

Clinical features and outcomes of vitrectomy in pediatric ocular injuries-eye injury vitrectomy study

Xuefeng Feng, Kang Feng, Yuntao Hu, Zhizhong Ma

Context: Severe pediatric ocular injury remains a frequent and difficult problem. Vitrectomy is a major technique that has been used to manage severely damaged eyes. However, limited follow-up studies exist currently. **Aims:** To evaluate the clinical features and predictive factors of visual and anatomic outcomes in Eye Injury Vitrectomy Study (EIVS). **Settings and Design:** Retrospective, consecutive, interventional case series. **Materials and Methods:** Reviewing and analyzing records of children, aged 15 years or younger, who had undergone vitrectomy for eye injuries in EIVS database between January 1997 and December 2009. **Statistical analysis used:** Descriptive analyses and multiple Logistic regressions were employed for all variables using SPSS software (version 17.0, SPSS Inc.). **Results:** Eighty-seven children (89 eyes) with more than 6 months follow-up and complete records identified in EIVS were included in this study. Average follow-up was 12.7 months. The mean age was 9.4 ± 3.8 years. Seventy-seven eyes (86.5%) had open globe injuries, and 12 (13.5%) had closed globe injuries. Seventeen eyes (19.3%) presented with endophthalmitis. Seventy-five eyes (88.2%) presented with visual acuity of 4/200 or worse; however, 42 eyes (47.7%) achieved 4/200 or better vision with anatomical restoration after vitrectomy. Multiple analysis showed that choroidal damage, large scleral wound, and endophthalmitis were significantly associated with unfavorable outcome, the OR values were 16.7 (95% CI: 2.7-102.4, $P = 0.002$), 10.9 (95% CI: 1.7-71.6, $P = 0.013$), and 6.6 (95% CI: 1.0-42.4, $P = 0.048$), respectively. **Conclusions:** Vitrectomy intervention resulted in favorable visual and anatomic outcomes in almost half of the injured eyes. Choroidal damage, large scleral wound, and endophthalmitis were the prognostic indicators of unfavorable outcome.

Key words: Children, eye injury vitrectomy study, eye injury, trauma, vitrectomy

Ocular injuries are the leading cause of non-congenital unilateral blindness in children.^[1] Pars plana vitrectomy (PPV) is a major technique that has been used to manage severely damaged eye. Special consideration for pediatric patients is necessary, since the course and postoperative results of complex trauma in children differ from those in adults. Previous studies have described the epidemiology of eye injuries and clinical outcomes of surgical repair in open globe injuries.^[2-9] To our knowledge, limited literature is available on the clinical features and outcomes of PPV in a large group of severe mechanical injuries in children. The Eye Injury Vitrectomy Study (EIVS) is a hospital-based multicenter prospective cohort study started from 1997. EIVS aims to investigate the epidemiology and prognosis of severe eye injury with intervention of vitreoretinal surgery. Six tertiary referral hospitals in China have successively participated in EIVS. Its inclusion criteria were patients who suffered from severe eye injury and were treated with vitreoretinal surgery. The EIVS exclusion criteria were patients with an eye injury that did not need vitreoretinal surgical intervention. The purpose of this study was to evaluate the clinical features and outcomes of vitrectomy intervention,

as well as to identify predictive factors of visual and anatomical outcomes in pediatric patients from EIVS database.

Materials and Methods

All cases in this study were selected from the database of EIVS from Jan. 1997 to Dec. 2009. The details of EIVS database setup has been described by Feng K.^[10,11] In this study, the inclusion criteria were: (1) children aged 15 years and below; (2) the minimum follow-up was 6 months. Cases with missing records were excluded. All injured patients in the database consented to enrollment in EIVS. 20G vitrectomy was performed in this case series.

Clinical features analyzed in this study included patient age, gender, involved eye, best-corrected visual acuity after injury, type and location of injuries, interval from injury to PPV, iris/lens extrusion, large scleral wound, ciliary body damage, severe intraocular hemorrhage, choroidal damage, retinal detachment, proliferative vitreoretinopathy (PVR) and endophthalmitis. All these features were recorded in the database of EIVS as introduced by Feng *et al.*^[10,11] Follow-up information, including the follow-up period, best-corrected visual acuity (BCVA) and intraocular pressure (IOP) at the last visit, tamponade of vitreous cavity, and anatomical outcome, was recorded at outpatient after follow-up no less than 6 months. The anatomical and visual outcomes were evaluated and predictive factors of unfavorable outcome were analyzed using multiple logistic regressions.

