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Predictive factors of visual outcome in posterior segment intraocular foreign body

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Abstract

Background: To identify the predictive factors for visual outcomes of patients with posterior segment intraocular foreign body (IOFB) after open-globe injury.

Methods: A retrospective, interventional study was conducted to evaluate consecutive patients with retained posterior segment IOFB who underwent vitrectomy over a 10-year period from 2007 to 2016. Multivariate linear regression analysis was used to identify the potential predictive factors for final visual outcomes.

Results: Forty-two patients were evaluated, with predominantly males (97.6%) and mean age 37.21 years. Hammering on metal (47.62%) was the major mechanism of injury. The majority of foreign bodies were metallic (95.24%) with a mean dimension of 4.3 mm. Twenty-four (57.14%) patients initially presented with a Snellen visual acuity <6/60. After surgery, 19 (45.24%) eyes had final visual outcomes of 6/12 or better; however, visual outcomes worse than 6/60 were documented in 17 (40.48%) eyes. Multivariate linear regression analysis revealed that the occurrence of retinal detachment (RD; $p<0.01$) and larger IOFB dimension ($p=0.02$) independently predicted worse final visual outcomes after adjusting for age and initial VA. Eyes with entry wounds located posteriorly into the sclera significantly increased the risk of RD compared to eyes with entry wounds involving cornea only ($p=0.03$). There was no association between time interval for IOFB removal and development of endophthalmitis.

Conclusion: RD and larger IOFB dimension are significant predictive factors associated with worse final visual outcomes. Increased time to IOFB removal is not associated with either a higher risk of endophthalmitis or worse visual outcomes.

Keywords: Trauma; Visual acuity; Vitrectomy

1. INTRODUCTION

Ocular trauma is a major cause of visual loss in young adults worldwide. Retained intraocular foreign body (IOFB) is a serious ocular injury and accounts for about 17% to 41% of penetrating ocular injuries.[1–2] Despite advances in vitreoretinal surgery in recent years, many patients with posterior segment IOFBs still have poor visual outcomes.[3–5] In the literature, 5%–31% of patients who sustained IOFB injuries had a final visual acuity (VA) of <6/60.[3] Even with initial successful removal of IOFB, retinal detachment (RD), endophthalmitis and proliferative vitreoretinopathy (PVR) may occur postoperatively and impact the final visual outcome. Therefore, the proper management of ocular penetrating injuries with posterior segment IOFB remains an important issue that is worthy of further study.

The purpose of this study was to analyze the clinical features, mechanisms of injury, surgical interventions, and visual outcomes of patients with retained posterior segment IOFB after open-globe injuries who underwent vitrectomy surgery at a major medical referral center. In this study, we highlight the predictive factors probably associated with an increased risk of poor final VA, and the predictive factors associated with endophthalmitis or RD. By identifying these predictive factors, clinicians may counsel patients about visual outcomes of this serious ocular trauma.

2. METHODS

A retrospective, interventional study was conducted to evaluate consecutive patients with retained posterior segment IOFB after open-globe injury who underwent pars plana vitrectomy over a 10-year period from 2007 to 2016. The study was conducted in accordance with the Declaration of Helsinki, and the study protocol was approved by the Institutional Review Board of Taipei Veterans General Hospital. Only the patients who had received vitrectomy surgery to remove an IOFB and had at least 6 months of follow-up were included in this study. Patients with anterior segment IOFB or incomplete medical records were excluded.

All patients underwent detailed trauma history taking and complete ophthalmological examination at the presentation, including measurements of Snellen best-corrected visual acuity (BCVA), intraocular pressure, slit-lamp biomicroscopy, color fundus photography, and indirect ophthalmoscopy. The Snellen VA was converted to the logarithm of the minimal angle of resolution (LogMAR) for statistical analysis and comparison. The diagnosis of posterior segment IOFB was confirmed by computed tomography (CT) imaging scan before operation. The

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ocular injuries were classified according to the Birmingham Eye Trauma Terminology. The definition of open-globe injury is ocular injury with a full-thickness wound to the eyeball. Posterior segment IOFB indicates open-globe injury with retained IOFB in the ocular posterior segment. Entry wounds for retained IOFB were categorized according to the most posterior extent of the wound, as either involving the cornea only (zone 1) or an entry wound located posteriorly into the sclera (zone 2), as either corneoscleral wounds or scleral wounds. Diagnosis and treatment of endophthalmitis were made clinically by a physician, mainly on the basis of clinical symptoms and signs. A microorganism culture of the aqueous or vitreous humor was performed in some patients. The culture results were adjunct to the diagnosis of endophthalmitis. Dimension of IOFB refers to the largest diameter of the IOFB.

