• Clinical Research •

Traumatic endophthalmitis and the outcome after vitrectomy in young children

Ya-Li Zhou[1,2], *Yi-Xiao Wang*[1,2], *Teng-Teng Yao*[1,2], *Yuan Yang*[1,2], *Zhao-Yang Wang*[1,2]

[1]Department of Ophthalmology, Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai 200011, China
[2]Shanghai Key Laboratory of Orbital Diseases and Ocular Oncology, Shanghai 200011, China
Correspondence to: Zhao-Yang Wang. Department of Ophthalmology, Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine; Shanghai Key Laboratory of Orbital Diseases and Ocular Oncology, Shanghai 200011, China. zhaokekewzy@hotmail.com
Received: 2018-10-27 Accepted: 2019-12-25

Abstract

● **AIM:** To explore the traumatic endophthalmitis in young children and the outcome of pars plana vitrectomy (PPV).

● **METHODS:** Twenty-two eyes of 22 cases of young children consecutive pediatric traumatic endophthalmitis treated and followed up between September 2014 and May 2018 were included. Aqueous humor or vitreous samples were taken for bacterial culture and sensitivity tests. Intravitreal antibiotics (norvancomycin and ceftazidime) injection, combined with 23-gauge PPV, were administered in 22 eyes. Silicone oil (SO; 5000 centistoke) tamponade or perfluoropropane gas (C_3F_8) was used in all patients. Main outcome measures were best-corrected visual acuity (BCVA) and retinal attachment, the ratio of penetrating injury, and the existence of intraocular foreign body.

● **RESULTS:** The mean age of patients was 6.9±2.2 (range, 3-10)y. All injured eyes suffered from penetrating ocular injury with retained intraocular foreign body in one eye. Bacterial culture was positive in only 2 eyes. The mean follow-up time was 21.1±4.7 (range, 12-30)mo. In the primary PPV, intravitreal antibiotics was administrated in all eyes, SO in 18 eyes, and C_3F_8 in 4 eyes. The secondary operation of SO removal and C_3F_8 endotamponade was performed in 16 eyes and a second SO endotamponade due to emulsification of the oil and retinal detachment (RD) was operated in 7 eyes underwent 3 to 11.5mo after primary PPV. A third operation was done in 7 eyes. The final intraocular pressure (IOP) was 8.9±1.8 (range, 6.9-11.4) mm Hg. The final BCVAs were 20/200 or better in 5, counting fingers in 2, and light perception to hand movement in 8 eyes. Whose (66.7%) had retinal injury exhibited worse BCVA (*P*=0.019, Fisher's exact test). Eyes underwent SO tamponade exhibited worse final BCVA than that with C_3F_8 in the primary PPV (*P*=0.026, Fisher's exact test).

● **CONCLUSION:** Traumatic endophthalmitis in children is generally more severe and associated with more complicated surgical procedures. Most patients have retinal injury need multiple operations and the final BCVA is poor. Prevention of ocular trauma, especially in children, is still critical.

● **KEYWORDS:** pediatric; penetrating eye injury; traumatic endophthalmitis; pars plana vitrectomy
DOI:10.18240/ijo.2020.03.06

Citation: Zhou YL, Wang YX, Yao TT, Yang Y, Wang ZY. Traumatic endophthalmitis and the outcome after vitrectomy in young children. *Int J Ophthalmol* 2020;13(3):406-411

INTRODUCTION

Endophthalmitis is a serious eye disease that is commonly complicated by systemic infection, intraocular surgery, or penetrating eye trauma[1-2]. Among children, penetrating ocular trauma is the most common cause of endophthalmitis[3-4]. Traumatic endophthalmitis in children is generally more severe and associated with more complicated surgical procedures, longer hospitalization times, more complications, and worse visual prognoses[5]. Additionally, some studies have indicated that patients who are less than 10 years of age often exhibit worse visual outcomes, perhaps because of amblyopia[6-7]. Therefore, prompt diagnosis and determination of a suitable treatment is particularly important for maintenance of retinal function and visual acuity in pediatric patients with traumatic endophthalmitis. The injection of intravitreal antibiotics combined with 23-gauge pars plana vitrectomy (PPV) is reportedly effective for treatment of endophthalmitis[8-9]. However, in clinical settings, completion of a primary PPV procedure may not be sufficient treatment because of the complexity of pediatric endophthalmitis. Further treatment operations, such as silicone oil (SO) removal, a second SO injection, and intraocular lens (IOL) implantation are often necessary to maintain the shape of the eye and achieve better visual outcomes.

