estimation of damage in pediatric ocular trauma without evaluating visual acuity

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ABSTRACT

Background. Quantifying visual acuity (VA) can be limited in children with ocular trauma. Could the parameters of the system for classifying mechanical injuries of the eye (SCMIE) detect the eyes with significant visual affection (SVA) and damage in the posterior ocular segment (DPOS) without the need for VA evaluation?
Methods. An observational, analytical, cross-sectional, retrospective and open label study was conducted. Pediatric patients with uni- or bilateral eye trauma and grading using the SCMIE were evaluated. We identified eyes with SVA and those with DPOS. Their rates were then compared between the parameters of SCMIE (χ^2 and odds ratio, OR).
Results. Two hundred eyes were evaluated (mean age: 10.88 years). The parameters associated clinically with SVA were type A open globe (p = 0.002, OR = 14.14), open globe (p <0.001, OR = 11.25), zone II (p = 0.001, OR = 3.17) and positive pupil (p <0.001). Those associated with DPOS were zone III (46.5%, p <0.001, OR = 26.43) and type A open globe (40.0%, p = 0.059, OR = 3.39).
Conclusions. Ocular trauma that causes SVA in children may be detected without measuring VA, provided that the remaining parameters of the SCMIE are evaluated.
Key words: ocular trauma, system for classifying mechanical injuries of the eye, visual acuity.

INTRODUCTION

Ocular trauma (OT) is the main cause of acquired monocular blindness during the pediatric age.[1,2] Functional prognosis after OT worsens in the child, especially because their visual rehabilitation is more difficult.[3] Reports of up to 50% of patients with significant trauma have ocular injury.[4] It is estimated that ~1.6 million cases of blindness, 2.3 million of cases with poor vision and 19 million of cases of monocular blindness in the world's population are due to ocular injuires.[5] In the U.S. it has been estimated that during 1 year there are 2.4 million cases of eye injuries: 35% in those <17 years[1] and 55% in those <15 years;[6] 43% of open globe injuries (OG) occur in individuals <18 years of age.[7]

Ocular lesions that occur with the greatest frequency in pediatric age are subconjunctival hemorrhage and retinal lesions[3] and, particularly, hyphema in closed globe (CG) injury and corneal wound in trauma with OG.[8] In ophthalmological centers the most frequent ocular injuries that affect the posterior ocular segment were retinal lesions in 11.8% of the cases, retinal detachment in 7.3%, ocular perforation in 4.5%, vitreous hemorrhage in 3.6%, intraocular foreign body in 1.2%, and optic nerve atrophy in 1.2%.[3]

One of the complications of OT that has great importance on the prognosis is retinal detachment; trauma causes up to 61% of retinal detachment in children. The only predictor for the patient preserving a VA ≥20/200 is an attached macula.[9]

In 1997, the System for Classifying Mechanical Injuries of the Eye (SCMIE) was developed for standardizing evaluation of traumatized eyes. Its application does not require specialized instruments and can be used from the initial contact with the patient. The system classifies trauma as OG (when there is total continuity solution of

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the ocular wall [cornea and sclera]) or closed globe (CG) (when there is no total continuity solution).

Evaluation of the system is based on four parameters that have demonstrated to have prognostic value for the final visual result: type (mechanism of the injury); grade (best corrected VA in the injured eye); pupil (presence of an afferent pupillary defect in the injured eye); and zone (defined by the location of the most posterior lesion).[10,11]

The parameters of grade and pupil are the most significant predictors of visual outcome; these physiological parameters measure the function without directly describing the lesion.[12] The highest mark in the grade parameter, which represents a major visual deficiency, has been associated with a greater frequency of lesions in the posterior ocular segment (retina and optic nerve).[11]

Evaluation of VA requires an active participation, which limits measurement in comatose patients, those who are not totally cooperative or in very young children.[12] Although it is always recommended to try to measure and document visual function in children who are conscious and able to speak,[13] this parameter may not be accessible in a pediatric patient with OT due to the lack of cooperation or to the difficulties on initial evaluation that limit precise evaluation of functional state with the SCMIE.[14,15]

Given that VA may be an indicator of retinal damage, a study was performed to estimate if the remainder of the SCMIE parameters could detect eyes with significant visual damage and damage to the posterior segment during initial evaluation, without the need to measure VA.