Outcome term definitions

Anatomically restored eyes

Determined after a period of follow-up no less than 6 months, IOP ≥ 8 mmHg, vitreous cavity filled with aqueous humor,

Access this article online

Website:

www.ijo.in

DOI:

10.4103/0301-4738.120222

Quick Response Code:



Department of Ophthalmology, Peking University Third Hospital, Ministry of Education's Key Laboratory of Vision Loss and Restoration, Beijing, People's Republic of China

Correspondence to: Prof. Zhizhong Ma, Department of Ophthalmology, Peking University Third Hospital, 49 Huayuan North Road, Haidian District, Beijing 100191, People's Republic of China. E-mail: puh3_yk@bjmu.edu.cn

Manuscript received: 09.10.12; **Revision accepted:** 23.05.13

retinal attachment or only local detachment that does not require surgery.

Hypotonic eyes

Determined after a period of follow-up no less than 6 months, IOP < 8 mmHg, vitreous cavity filled with aqueous humor, and the sign of Tyndall is positive in vitreous cavity owing to the presence of damage to the blood–ocular barrier.

Silicone oil–sustained eyes

Silicone oil–sustained eyes refer to eyes injected with silicone oil because of an incomplete treatment, lower IOP (<8 mmHg), unrecovered retinal detachment or inoperable retinal detachment.

Favorable outcome

Favorable outcome is defined as anatomically restored eye whose final BCVA is 4/200 or better after 6 months of follow-up. If an injured eye with initial NLP vision is anatomically restored with recovered vision of LP or better, it is also considered as a favorable outcome.

Unfavorable outcome

Unfavorable outcome is defined as cases of hypotonic, silicone oil sustained eyes, and eyes that underwent enucleation or evisceration. Anatomically restored eyes with final BCVA of less than 4/200 after 6 months of follow-up are also considered as an unfavorable outcome, except for the injured eyes presenting with initial NLP vision.

Visual acuity was graded in accordance with published visual acuity grade set up by The Ocular Trauma Classification Group.^[12]

Statistical analysis

All analyses were performed using SPSS software (version 17.0, SPSS Inc, Chicago, USA). Descriptive analyses and multiple Logistic regressions were employed for all variables. Those variables with odds ratios greater than 2 were considered to be predictive factors of unfavorable outcome, and a *P* value of less than 0.05 was considered significant.

Results

Eighty-nine eyes of 87 children were identified in EIVS database and included in this study. Average follow-up was 12.7 months (6.0 months to 78.9 months). The mean age was 9.4 ± 3.8 years (1 year to 15 years). 81.6% (71/87) cases were boys. Fifty-seven (64.0%) injured eyes were the right eye.

The causes of injury were presented in Table 1. Top 3 causes were: Crash down/tumble (28.1%); traffic accident (12.4%), and flying objects (10.11%).

The type and location of injuries were presented in Table 2. Closed globe injuries accounted for 13.5% (12/89) in this case series. There were no differences between closed globe injuries and open globe injuries in final visual and anatomic outcome. (*P* = 0.217).

Seventeen eyes (19.3%) were presented with endophthalmitis. Six of which caused by intraocular foreign bodies; six occurred in penetrating injuries; four cases with perforating wound, and one case had ruptured globe.

Four children (4.5%) were too young to obtain a vision record at time of injury. Final vision was, however, available in all cases.

The comparison of pre-vitrectomy vision and final vision was presented in Table 3. After vitrectomy, 42 eyes (47.7%) achieved favorable outcomes. One case with final vision of Finger Count but without pre-vitrectomy visual acuity was not included in the multivariate analysis, as it was hard to determine the visual outcome according to our definition of favorable outcome.

Anatomic outcomes of injured eyes were presented in Table 4. Three enucleations were done in the subsequent procedure due to phthisis bulbi following PPV. All three eyes had open globe injuries.

Multivariate analysis showed that choroidal damage, large scleral wound (≥10 mm), and endophthalmitis were significantly correlated with unfavorable outcome. The OR values were 16.7 (95% CI: 2.7-102.4, *P* = 0.002), 10.9 (95% CI: 1.7-71.6, *P* = 0.013), and 6.6 (95% CI: 1.0-42.4, *P* = 0.048), respectively [Table 5]. Other clinical features, including age, type and location of injury, preoperational visual acuity, retinal detachment, PVR, vitreous hemorrhage, or interval from injury to PPV, however, did not show significant association with unfavorable outcome.