All the surgeries were performed by trained vitreoretinal surgeons at our department. The patients were operated under general anesthesia. All surgical procedures included the following steps: three-port, 20 or 23 gauge pars plana vitrectomy setting, core vitrectomy, and removing all vitreous traction around IOFB under the aid of triamcinolone acetonide. The IOFB was mobilized and removed with intraocular forceps or intraocular magnets after enlargement of sclerotomy wound. After IOFB removal, peripheral retinal examination was carefully performed to detect any retinal breaks under scleral depression. Retinal breaks related to the IOFB injury was treated with endolaser photocoagulation or cryopexy. In patients with concomitant RD, injection of sulfur hexafluoride gas or silicone oil tamponade was performed at the end of surgery. The use of sclera buckle placement was according to the surgeon's discretion. When the surgical view was significantly blurred due to the traumatic cataract opacity, simultaneous cataract surgery was performed to allow clearer visualization of the posterior segment.

Medical data of patients included the following: age and gender of patients, mechanism of injury, dimension and nature of IOFB, location of entrance wound, wound size, initial VA, associated ocular injuries, methods used to locate the IOFB, time from injury to primary repair, time interval from injury to IOFB removal, surgical techniques, subsequent surgical procedures, and final VA. Final BCVA of 6/7.5 or better was defined as an excellent visual outcome. A poor visual outcome was defined as final VA of 6/60 or worse.

To identify the probable predictive factors associated with final visual outcomes in patients with posterior segment IOFB, the clinical data were statistically analyzed. Clinical variables evaluated for association with visual outcomes included the following: age of the patients; location and size of entrance wound; initial VA; associated ocular injuries including RD, vitreous hemorrhage, macular lesion, endophthalmitis, and PVR; dimension of the IOFB; occurrence of RD; endophthalmitis; and the time interval from injury to IOFB removal.

2.1. Statistical analysis

All subjects were divided into three groups according to final VA: group 1, poor visual outcome (VA<6/60); group 2, moderate visual outcome (6/60≤VA<6/7.5); and group 3, excellent visual outcome (VA≥6/7.5). Statistical analysis of the data was performed using SPSS software (SPSS Inc., Chicago, IL, USA), version 17.0. Analysis of variances and Pearson correlation were used to analyze differences in patient demographics and ocular data among the three groups. Univariate linear regression analysis was performed to identify the prognostic variables associated with final visual outcomes. Multivariate linear regression analysis was used to identify the potential predictive factors for final visual outcomes after adjustment for age and initial VA by the enter method. Logistic regression analysis was also used to assess the predictive factors associated with endophthalmitis or RD. In all analyses, $p<0.05$ was considered as statistically significant.

3. RESULTS

Of 62 patients, 62 eyes were identified as having sustained penetrating ocular injury and retaining IOFB that required surgical management. Of 62 patients, seven patients with anterior segment IOFB were excluded and 13 patients were excluded due to insufficient data in the medical records, including <6 months follow-up period in eight cases and lack of CT scan before operation in five cases. Overall, 42 patients with posterior segment IOFB were evaluated in this study, with males predominating, at 41 (97.6%) patients. The right eye was injured in 16 (38.1%) cases and the left in 26 (61.9%) cases. The mean age was 37.21 years. The mean follow-up period was 41.5 months (range: 6-253 months).