SUBJECTS AND METHODS

We performed an observational, analytical, cross-sectional, retrospective and open study. The target population was pediatric patients with OT treated at general hospitals in the Mexico City metropolitan area. The accessible population was comprised of pediatric patients who were seen for consultation at the ophthalmology service of a general hospital in Mexico City between January 2003 and June 2007. The study was authorized by the research and ethics committee of the hospital where it was conducted.

All pediatric patients evaluated in the ophthalmology department for uni- or bilateral OT of any gender, aged <17 years, and who had a complete ophthalmological evaluation and classification using SCMIE were included.

The parameter type in CG trauma was classified as follows: 1) A (contusion) when the agent was a blunt object, 2) B (lamellar laceration) if the agent was a sharp object, 3) C when there was a superficial foreign object and 4) D when the injury was due to mixed causes. In OG trauma it was classified as follows: 1) A (rupture) when the agent was a blunt object, 2) B (penetration) when the agent was a sharp object, 3) C when there was an intraocular foreign body, 4) D (perforation) when there were two solutions of continuity by the same agent and 5) E injuries due to mixed causes.[10]

The degree parameter was classified according to the visual capacity of the injured eye: 1, ≥20/40; 2, 20/50 to 20/100; 3, 19/100 to 5/200; 4, 4/200 to light perception and 5, eyes without light perception.[10]

Pupil parameter was classified as positive when there existed an afferent pupillary defect and negative when there was no afferent pupillary defect.[10]

The zone parameter in CG trauma was classified according to the location of the most posterior lesion: 1) I when it was located in the external part of the globe (conjunctiva, cornea and sclera), 2) II from the anterior chamber up to the posterior capsule of the posterior lens capsule including the *pars plicata* and 3) III if it encompassed the *pars plana*, vitreous, retina or optic nerve. In OG trauma, the zone was classified as follows: 1) I when the continuity solution affected the cornea (including the limbus), 2) II when it was localized in the sclera up to 5 mm posterior to the limbus and 3) III when it was located in the sclera >5 mm from the limbus (Figure 1).[10]

Patients with any other type of pre-existing ocular disease that modified visual capacity were excluded.

Distribution of the parameters of the SCMIE in the sample were identified; additionally, patients with any type of lesion in the posterior segment of the eye were identified because these lesions could potentially cause subsequent visual loss due to retinal problems and also would require additional evaluation by a specialist.

Dependent variables were the presence of significant visual affection and damage in the posterior segment. Significant visual affection was defined as the presence of visual capacity <20/100 (grade >2) in the affected eye. Damage in the posterior segment was defined as the existence of posttraumatic injuries in the vitreous or the retina; both were classified as present or absent.

Independent variables were the SCMIE parameters: globe, type, pupil and zone, operatively defined according

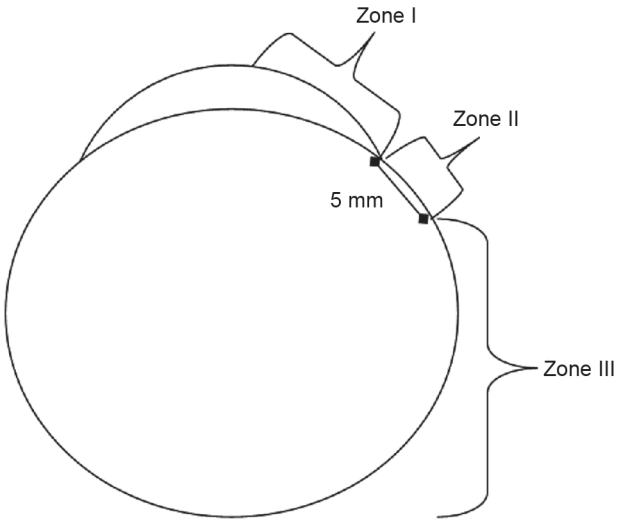

Figure 1. Zones of trauma with open globe.

to the conceptual definitions of the system. Posttraumatic injuries of the posterior segment that were searched for were choroid rupture, retinal detachment, avulsion of the optic nerve, vitreous hemorrhage, intraocular foreign body and subluxation of the lens in the vitreous chamber.