In an assessment of the published literature, we found no studies containing detailed descriptions of follow-up treatment after the primary PPV procedure. In the present study, we aimed to explore the effects of PPV and (when necessary) the next intervention (*e.g.*, SO removal, SO injection, or IOL implantation) on the visual outcomes of pediatric patients with traumatic endophthalmitis.

SUBJECTS AND METHODS

Ethical Approval This retrospective study was conducted at Xinhua Hospital and Ninth People's Hospital, which are affiliated with the Shanghai Jiao Tong University School of Medicine, from September 2014 to May 2018. Ethics Committee approval was obtained before the study began. Patients who were less than 10 years of age and who had pediatric endophthalmitis caused by eye trauma were included in our study. The study protocol conformed to the tenets of the Declaration of Helsinki. Informed consent was obtained from all patients for surgery and for the use of their information for this retrospective study. The surgery was performed as part of routine medical care prior to writing this manuscript. The following data were extracted from medical records for each patient with pediatric endophthalmitis: inpatient number, date of birth, sex, ocular injury history, specimen (vitreous or aqueous humor) culture results, PPV surgery details, pre-/postoperative best-corrected visual acuity (BCVA), intraocular pressure (IOP), retina status and follow-up duration.

Operation Procedure Most patients were referred from other hospitals for primary care after trauma. After the endophthalmitis diagnosis was confirmed, all patients were treated with intravitreal antibiotics (norvancomycin and ceftazidime) combined with standard 3-port 23-gauge vitrectomy. All surgeries were performed by the same experienced surgeon (Wang ZY) using the Constellation 800 CS System (Alcon Laboratories, Fort Worth, TX, USA). An SO (5000 centistoke) injection or long-acting perfluoropropane (C_3F_8) was used as an extended tamponade in all patients. Lensectomy was performed for patients who exhibited a lesion on the lens, such as a cataract, and for patients who exhibited dislocation of the lens. All patients underwent complete vitrectomy, and posterior hyaloid detachment was induced during surgery for all patients. Lensectomy was performed for patients who exhibited a lesion on the lens, such as a cataract, and for patients who exhibited lens subluxation and dislocation of the lens. The secondary operation of SO, C_3F_8, and IOL implantation were performed. In addition, a few patients underwent a third PPV. Patients were examined 1d, 1, and 3wk after vitrectomy, as well as every 1 to 2mo thereafter. At each return visit, a complete eye examination was performed, including a slit-lamp examination of BCVA with a Snellen chart, IOP measurement *via* applanation tonometry, B-scan ultrasonography, and a fundus examination. The mean follow-up duration was 21.1±4.7mo (range, 12-30mo).

Specimen Culture Aqueous humor or ocular vitreous was aseptically obtained with a syringe during the operation. Our hospital was unable to perform microbiological diagnosis; thus, the samples were sent to the Eye & ENT Hospital of the Fudan University, which has a microbiology facility that could perform gram stain, bacterial culture, fungal smear and culture, and sensitivity analyses.

Statistical Analysis Statistical analysis was performed using SPSS software version 22 (SPSS, IBM, Chicago, IL, USA). The data were tabulated and analyzed with Microsoft Excel (Microsoft Inc., Redmond, WA, USA). Data were calculated as the mean±standard deviation. Statistical analysis consisted of a Pearson Chi-squared test and Fisher's exact test. $P<0.05$ were considered statistically significant.