3.1. Clinical presentation, features of entry wound, and IOFB

Hammering on metal, in 20 (47.62%) eyes, was the most common mechanism of penetrating ocular injuries. Other construction work-related injury mechanisms included missile from lathe or machine in six (14.29%) eyes and shoot injuries in three (7.14%) cases. The majority of foreign bodies were metal (40 cases, 95.24%) with a mean dimension of 4.3 mm. The demographics, initial and final VA, location and size of entry wound, IOFB dimension, and time interval from injury to IOFB removal are shown in Table 1. All patients were divided into three groups

Table 1

Demographics, visual acuity, characteristics of wound, and IOFB in patients with posterior segment IOFB who were classified into three groups according to final VA

	Poor VA (VA<6/60)		Moderate VA (6/60≤VA< 6/7.5)		Excellent VA (VA≥6/7.5)		
	n=16		n=13		n=13		
	Mean±SD	n	Mean±SD	n	Mean±SD	n	*p*
Age, years	39.2±11.6		36.8±8.5		35.2±12.6		0.62
Gender							0.45
Male		15		13		13	
Female		1		0		0	
Time interval of IOFB removal (days)	5.6±8.0		8.5±21.3		5.8±12.5		0.85
Initial VA in LogMAR (Snellen equivalent)	2.2±0.7 (6/950)		1.1±0.9 (6/75)		0.7±0.8 (6/30)		<0.01
Final VA in LogMAR (Snellen equivalent)	2.4±0.5 (6/1507)		0.6±0.4 (6/24)		0.0±0.1 (6/6)		NA
Wound size (mm)	3.9±2.5		2.8±5.2		2.0±1.3		0.3
Entry wound location							0.6
Zone 1		10		7		10	
Zone 2		6		5		3	
IOFB dimension (mm)	7.1±5.6		3.6±3.8		2.2±0.8		<0.01

Zone 1: entry wound involving the cornea only.
Zone 2: entry wound located posterior to the limbus, either corneoscleral wound or scleral wound.
IOFB = intraocular foreign body; LogMAR = logarithm of the minimal angle of resolution; NA = not applicable; VA = visual acuity.

according to final VA: group 1, poor visual outcome (VA<6/60); group 2, moderate visual outcome (6/60≤VA<6/7.5); and group 3, excellent visual outcome (VA≥6/7.5). The analysis of variances and Pearson correlation analysis showed that there were statistically significant differences in initial VA and IOFB dimension among the three groups ($p<0.01$), as shown in Table 1. Twenty-four (57.14%) patients initially presented with a Snellen VA <6/60. After surgical removal of IOFB, 19 (45.24%) eyes had a final visual outcome of 6/12 or better; however, visual outcomes worse than 6/60 were documented in 17 (40.48%) eyes. Entry wounds involving the cornea only (zone 1), in 27 (64.29%) cases, were the most common location. These were followed by entry wounds located posteriorly into the sclera (zone 2), including corneoscleral wounds <5 mm from the limbus, in eight (19%) cases, and scleral wound located >5 mm from limbus, in six (14.29%) cases. Wound size was <3 mm in 21 (50%) eyes, 3 to 5 mm in five (11.9%) eyes, and >5 mm in seven (16.7%) eyes. Self-sealing corneal wounds were noted in six (14.28%) eyes. Mean dimension of IOFB was 2.6 mm, 9.0 mm, and 7.2 mm in the hammering injury, shoot injury, and lathe injury, respectively. The analysis of variance showed that the IOFB dimension was statistically associated with the mechanism of injury ($p=0.007$). Hammering injuries were associated with a statistically smaller IOFB dimension than missile IOFB in lathe injury ($p=0.05$) and IOFB in shoot injury ($p=0.04$). The median time interval from trauma to presentation was 3 days, and the median time interval from injury to IOFB removal was 6 days.

3.2. Ocular injuries and surgical management

Associated ocular injuries and signs included traumatic cataracts in 37 (88.1%) eyes, vitreous hemorrhages in 29 (69.05%) eyes, retinal breaks in 21 (50%) eyes, RD in 23 (54.76%) eyes, hyphema in 13 (30.95) eyes, endophthalmitis in eight (19.05%) eyes, and prolapse of uveal tissue in six (14.29%) eyes. Table 2 shows the associated ocular injuries in patients with posterior segment IOFB, as divided among the three different visual outcome groups. The locations of IOFB included the vitreous cavity in 10 (23.81%) eyes, retina in 30 (71.43%) eyes, subretinal space in one eye, and orbital cavity in one eye.

During the initial surgical procedure, in a majority of patients with posterior segment IOFB, the foreign body was removed using vitrectomy surgery and intraocular forceps in 39 (92.86%) patients and intraocular magnet in three (7%) patients. Ancillary surgical techniques in the management of retained IOFB included endolaser photocoagulation (30 eyes), gas tamponade (23 eyes), cryopexy (16 eyes), sclera buckle placement (10 eyes), and silicone oil (one eye). Lens extraction during surgery was performed in 23 (54.76%) patients. Simultaneous intraocular lens (IOL) implantation was performed in two eyes. Secondary IOL implantation with sulcus lens implantation was performed in 14 eyes.