Isolated retinal commotion was excluded because it is a transitory condition that is generally self-limiting without functional repercussions. Proportion and confidence intervals were identified (95% CI) of patients with significant visual disease and of patients with damage in the posterior segment.

To determine if the type, pupil, and zone parameters of the SCMIE could at some point replace the grade parameter to determine the existence of visual involvement and damage in the posterior segment, which are characteristics that influence in the prognosis of visual function, the frequency of those variables in each category of the globe, type, pupil and zone parameters were compared with the frequency of the remaining categories of each parameter.

The differences between the categories of each parameter were analyzed using χ^2 and odds ratios (OR). It was determined that a category may be useful to detect the outcome variables if it was significantly associated with them, defined as OR ≥3. All data were stored and analyzed with the program STATA v.4.0.

RESULTS

There were 200 eyes in 196 patients, with ages from 6 months to 17 years (median 10.88 ± 4.62 years). There were 48 female patients (24.0%). There were 174 eyes with CG trauma (87.0%) and 26 eyes had OG trauma (13.0%); distribution of the parameters of the SCMIE is shown in Table 1.

There were 47 eyes with significant visual affection (23.5%, 95% CI 17.62-29.38). It was found that 27.7% of the eyes that had significant visual affection had some type of retinal injury (p <0.001, OR 4.49); the categories associated with significant visual affection were OG type A (80.0%, p = 0.002, OR 14.14), OG trauma (69.2%, p <0.001, OR 11.25), zone II (40.8%, p =0.001, OR 3.17) and positive pupil (100% p <0.001, Table 2).

There were two eyes identified with choroid rupture (1.0%), three with retinal detachment (1.5%), 13 with vitreous hemorrhage (6.5%) and two with intraocular foreign body (1.0%). There were no eyes with lens subluxation or optic nerve avulsion. In total, 25 patients presented with posterior segment damage (12.5%, 95% CI 7.92-17.08)

Table 1. Distribution of the parameters of SCMIE

		Type of lesion			
		CG		*OG*	
		n	*%*	*n*	*%*
Type	A	122	61	5	2.5
	B	19	9.5	20	10
	C	21	10.5	1	0.5
	D	12	6	0	0
	E			0	0
Grade	1	128	73.6	3	11.5
	2	17	9.8	5	19.2
	3	13	7.5	3	11.5
	4	15	8.6	11	42.3
	5	1	0.6	4	15.4
Pupil	(+)	2	1.1	2	7.7
	(-)	172	98.9	24	92.3
Zone	I	93	53.4	15	57.7
	II	41	23.6	8	30.8
	III	40	23	3	11.5
Total		174	87.0	26	13.0

Table 2. Association of significant visual affection with the parameters of the SCMIE

Category	*Significant visual affection*		*p*	*OR**
	% in the category	*% in the rest of the categories*		
OG (*n*=26)	69.23	30.7	<0.001	11.25
Type A closed (*n*=122)	21.31	78.68	0.36	0.74
Type B closed (*n*=19)	5.2	94.8	0.04	0.16
Type C closed (*n*=21)	0	100	0.007	0.00
Type D closed (*n*=12)	16.66	83.34	0.56	0.64
Type A open (*n*=5)	80	20	0.002	14.14
Type B open (*n*=20)	70	30	<0.001	10.39
Type C open (*n*=1)	0	100	0.57	0.00
Positive pupil (*n*=4)	100	0	0.003	
Zone I (*n*=108)	11.11	88.89	<0.001	0.20
Zone II (*n*= 49)	40.81	59.19	0.001	3.17
Zone III (*n*=43)	34.8	65.2	0.04	2.09

*OR, odds ratio.
SCMIE, system for classifying mechanical injuries of the eye; OG, open globe.

and four patients had more than one lesion (2.0%, 95% CI 0.06-3.94).