RESULTS

Subject Characteristics Twenty-two patients with pediatric endophthalmitis were treated during the 30-month study period. Their conditions resulted from trauma; sixteen patients were boys and the other 6 patients were girls. All patients had penetrating corneal trauma, 20 patients exhibited corneal and lens lesions, 7 patients had pupil deformation, 11 patients had retinal injuries, and 2 patients had combined retinal and choroidal detachment. The etiology of penetrating ocular trauma included sharp injuries (n=13; 59.1%), blunt injuries (n=5; 22.7%) and unknown etiology (n=4; 18.2%). The mean patient age was 6.9±2.2 (range, 3-10)y. The mean duration until the first PPV operation was 4.6±2.7 (range, 1-11)d (Table 1).

Culture Results In all patients, we performed an intraoperative aqueous humor or vitreous biopsy using syringes, and the culture results are summarized in Table 1. Only two eyes (9.1%) had positive vitreous cultures: one showed signs of fungus and the other was *Pneumoniae*.

Surgical Results The clinical onset of post-trauma endophthalmitis occurred within 2wk of injury. All patients were referred from other hospitals for primary care at 1-2d after trauma, with perforation wound closure and without PPV treatment. Only one patient was diagnosed and treated by standard vitrectomy within 1d. During surgery, we observed the formation of a ciliary body exudative membrane in all patients. All patients with pediatric endophthalmitis achieved successful infection control. Eighteen patients (81.8%) underwent more than 2 PPV. In the primary PPV, all patients received intravitreal antibiotics; eighteen children (81.8%) of the patients underwent SO injection and four (18.2%) of the patients underwent C_3F_8 application. Of the patients who underwent SO injection in the primary operation, after a mean follow-up duration of 5.1±2.4 (range, 3-11.5)mo, seven children underwent a second SO removal combined

Table 1 Characteristics of patients with pediatric endophthalmitis in this study

Cases	Sex	Age (y)	Eye	Etiology	Treatment time (d)	Lesion	Pre BCVA//logMAR
1	F	8	Right	Pencil	11	Cornea/lens/retina	NLP/NLP
2	M	5	Left	Unknown	5	Cornea/lens	HM/3.0
3	M	6	Left	Bamboo stick	4	Cornea/lens	LP/LP
4	F	3	Right	Plastic ball	3	Cornea/lens	NA/NA
5	M	6	Right	Scissor	4	Cornea/lens/retina	LP/LP
6	M	4	Left	Branch	8	Cornea/lens	NA/NA
7	M	6	Left	Wood stick	4	Corneas	LP/LP
8	M	8	Left	Unknown	3	Cornea/lens	CF/2.0
9	M	3	Left	Unknown	9	Cornea/lens/retina	NA/NA
10	F	8	Right	Copper wire	2	Cornea/lens	LP/LP
11	M	9	Left	Wood stick	1	Cornea/lens	LP/LP
12	F	8	Left	Iron	5	Cornea/lens/retina/choroid	HM/3.0
13	M	7	Left	Cement nail	2	Cornea/lens/retina	HM/3.0
14	M	9	Left	Wood stick	2	Cornea/lens	CF/2.0
15	F	4	Right	Plastic ball	4	Cornea/lens/retina	LP/LP
16	M	4	Left	Wood stick	3	Cornea/lens	CF/2.0
17	M	10	Right	Explosion	5	Cornea/lens/retina	NLP/NLP
18	M	7	Left	Impact	3	Cornea/lens/retina	LP/LP
19	M	9	Right	Impact	9	Cornea/lens/retina	LP/LP
20	F	9	Left	Explosion	7	Cornea/lens/retina/choroid	LP/LP
21	M	10	Left	Iron	4	Cornea/lens/retina	LP/LP
22	M	8	Right	Unknown	2	Cornea/lens/retina	NLP/NLP

Pre: Preoperative; BCVA: Best-corrected visual acuity; LP: Light perception; HM: Hand movement; NLP: No light perception; CF: Counting fingers.