3.3. Predictive factors for visual outcomes

Univariate linear regression analysis was performed to identify the prognostic variables associated with final LogMAR VA. Univariate analysis revealed multiple factors associated with final visual outcomes. These factors included the initial VA, occurrence of RD, dimension of IOFB, and IOFB location ($p<0.01$) (Table 3). Furthermore, the potential predictive factors for visual outcomes were analyzed using multivariate linear regression analysis after adjustment for age and initial VA. Table 4 shows that postoperative final VA was significantly associated with the

Table 2

Associated ocular injuries of posterior segment intraocular foreign body among three groups of different visual outcome

	Visual outcome		
	Poor (VA<6/60)	Moderate (6/60≤VA<6/7.5)	Excellent (VA≥6/7.5)
Ocular findings	n=16	n=13	n=13
Hyphema	6	6	1
Damage of iris	7	6	4
Uveal prolapse	5	1	0
Lens subluxation	4	0	0
Lens capsule damage	3	4	2
Traumatic cataract	12	12	13
Vitreous hemorrhage	13	8	8
Endophthalmitis	5	3	0
Retinal detachment	14	5	4
Macular lesions	4	2	3
Proliferative vitreoretinopathy	9	3	3

VA = visual acuity.

Table 3

Univariate linear regression analysis of the associated factors for worse final VA in patients with IOFB

	p	R^2	Regression coefficient β	95% CI
Vitreous hemorrhage	0.10	–0.02	0.61	–0.12 to 1.33
Endophthalmitis	0.10	0.01	0.70	–0.15 to 1.55
Retinal detachment	<0.01	0.19	1.18	0.60 to 1.76
Macular lesions	0.98	0.03	0.01	–0.82 to 0.84
Proliferative vitreoretinopathy	0.15	0.08	0.51	–0.19 to 1.22
Initial VA	<0.01	0.21	0.73	0.47 to 0.99
Age	0.69	–0.04	0.01	–0.03 to 0.04
Time interval of IOFB removal	0.56	–0.02	–0.01	–0.03 to 0.02
Entry wound Location	0.59	–0.03	0.13	–0.35 to 0.61
Wound size	0.30	–0.05	0.06	–0.05 to 0.16
IOFB Location	0.02	0.04	–0.68	–1.25 to –0.12
IOFB dimension	<0.01	0.02	0.14	0.06 to 0.21

IOFB = intraocular foreign body; VA = visual acuity.

Table 4

Multivariate linear regression analysis of the associated factors for worse final visual acuity after adjustment for age and initial visual acuity by the enter method

	p	R^2	Regression coefficient β	95% CI
Endophthalmitis	0.37	0.16	0.31	−0.38 to 1.00
Retinal detachment	<0.01	0.33	0.72	0.20 to 1.23
Macular lesion	0.19	0.14	−0.49	−1.23 to 0.25
Time of IOFB removal	0.91	0.12	0	−0.02 to 0.02
Entry wound location	0.52	0.16	0.11	−0.24 to 0.47
Wound size	0.27	0.21	0.04	−0.04 to 0.12
IOFB dimension	0.02	0.09	0.08	0.01 to 0.15

IOFB = intraocular foreign body.

Table 5

Logistic regression analysis to identify the associated predictive factors for the development of endophthalmitis

Variables	*p*	Regression coefficient β	95% CI
Hyphema	0.04	5.42	1.06-27.81
Vitreous hemorrhage	0.66	0.70	0.14-3.47
Uvea prolapse	0.35	2.50	0.37-16.89
Time of IOFB removal	0.47	0.96	0.84-1.08
Wound size	0.56	1.07	0.86-1.32
Self-sealing wound	0.87	0.83	0.83-8.27
IOFB Location	0.16	0.29	0.05-1.62
IOFB dimension	0.16	1.14	0.95-1.36

IOFB = intraocular foreign body.

occurrence of RD and IOFB dimension. Patients with RD had worse final VA ($p<0.01$, regression coefficient β=0.72 [95% CI: 0.20-1.23]). Final VA for patients with RD decreased by 0.72 LogMAR units (approximately decreased by seven Snellen lines). Moreover, patients with IOFB of a larger size had worse final VA as compared to patients with smaller IOFB ($p=0.02$, β=0.08 [95% CI: 0.01-0.15]). Final VA decreased by 0.8 Snellen lines per millimeter increase in IOFB size.