Table 1: Causes of 89 pediatric ocular injuries

Cause of injury	Count	Percentage
Traffic	11	12.36
Crash down	8	8.99
Violence	7	7.78
Squeeze	1	1.12
Blast	5	5.62
Tumbled	17	19.10
In daily living	4	4.49
Bullet	1	1.12
Others	13	14.61
Projectile/flying	9	10.11
No answer	13	14.61

Table 2: Type and location of 89 pediatric ocular injuries

Type and location of injury	Count	Percentage
Types of injury		
Rupture	23	25.8
Penetrating	28	31.5
Intraocular foreign body	20	22.5
Perforating	6	6.7
Contusion	12	13.5
Ocular trauma zone		
Close globe zone 3	12	13.5
Open globe zone 1	17	19.1
Open globe zone 2	27	30.3
Open globe zone 3	33	37.1

Open globe zone 1 injuries: When opening of the globe is isolated to the cornea or limbus. Zone 2 injuries: Involve the anterior 5 mm of the sclera. Zone 3 injuries: Extend the full thickness into the sclera more than 5 mm posterior to the limbus. Close globe zone 3 injuries: When injury involve the posterior segment (all internal structures posterior to the posterior lens capsule)

Discussion

Severe pediatric ocular injury remains a frequent and difficult problem. Demographic data analysis and identification of predictive factors may be helpful in primary prevention and further management. In this study, we have described the clinical features and outcomes of PPV in a series of 87 children (89 eyes) selected from EIVS. We also investigated the predictive factors of unfavorable outcome in pediatric eye injuries.

The mean age of children was 9.4 years, comparable to other similar case series.^[7,9,13] A higher incidence of trauma in boys than in girls is well recognized.^[5,8,9] Our study also showed a comparable male predominance of 4.4:1 ratio of boys to girls.

Closed globe injuries account for 13.5% of cases in this study. It is hard to compare with the literature as most studies reviewed only open globe injuries. Sheard *et al.*^[9] reported 54.1% (33/61) of closed globe injuries in their case series, but in their study, either PPV or scleral buckling (27.9% children underwent scleral buckling) were included. They did not compare the outcomes between closed and open globe injuries. We compared the outcomes of closed and open-globe injuries, and the result shown no difference between the two kinds of injuries. Indications for PPV in 12 closed globe injuries of this case series were vitreous hemorrhage and retinal detachment, in which 3 cases were recorded as macular damage with sub-retinal hemorrhages, 3 cases with PVR stage C or more advanced stages, and another 3 cases had choroidal damage. Those severe and complicated closed globe injuries could lead to a comparable outcome to the open globe injuries. The small sample size of closed globe injuries in this study may also be

a reason for the comparable result. Further large-sample and comparative studies are needed to confirm this result.

Multivariate analysis shows three clinical features that correlate with final visual and anatomic outcome. Large scleral wound (≥ 10 mm) as a predictive unfavorable factor is comparable to other published studies both in adults and in children. A large scleral wound is often accompanied by prolapse of intraocular contents. It also presents difficulties on wound closure and thus severely damages the retina and choroid. Fibrous in-growth following a large laceration of globe in children could also be a reason for bad outcome.

In this study, choroidal damage included choroidal laceration, choroidal detachment, choroidal rupture, and choroidal defect, which was confirmed during exploratory surgery. Few published articles document the outcome of choroid damage, whereas, articles documenting poor prognosis attributable to vitreous hemorrhage are numerous.^[14] We consider that severe choroid damage following ocular injury as the cause of profound intraocular hemorrhage; moreover, in open-globe injured eyes with choroidal lacerations, surgical re-attachment of choroid is very difficult because the choroidal tissue and blood vessels contain abundant collagen and elastic fibers, which constrict and make the choroidal wound shorter. Schepens^[15] considered that persistent choroidal detachment may also be an important factor of hypotony after vitrectomy. In closed globe injuries, choroidal damage also has been demonstrated as a prognostic indicator for unfavorable outcome.^[16] Therefore, it is essential to explore the status of choroid during globe exploration.