with C_3F_8 endotamponade, seven eyes underwent a second SO endotamponade due to emulsification of the oil, and seven patients required a third operation. Of the 4 patients who underwent C_3F_8 application in the primary operation, secondary IOL implantation was needed for 2 patients. In our study, only 5 patients had retinal detachment (RD) within 3-4d of initial presentation, which likely resulted from trauma. In addition, 4 patients had traction RD after the second PPV, which was regarded as a complication of surgery. Four patients exhibited band-shaped degeneration of the cornea during follow-up after the third operation. The final IOP was 8.9±1.8 mm Hg. As shown in Tables 1 and 2, at the preoperative baseline, twelve patients had BCVA of light perception, three patients had no light perception, three patients could detect hand movement, and one patient could count fingers. The final BCVAs were 20/200 or better in five patients, two patients could count fingers, eight patients could detect hand movement, one patient had light perception and one patient had no light perception. Final BCVAs were not available for three patients. As shown in Table 3, multiple factors (*e.g.*, sex, age, eye, etiology, onset of PPV, and lesions) were not associated with the final visual outcomes. However, BCVA worse than counting fingers was present in seven children who underwent PPV+SO in the primary PPV operation, whereas this poor BCVA was not observed in children who underwent PPV+C_3F_8 in the primary PPV operation (P=0.026, Table 3). Twelve patients had retinal injury exhibited worse BCVA (P=0.019, Table 3).

DISCUSSION

The diagnosis of traumatic endophthalmitis is based on a history of injury and an ophthalmic examination. However, early diagnosis and immediate treatment for endophthalmitis is challenging in pediatric patients, especially in young children, because they may not be able to describe reduced BCVA or pain symptoms[10-12]; moreover, they are often uncooperative during clinical examinations, which causes delayed diagnosis[13-14]. In the present study, we conducted a retrospective analysis of children with endophthalmitis; we identified a total of twenty-two patients who exhibited endophthalmitis after penetrating eye trauma during a 12 to 30mo period. Notably, of the twenty-two patients, only 1 was diagnosed with endophthalmitis and treated with standard vitrectomy within 1d. This low rate of early diagnosis and treatment was likely related to the high incidence of traumatic endophthalmitis and the low proportion of timely consultations, which may have occurred because most pediatric patients in our study were from rural areas and experienced delays in