3.4. Endophthalmitis and the associated factors

Endophthalmitis was diagnosed in eight (19%) patients in the current study. Bacterial cultures were performed preoperatively or during surgery for 20 patients. Among these patients, the positive culture rate was 40%. Intravitreal antibiotics injection in combination with vancomycin and ceftazidime was performed during operation in four patients. Topical antibiotics treatment was given to all patients. Logistic regression analysis showed that the timing of the IOFB removal, wound size, and whether or not the wound was self-sealing were not significant factors for the development of endophthalmitis. Hyphema was the statistically significant predictive factor associated with the development of endophthalmitis ($p=0.04$, regression coefficient β=5.42 [95% CI: 1.06-27.81]) (Table 5). In univariate logistic regression analysis, hyphema was also associated with sclera-involved wounds ($p=0.02$, regression coefficient β=5.87, 95% CI: 1.40-24.67) and larger IOFB size ($p<0.01$, regression coefficient β=1.45, 95% CI: 1.12-1.88). For each millimeter increase in IOFB diameter, the risk of hyphema was 1.45 times higher. Compared to corneal wounds alone, IOFB associated with scleral wound or limbus involvement has 5.87 times greater risk of hyphema.

3.5. RD and the associated factors

RD upon initial injury was diagnosed in 15 patients in the current study. RD during the postoperative follow-up period was noted in eight patients who underwent additional vitrectomy surgery. In the present study, all the abovementioned eight patients presented with traumatic cataract, and PVR development was noted

Table 6

Logistic regression analysis to identify the associated predictive factors for retinal detachment

Variables	*p*	Regression coefficient β	95% CI
Hyphema	0.06	4.10	0.93-18.08
Vitreous hemorrhage	0.16	2.62	0.68-10.06
PVR	0.06	3.44	0.87-13.57
Time of IOFB removal	0.32	0.97	0.92-1.03
Wound size	0.17	1.24	0.92-1.67
Wound location at zone 2	0.03	5.33	1.2-23.66
Self-sealed wound	0.27	0.36	0.06-2.21
IOFB Location	0.90	0.91	0.21-4.01
IOFB dimension	0.06	2.29	0.98-5.36

Wound location at zone 2: entry wound located posteriorly into sclera as either corneoscleral wound or scleral wound.
IOFB = intraocular foreign body; PVR = proliferative vitreoretinopathy.

in six (75%) cases. Logistic regression analysis showed that entry wounds located in zone 2 significantly increased the risk of RD occurrence. Eyes with entry wounds located posteriorly into the sclera had a risk of RD 5.33 times greater than eyes with entry wounds involving the cornea only ($p=0.03$, regression coefficient β=5.33 [95% CI: 1.20-23.66]) (Table 6). Moreover, the following three variable factors had a trend toward a higher risk of RD: larger IOFB size ($p=0.06$, regression coefficient β=2.29 [95% CI: 0.98-5.36]), hyphema ($p=0.06$, regression coefficient β=4.1 [95% CI: 0.93-18.08]), and PVR ($p=0.06$, regression coefficient β=3.44 [95% CI: 0.87-13.57]).

4. DISCUSSION

Penetrating ocular injury with retained IOFB may result in severe ocular morbidity and visual loss in the working-age population.[6] In the current study, after surgical intervention, a majority of eyes had a significant improvement, with final visual outcomes of 6/12 or better in 19 (45.24%) eyes. However, visual outcomes worse than 6/60 were documented in 17 (40.48%) eyes. Multivariate statistical analysis was used to identify the factors contributing to prediction of visual outcomes. We demonstrated that the occurrence of RD and larger IOFB dimension are important predictive factors for worse visual outcomes in patients with posterior segment IOFB. Final VA decreased by 0.8 Snellen lines per one millimeter increase in IOFB size. Moreover, entry wounds located posteriorly into the sclera significantly increased the risk of RD occurrence.