The categories associated with posterior segment damage were zone III (46.5%, p <0.001, OR 26.43) and OG type A trauma A (40.0%, p = 0.059, OR 3.39).

DISCUSSION

In a proportion of the patients with OT during the pediatric age, the physician may encounter lack of patient cooperation during the initial visit. This problem may become worse during evaluation of the grade parameter (best corrected VA) of the SCMIE which, by itself, may be difficult in this age.

For this reason, the possibility that the other SCMIE parameters could have a clinical association with significant visual disease was evaluated, which would allow substitution of the evaluation of visual capacity, whenever performing it precisely and accurately was not possible.

In pediatric patients in the sample studied, the probability of presenting with significant visual affection during the initial evaluation was clinically associated, in descending order, with type A OG trauma, OG trauma in general, zone II and positive pupil. The remainder of the parameters did not demonstrate clinical association with significant visual disease.

The probability of presenting damage in the posterior ocular segment was significantly associated with involvement of zone III and with type A OG trauma. The first association does not provide additional information in CG trauma because if reflex abnormalities are found during fundus examination, it may be inferred that there is damage to the posterior segment.[16] In the case of OG trauma this association is expected because zone III corresponds to the retinal location. With the purpose of identifying damage in the posterior segment, none of the remaining classification parameters were as valuable as identifying the location of the most posterior lesion.

With respect to the type of trauma associated with damage in the posterior segment, the most significant association corresponded to OG trauma, which represents one of the medical care priorities independent of the localization of the continuity of solution or of the presence of intraocular lesions.

In a previous study with a population of all ages, it was identified that visual function was not a parameter that would help to localize the injuries that originated them, only a greater proportion of involvement of the posterior ocular segment was found in eyes with grade 5, but the low prevalence of the latter lacks usefulness.[14]

Based on the information available of the pediatric patient with OT in whom visual function cannot be evaluated, retinal damage was associated with variables that do not depend on that evaluation, or that would require immediate medical attention for other causes. Although trauma is not predictable, the detection of its impact, especially in CG lesions, allows early identification of alterations that can be treated, reducing the complications that cause blindness.[17]

From the determination of the SCMIE, it was demonstrated that each of its parameters had high prognostic value for the final result; prognosis is poorer when there is retinal damage or optic nerve damage, even if anatomic correction is achieved.[10,11] The value of the system parameters have already been identified, but we are not aware of other studies that evaluate its usefulness in pediatric patients when it is not possible to measure visual function during the initial examination.

It may be difficult to identify some characteristics in a pediatric emergency service such as ocular perforation, which should be classified by the ophthalmologist.[18]

However, in general, an adequate evaluation of the status of the traumatized eye can be obtained through the SCMIE. Visual function is a prognostic factor for OT that should be evaluated by the ophthalmologist, but in a first contact with the pediatric patient it may not be indispensable because as identified in this study, there are other characteristics significantly associated with visual deficiency.

It has been identified that patients who require immediate medical attention due to OT are those who present visual deficiency and OG trauma: when there is a pediatric patient with continuity solution of the ocular wall (cornea or sclera) the behavior to follow is immediate referral to an ophthalmologist. The decision could become difficult when there is CG trauma and the pediatric patient's visual function cannot be evaluated. According to the results of this study, in pediatric patients with CG trauma limited to zone I, it would not be indispensable to evaluate visual function unless there is positive pupil; in cases of zone II and III involvement, the association with significant visual disorder or damage to the posterior segment, respectively, would allow for referral to be made to an ophthalmologist.

The results of the study suggest that according to the scenario of a pediatric patient in whom it would be impossible to evaluate the grade, the remaining SCMIE parameters provide sufficient information to identify cases that would require emergency referral due to the probability of developing significant visual affection.

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