Table 2 The pars plana vitrectomy results of children with endophthalmitis

Cases	Final IOP	Final BCVA/ logMAR	Retina status	PPV operation					Culture (organism)	Follow-up (mo)
				First	Interval time (mo)	Second	Interval time (mo)	Third		
1	9.1	HM/3.0	Attachment	Lensectomy+PPV+SOE	5	SOR+PPV+C_3F_8	6	CT	V (fungus)	30
2	8.3	20/40+0.3	Attachment	Lensectomy+PPV+C_3F_8	-	-	-	-	V(-)	20
3	11.4	HM/3.0	Attachment	Lensectomy+PPV+SOE	4	SOR+PPV+C_3F_8	-	-	V(-)	24
4	13.2	NA/NA	Attachment	Lensectomy+PPV+SOE	6	SOR+PPV+C_3F_8	-	-	V(-)	20
5	7.6	NLP/NLP	Attachment	Lensctomy+PPV+SOE	11.5	SOR+PPV+C_3F_8	2	PPV+SOE	V (*Pneumoniae*)	24
6	9.7	NA/NA	Reattachment	Lensectomy+PPV+SOE	4	SOR+PPV+SOE	-	-	V(-)	26
7	7.5	HM/3.0	Attachment	PPV+SOE	9	SOR+PPV+SOE	0.5	Partial SOR+PPV	V(-)	26
8	14.1	20/200/1.0	Attachment	Lensectomy+PPV+C_3F_8	-	-	-	-	V(-)	25
9	8.3	NA/NA	Attachment	Lensectomy+PPV+C_3F_8	3.5	IOLs+PR+PPV	0.5	IOLs+PR+PPV	V(-)	28
10	10.2	CF/2.0	Attachment	Lensectomy+PPV+SOE	11	SOR+PPV+C_3F_8	-	-	V(-)	25
11	7.7	CF/2.0	Attachment	Lensectomy+PPV+C_3F_8	5	IOLs	-	-	V(-)	22
12	6.9	HM/3.0	Reattachment	Lensectomy+PPV+SOE	4	SOR+PPV+C_3F_8	3	PPV+SOE	V(-)	20
13	8.3	HM/3.0	Attachment	Lensectomy+PPV+SOE	3	SOR+PPV+C_3F_8	-	-	V(-)	21
14	9.6	20/200/1.0	Attachment	Lensectomy+PPV+SOE	4	-	2.5	IOLs	V(-)	20
15	7.8	HM/3.0	Attachment	Lensectomy+PPV+SOE	4	-	-	-	V(-)	17
16	8.1	20/200/1.0	Attachment	Lensectomy+PPV+PR+SOE	6	SOR+PPV+SOE	-	-	V(-)	18
17	8.4	LP/LP	Reattachment	Lensectomy+PPV+SOE	4.5	SOR+PPV+SOE	6	SOR+PPV+SOE	V(-)	19
18	7.3	HM/3.0	Attachment	PPV+PR+SOE	7	SOR+PPV+SOE	-	-	V(-)	20
19	9.2	HM/3.0	Attachment	Lensectomy+PPV+SOE	5	-	-	-	V(-)	21
20	7.7	NLP/NLP	Attachment	Lensectomy+PPV+SOE	3.5	SOR+PPV+SOE	-	-	V(-)	14
21	8.5	HM/3.0	Attachment	Lensectomy+PPV+SOE	5	-	-	-	V(-)	12.5
22	7.3	20/200/1.0	Reattachment	Lensectomy+PPV+SOE	8	SOR+PPV+SOE	-	-	V(-)	12

BCVA: Best-corrected visual acuity; LP: Light perception; HM: Hand movement; NLP: No light perception; CF: Counting fingers; IOP: Intraocular pressure; PPV: Pars plana vitrectomy; SOE: Silicone oil endotamponade; S OR: Silicone oil removal; PR: Pupil reformation; CT: Corneal transplant; IOL: Intraocular lens implantation; IOLs: Intraocular lens suspension; V: Vitreous.

primary diagnosis and treatment. Other studies have also found that patients injured in a rural setting exhibited an increased risk of post traumatic endophthalmitis[15-16].

The most common etiology of penetrating ocular trauma was sharp injuries (*n*=13; 59.1%), such as those from pencils, sticks, scissors, metal wires, wood stick and cement nails. Both Bayar *et al*[16] and Dehghani *et al*[17] reported similar findings. Regarding microbial culture results in our study, only two of the 22 patients (9.1%) were culture-positive (one fungus and one *Pneumoniae*). Importantly, most hospitals do not have adequate microbiology facilities to test for pathogenic bacteria. In previous studies, culture-positive rates were 44%-75%[18-19]; thus, many patients were culture-negative. Regardless of positive or negative microbiological test results, improved visual outcomes may be achieved by providing the best initial management strategy using intravitreal antibiotics combined with vitrectomy, as soon as possible[20-21]. However, completion of a single PPV procedure was typically not sufficient treatment. Further treatment operations, such as SO removal, SO endotamponade, and IOL implantation, were often implemented to maintain the shape of the eye and ensure better visual outcomes. In the present study, all patients with pediatric endophthalmitis achieved successful infection control. Bayar *et al*[16] reported similar results. As shown in Tables 1 and 2, the final BCVAs were 20/200 or better in five patients. This proportion was smaller than the 40% observed in a previous study[13]. As shown in Table 2, patients who underwent PPV+SO injection in the primary PPV operation (81.8%) had worse visual recovery than those who underwent PPV+C_3F_8 in the first PPV operation (18.2%; *P*=0.026, Fisher's exact test). Patients who underwent SO might have had worse outcomes because traumatic endophthalmitis resulted in serious ocular damage that limited overall visual recovery.