The majority of our patients were male (97.6%) and relatively young (mean age 37.21 years), which was similar to the demographic features of previous studies.[7–8] In our study, hammering metal and lathe-related activity comprised 61.9% of all ocular injury mechanisms.[7,9] In the current study, the cornea was the most common entry wound location (zone 1) (64.29%), and the vitreous humor and retina were the most common IOFB location (95.24%); this is similar to prior studies.[8–10] The most common associated ocular injury was traumatic cataracts (88.1%), followed by vitreous hemorrhage (69.05%), retinal breaks (50%), RD (54.76%), hyphema (30.95%), endophthalmitis (19.05%), and prolapse of the uvea tissue (14.29%). Simultaneous cataract surgery was performed during IOFB removal to allow clearer visualization of the posterior segment in 23 patients who had traumatic cataract opacity. Two patients underwent one-stage combined surgery, with primary implantation of an IOL in the bag, to achieve rapid visual rehabilitation.[11] However, most patients were left aphakic initially, due to the concern of increased risk in endophthalmitis and inaccurate IOL power calculation.[12] Secondary IOL implantation with sulcus lens implantation was performed in most eyes.

Advanced modern vitroretinal surgical instruments, including intraocular forceps and magnets, have provided theoretically better control in ferromagnetic IOFB removal than traditional external magnets in the treatment of posterior segment IOFBs.[3–5,13–14] In addition to IOFB removal, the role of pars plana vitrectomy in the management of penetrating ocular injury included vitreous hemorrhage, retinal break with RD, and traumatic endophthalmitis. The additional advantage of vitrectomy is its ability to remove IOFBs harboring infectious organisms, inflammatory debris, and cells during operation.[15–17] Recent advances in vitreoretinal surgical instruments have enabled hybridization with a small-gauge vitrectomy in the operation of patients with IOFB, which may result in reduced inflammation and edema due to shortening of the operation time and decreased postoperative astigmatism.[18–19] Our study has also demonstrated that advances in surgical techniques are associated with a significant improvement in visual outcome. In the current study, although 24 (57.14%) eyes initially presented with a Snellen VA <6/60 and only 12 (28.57%) eyes had initial VA better than 6/12, after successful management and removal of IOFB, 19 (45.24%) eyes had improved final visual outcome to 6/12 or better. However, 17 (40.48%) eyes still had poor visual outcome worse than 6/60.

In the present study, the probable predictive factors associated with final visual outcomes for posterior segment IOFB injuries were analyzed.[20–23] When all patients were divided into three groups according to final VA, there were statistically significant difference in initial VA and IOFB dimension among the three groups. Furthermore, univariate linear regression analysis in our study revealed multiple factors associated with the final LogMAR visual outcome, including initial VA, occurrence of RD, and IOFB dimensions and location. Few studies in the literature have evaluated the predictive factors for visual outcomes using a multivariate analysis. Ehlers et al. have reported that posterior segment IOFB location, younger age, and increased wound length are significant predictors for poor final vision.[24] Our study demonstrated that, in multivariate linear regression analysis and after adjustment for age and initial VA, the occurrence of RD and larger IOFB dimensions independently predicted worse final visual outcomes. In the present study, the final VA of patients with RD decreased by 0.72 LogMAR unit (approximately decreased by seven Snellen lines). In the present study, we also demonstrate that lack of endophthalmitis, lack of RD, and smaller IOFB size are statistically significant variables for excellent visual outcomes (VA≥6/7.5). Conversely, the development of RD is a significant variable for poor visual outcomes (VA<6/60).

In the current study, we demonstrate that IOFB dimension is a significant predictive factor for final visual outcome in patients with posterior segment IOFB. Moreover, the final VA decreased by 0.8 Snellen lines per one millimeter increase in IOFB size. Furthermore, our study demonstrates that IOFB dimension was associated with the mechanism of injuries and the IOFB dimension in hammering injury is significantly smaller than IOFB size in lathe injury. Valmaggia et al., in a recent study, have also reported that ocular injuries with a metallic IOFB in the posterior segment as a result of hammering have a good visual outcome unless the macula is involved.[23] IOFB size plays a significant role in the final anatomic and visual outcome; generally, larger IOFBs give a guarded prognosis.