The frequency of endophthalmitis after open globe injury varies from 6.8% to 54.2% in different geographic areas and populations. The risk factors include contamination of injured materials, remained intraocular foreign bodies, damage to the lens, and delayed wound care.^[17] In this series, the frequency of endophthalmitis was 19.3% (17/89), which is similar to the report of Lee *et al.*^[8] We consider that fibrosis of ciliary body

Table 3: Comparison of pre-vitrectomy and final visual acuity in 89 pediatric ocular injuries

Preop VA	Final VA				NLP	Total
	$\geq 20/40$	20/50 to 20/100	19/100 to 5/200	4/200 to LP		
$\geq 20/40$	2	2	0	0	2	6
20/50 to 20/100	0	1	0	0	0	1
19/100 to 5/200	1	2	0	0	0	3
4/200 to LP	5	14	12	21	6	58
NLP	0	0	1	8	8	17
No record	0	0	1	2	1	4
Total	8	19	14	31	17	89

VA: Visual acuity, LP: Light perception, NLP: No light perception, Preop VA: Pre-vitrectomy visual acuity

Table 4: Anatomical outcomes of 89 injured eyes

Anatomical outcomes	Count	Percentage
Anatomical recovery	52	58.4
Hypotonic eyes	2	2.2
SO sustained eyes	20	22.5
SO low-IOP	3	3.4
Atrophy	9	10.1
Enucleation in subsequent procedure	3	3.4
Enucleation in primary surgery	0	0

SO: Silicone oil, IOP: Intraocular pressure

Table 5: Prognostic factors for anatomic outcomes and visual outcomes developed by Logistic model in the series cases

	B.	S.E.	Wald	df	Sig.	Exp (B)	95.0% C.I. for EXP (B)	
							Lower	Upper
Large scleral wound	2.386	0.962	6.156	1	0.013	10.870	1.651	71.588
Choroidal damage	2.815	0.925	9.257	1	0.002	16.696	2.723	102.375
Endophthalmitis	1.880	0.953	3.893	1	0.048	6.554	1.013	42.423

B: Regression coefficient, C.I.: Confidence interval, df: Degrees of freedom, Exp (B): Odds ratio, PVR: Proliferative vitreoretinopathy, SE: Standard error, Sig.: Significance

in endophthalmitis cases after PPV could be a reason for unfavorable outcome due to the resulted hypotony and phthisis.

Many studies in adults have shown that the most common cause of an unsuccessful outcome of retinal surgery following trauma is the development of PVR. Sheard *et al.*,^[9] also reported PVR was a significant factor influencing the visual and anatomic outcome for children. In our study, PVR was recorded in 47 eyes (52.8%), among which, 16 (38.1%) eyes had favorable outcomes while 31 (67.4%) obtained an unfavorable outcome. However, PVR is not an independent risk factor for unfavorable outcome in multivariate analysis. Large scleral wound carries a poor prognosis, and retinal detachment with PVR is most likely a result of the large scleral wound.

Different from the literature,^[7-9,18] pre-surgery VA is not an indicator of unfavorable outcome in our study. 88.2% of eyes presented with visual acuity of 4/200 or worse before vitrectomy. More than 50% of patients achieved vision of 4/200 or better, and 38.2% achieved 20/200 or better after vitrectomy. The improvements in PPV techniques and technology have not only enabled the sparing of severely damaged eyes that would previously have been enucleated but also salvage vision of the severely injured eye.

The limitation of this study was a bias created by patients lost to follow up. Since the institutions in which the ocular trauma data were collected are tertiary referral centers, some children had travelled from distance to referral centers for surgery and continued their follow-up locally.

In conclusion, treatment with PPV can salvage nearly half of severely injured eyes of children with favorable outcome, which defined as a final VA of 4/200 or better and with anatomical restoration. Choroidal damage, large scleral wound, and endophthalmitis were the predictive factors of unfavorable outcome. The authors recommend that clinicians should pay more attention to the injuries of choroid, large scleral wound, and endophthalmitis during globe exploration and adopt appropriate interventional measures when treating traumatized eyes in pediatric population.

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Cite this article as: Feng X, Feng K, Hu Y, Ma Z. Clinical features and outcomes of vitrectomy in pediatric ocular injuries-eye injury vitrectomy study. *Indian J Ophthalmol* 2014;62:450-3.

Source of Support: The study was supported by grants: 1. Clinical characteristic application research project of Capital Beijing. (Z121107001012045); 2. National Basic Research Program of China (973 Program, No.2011CB510200). The funding organization had no role in the design or conduct of this research. **Conflict of Interest:** None declared.