The rate of RD as a complication of pediatric endophthalmitis was reportedly 38% in previous studies[4]. However, in our study, only two patients exhibited RD within 3-4d of presentation, which was a common result of trauma. In addition, two patients had traction RD after the second PPV operation, which was likely a complication of surgery; these patients received a third PPV operation with SO and both

Table 3 Predictors of final visual outcomes

Variable	Final BCVA		*P* (Fisher's exact test)
	≥CF	<CF	
Sex			
M	6	8	0.603
F	1	4	
Age (y)			
≥5	6	11	0.999
<5	1	1	
Eye			
Left	5	7	0.656
Right	2	5	
Etiology			
Sharp	4	7	0.999
0	2	5	
Onset of PPV (d)			
≥5	1	5	0.333
<5	6	7	
Lesion			
Retinal injury	2	10	0.019
No retinal injury	6	2	
First operation			
PPV+C_3F_8 (*n*=4)	3	0	0.026
PPV+SO (*n*=18)	4	14	

BCVA: Best-corrected visual acuity; CF: Counting fingers; PPV: Pars plana vitrectomy; C_3F_8: C_3F_8 endotamponade; SO: Silicone oil endotamponade. *P*<0.05 means the difference is statistically significant.

achieved retinal stability. The final IOP was 8.9±1.8 mm Hg. Four patients exhibited band-shaped degeneration of the cornea during follow-up after their third PPV operation, which influenced final vision recovery

There were some limitations in the present study. First, the sample size was limited to 22 patients, which precluded some statistical analyses. Additionally, the data were all from a hospital and may not be representative of patients who are treated in other settings, thus limiting the generalizability of the findings. Second, because the primary treatments were performed by different surgeons, patients experienced variable delays in treatment; moreover, the primary BCVA and other data were not be collected in a consistent manner. Third, for microbial cultures, only two eyes had positive vitreous cultures (fungus and *Pneumoniae*). Thus, we were unable to determine any associations between these organisms and the final BCVA in our patients.

In conclusion, traumatic endophthalmitis in children is generally more severe and associated with more complicated surgical procedures. Most patients underwent SO endotamponade in the primary PPV operation had more serious ocular damage that resulted in worse visual recovery, compared with patients who underwent C_3F_8 in the first PPV operation. Despite advanced management of intravitreal antibiotics combined with vitrectomy for all patients in this study, most patients need multiple operations and the final BCVA is poor. Prevention of ocular trauma, especially in children, is still critical.

ACKNOWLEDGEMENTS

We thank Ryan Chastain-Gross, Ph.D., from Liwen Bianji, Edanz Group China (www.liwenbianji.cn/ac), for editing the English text of a draft of this manuscript.

Authors' contributions: Wang ZY and Zhou YL conceived and designed the study. Zhou YL, Wang ZY collected the data. Yao TT performed the data statics and analysis. Zhou YL wrote the paper. Wang YX and Yang Y reviewed and edited the manuscript.

Foundations: Supported by the National Natural Science Foundation of China (No.81770934); Shanghai Municipal Education Commission-Gaofeng Clinical Medicine Grant Support (No.20181810).

Conflicts of Interest: Zhou YL, None; **Wang YX,** None; **Yao TT,** None; **Yang Y,** None; **Wang ZY,** None.

REFERENCES

1 Greenwald MJ, Wohl LG, Sell CH. Metastatic bacterial endophthalmitis: a contemporary reappraisal. *Surv Ophthalmol* 1986;31(2):81-101.

2 Forster RK, Abbott RL, Gelender H. Management of infectious endophthalmitis. *Ophthalmology* 1980;87(4):313-319.

3 Zhang M, Xu GZ, Jiang R, Ni YQ, Wang KY, Gu RP, Ding XY. Pediatric infectious endophthalmitis: a 271-case retrospective study at a single center in China. *Chin Med J* 2016;129(24):2936-2943.