Traumatic RD is an ocular morbidity that may result in serious ocular sequelae after an IOFB injury. In the current study, entry wounds located in zone 2 significantly increased the risk of RD occurrence. In logistic regression analysis, entry wounds located posteriorly into the sclera increased the risk of RD by 5.33 times compared to entry wounds involving the cornea only. Under scleral depression, a thorough peripheral retinal examination is crucial to detect any retinal break after IOFB removal. All patients should be closely followed up for RD and PVR formation in the postoperative period. In the current study, RD during the postoperative follow-up period was noted in eight (19%) patients, who required additional vitrectomy surgery. Ehlers et al. have also reported that 27% of patients with metallic IOFB required secondary surgery for RD repair.[24] In addition to endolaser photocoagulation and gas tamponade, or silicone oil in the management of retinal breaks and detachment, scleral buckle placement was done in 10 eyes in the current study. Azad et al. have also reported that concomitant scleral buckle procedure at the time of IOFB removal surgery may reduce the risk of RD by 24%.[25] In addition to undetected retinal breaks, PVR is the main cause of RD development after IOFB removal. Trauma and the inciting inflammation after open-globe injury are the risk factors for development of PVR.[26] In the present study, larger IOFB, hyphema, and PVR show a trend toward a higher risk of RD. We hypothesize that occurrence of hyphema after severe ocular trauma associated with larger IOFB leads to extensive retinal damage and choroidal lesions, which may increase the risk of PVR formation.

Traumatic endophthalmitis was initially present in eight (19.05%) eyes with retained IOFB after open-globe injury in the present study. Prompt diagnosis and early antibiotics are the most critical steps in the treatment of traumatic endophthalmitis. The early signs of endophthalmitis may be obscured by associated ocular injuries.[27] Therefore, the diagnosis of endophthalmitis requires a high degree of suspicion. Ophthalmologists should be alert and wary of bacterial infection whenever any object contaminated with soil penetrates the eyeball. Our current study has demonstrated early intravitreal antibiotics and prompt vitrectomy to remove the contaminating IOFB, which may salvage useful vision in patients of traumatic endophthalmitis with retained IOFB. Immediate removal of IOFB has been reported to reduce the incidence of endophthalmitis.[17,28] In the present study, IOFB removal surgery was performed within 24 hours after patient presentation to our hospital. However, the time interval for IOFB removal was not associated with either the visual outcome or risk of endophthalmitis in our study. The median time interval from injury to IOFB removal was 6 days, due to delays in presentation. This is because our hospital is a tertiary referral center that receives relatively severe patients for referrals. Recent studies have also reported delayed IOFB removal not influencing the final visual outcome, as long as the lacerated wound is repaired promptly and prophylactic antibiotics are prescribed.[3,29] We hypothesize that it is the injury itself (intraocular intrusion of the contaminated IOFB), rather than the time of IOFB retention, that increases the risk of developing endophthalmitis after open-globe injury in the present study. The presence of hyphema is related to the higher rate of endophthalmitis in the current study. We hypothesized that hyphema may be correlated to a larger IOFB dimension, a severe traumatic injury with ocular blood barrier disruption, and lead to the development of endophthalmitis after intraocular intrusion of contaminated IOFB.

The potential limitations of our study include its retrospective nature and nonrandomized study design. In the future, a randomized prospective clinical trial will be required to determine other prognostic factors to predict visual outcomes, such as initial severity of ocular injuries, early surgical intervention, features of the wound and IOFB, and prophylactic antibiotic injection in patients with retained IOFB. Nevertheless, this study followed a cohort of patients with posterior segment IOFB for a long period and provides valuable information about long-term outcomes following surgery. Furthermore, RD and IOFB dimension have been identified as important predictive factors for visual outcomes.

In conclusion, ocular injury with posterior segment IOFB continues to be a major cause of ocular morbidity and visual loss in the working-age population. Domestic occupational safety regulation and awareness of importance of eye goggle protection by the public health education can help to decrease the incidence of IOFB ocular injury in the future. Our study demonstrates that the occurrence of RD and larger IOFB dimension are significant predictive factors associated with worse final VA in patients with posterior segment IOFB. Entry wounds located posteriorly into the sclera significantly increase the risk of RD. Factors associated with good visual outcomes included smaller IOFB size, lack of endophthalmitis, and no RD. To clinicians, this study will provide useful information about the visual prognosis. Patients should be informed about the uncertainty of visual outcomes and the potential need for additional surgery.

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