4 Sheng Y, Sun W, Gu YS, Grzybowski A. Pediatric posttraumatic endophthalmitis in China for twenty years. *J Ophthalmol* 2017;2017:5248767.

5 Wu HX, Ding XY, Zhang M, Xu GZ. Pediatric posttraumatic endophthalmitis. *Graefes Arch Clin Exp Ophthalmol* 2016;254(10):1919-1922.

6 Thordsen JE, Harris L, Hubbard GB 3rd. Pediatric endophthalmitis. A 10-year consecutive series. *Retina* 2008;28(3 Suppl):S3-S7.

7 Al-Rashaed SA, Abu El-Asrar AM. Exogenous endophthalmitis in pediatric age group. *Ocul Immunol Inflamm* 2006;14(5):285-292.

8 Li XT, Zarbin MA, Bhagat N. Pediatric open globe injury: a review of the literature. *J Emerg Trauma Shock* 2015;8(4):216-223.

9 Rishi E, Rishi P, Koundanya VV, Sahu C, Roy R, Bhende PS. Post-traumatic endophthalmitis in 143 eyes of children and adolescents from India. *Eye (Lond)* 2016;30(4):615-620.

10 Alfaro DV, Roth D, Liggett PE. Posttraumatic endophthalmitis. Causative organisms, treatment, and prevention. *Retina* 1994;14(3):206-211.

11 Pieramici DJ, Sternberg P Jr, Aaberg TM Sr, Bridges WZ Jr, Capone A Jr, Cardillo JA, de Juan E Jr, Kuhn F, Meredith TA, Mieler WF, Olsen TW, Rubsamen P, Stout T. A system for classifying mechanical injuries of the eye (globe). The Ocular Trauma Classification Group. *Am J Ophthalmol* 1997;123(6):820-831.

12 Cakir M, Cekiç O, Pekel G, Yilmaz OF. Pars plana vitrectomy results of exogenous endophthalmitis in children. *Eur J Ophthalmol* 2010;20(2):424-428.

13 Jiang T, Jiang J, Wang RP, Lei JL, Zhou Y. Visual outcomes and prognostic factors after pars Plana vitrectomy for traumatic endophthalmitis. *Biomed Res Int* 2017;2017:5851318.

14 Narang S, Gupta V, Simalandhi P, Gupta A, Raj S, Dogra MR. Paediatric open globe injuries. Visual outcome and risk factors for endophthalmitis. *Indian J Ophthalmol* 2004;52(1):29-34.

15 Essex RW, Yi Q, Charles PG, Allen PJ. Post-traumatic endophthalmitis. *Ophthalmology* 2004;111(11):2015-2022.

16 Bayar H, Coskun E, Öner V, Gokcen C, Aksoy U, Okumus S, Erbagci I. Association between penetrating eye injuries and attention deficit hyperactivity disorder in children. *Br J Ophthalmol* 2015;99(8):1109-1111.

17 Dehghani AR, Rezaei L, Salam H, Mohammadi Z, Mahboubi M. Post traumatic endophthalmitis: incidence and risk factors. *Glob J Health Sci* 2014;6(6):68-72.

18 Alfaro DV, Roth DB, Laughlin RM, Goyal M, Liggett PE. Paediatric post-traumatic endophthalmitis. *Br J Ophthalmol* 1995;79(10):888-891.

19 Durand ML. Bacterial and fungal endophthalmitis. *Clin Microbiol Rev* 2017;30(3):597-613.

20 Puliafito CA, Baker AS, Haaf J, Foster CS. Infectious endophthalmitis. Review of 36 cases. *Ophthalmology* 1982;89(8):921-929.

21 Rejdak R, Juenemann AG, Natarajan S. Posterior segment ocular trauma: timing and indications for vitrectomy. *J Ophthalmol* 2017;2017:5250924.