23-Gauge Vitrectomy for the Removal of the Intraocular Foreign Bodies in the Posterior Segment: Visual Outcomes and Prognostic Factors

Arka Segmentteki İntraoküler Yabancı Cisimlerin Çıkarılmasında 23-Gauge Vitrektomi Uygulanması: Görsel Sonuçlar ve Prognostik Faktörler

Pelin YILMAZBAŞ[1], Sibel DOĞUİZİ[2], Mehmet Ali ŞEKEROĞLU[2], Salih ÇOLAK[3]

ABSTRACT

Background: We aimed to evaluate the clinical characteristics, prognostic factors and visual outcomes of patients with intraocular foreign bodies (IOFBs) who underwent 23-gauge pars plana vitrectomy (PPV).

Material and Methods: In this retrospective study, the medical files of the patients who underwent 23-gauge transconjuctival PPV for the removal of IOFB retained in the posterior segment between January 2013 and January 2016 were evaluated. The primary outcome parameter was the best-corrected visual acuity (logMAR). Association between visual outcome and various

preoperative, operative, and postoperative variables was statistically analyzed.

Results: Forty-one eyes of 41 patients (40 males, 1 female; mean age 34.6±12.3 years, age range 18–70 years were evaluated. The initial BCVA significantly increased after surgical operation (from 1.42±0.58 to 0.83±0.74, respectively, p<0.001). In the stepwise multivariate logistic regression analysis, macular involvement (β=0.974, p<0.001), vitreous hemorrhage (β=0.215, p=0.049), and low ocular trauma score (β=-0.017, p=0.007) were the independent significant predictors of the poor final visual acuity.

Conclusion: 23-gauge transconjuctival PPV is an effective and safe surgical procedure for the removal of IOFB retained in the posterior segment. The presence of macular involvement, vitreous hemorrhage, and lower ocular trauma score are negative prognostic factors affecting the final visual acuity.

Key Words: Intraocular foreign body, ocular trauma, 23-gauge PPV.

ÖZ

Amaç: Göz içi yabancı cisim nedeniyle 23-gauge pars plana vitrektomi (PPV) uygulanan hastaların klinik özelliklerinin, cerrahi sonrası görsel sonuçlarının ve prognozu etkileyen faktörlerin belirlenmesi amaçlanmıştır.

Gereç ve Yöntemler: Kliniğimizde Ocak 2013 ile Ocak 2016 tarihleri arasında arka segmente yerleşmiş intraoküler yabancı cisim nedeniyle 23-gauge PPV uygulanan hastaların dosya kayıtları retrospektif olarak incelendi. Çalışma kapsamında incelenen temel sonuç parametresi en iyi düzeltilmiş görme keskinliği (EİDK) (logMAR) idi. Ayrıca görsel sonuçlar üzerinde etkili olabilecek preoperatif, intraoperatif ve postoperatif parametreler analiz edildi.

Bulgular: Çalışma kapsamına 41 hastanın 41 gözü dahil edildi (40 erkek, 1 kadın; ortalama yaş; 34.6±12.3, yaş aralığı 18–70 yıl). Görme keskinliği cerrahi sonrası istatistiksel olarak anlamlı düzeyde yükseldi (Başlangıç EİDK: 1.42±0.58; Son takip EİDK: 0.83±0.74, logMAR, p<0.001). Yabancı cisme bağlı makulada etkilenme olması (β=0.974, p<0.001), vitreus hemorajisi varlığı (β=0.215, p=0.049), ve düşük oküler travma skoru (β=-0.017, p=0.007) düşük sonuç görme keskinliği ile ilişkili bağımsız risk faktörleri olarak belirlendi.

Sonuç: 23-gauge PPV arka segmentteki intraoküler yabancı cisimlerin tedavisinde etkili ve güvenli bir tedavidir. Yabancı cisme bağlı makulada etkilenme olması, vitreus hemorajisi varlığı ve düşük oküler travma skoru görme keskinliği üzerine negatif etkili prognostik faktörler olarak belirlenmiştir.

Anahtar Sözcükler: İntraoküler yabancı cisim, oküler travma, 23-gauge PPV.

1- Prof. Dr., Ulucanlar Göz Eğitim ve Araştırma Devlet Hastanesi, Oftalmoloji, Ankara - Türkiye

2- Uz. Dr., Ulucanlar Göz Eğitim ve Araştırma Devlet Hastanesi, Oftalmoloji, Ankara - Türkiye

3- Asist. Dr., Ulucanlar Göz Eğitim ve Araştırma Devlet Hastanesi, Oftalmoloji, Ankara - Türkiye

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Yazışma Adresi / Correspondence Adress:
Pelin YILMAZBAŞ
Ulucanlar Göz Eğitim ve Araştırma Devlet Hastanesi, Oftalmoloji, Ankara - Türkiye

Phone: +090 532 463 7651
E-mail: eryigits@yahoo.com

INTRODUCTION

Intraocular foreign bodies (IOFBs) are serious form of eye trauma that can lead to significant visual loss.[1] Ocular trauma caused by IOFBs are often associated with corneal and scleral penetrating injury, hypheama, vitreous hemorrhage, traumatic cataract, retinal detachment or more severe complications such as endophthalmitis.[2] Among the open-globe injuries, the traumas related to IOFBs are classified separately because of their unique clinical characteristics.[3] Several studies have reported the outcome of pars plana vitrectomy (PPV) for posterior segment IOFBs and have evaluated the visual prognostic values of different preoperative, operative, and postoperative variables.[4-8] Recent improvements in vitreoretinal surgical techniques provided better outcome of PPV in the management of posterior segment IOFBs.[9,10]

In the present study, we aimed to present the epidemiologic and clinical characteristics of patients with IOFBs and open-globe injuries who underwent 23-gauge transconjonctival PPV in a single tertiary referral center and to evaluate the outcomes of patients and prognostic factors.

METHODS

Study Design and Collected Data

In this retrospective study, the medical files of patients who underwent 23-gauge transconjuctival PPV for the removal of IOFB retained in the posterior segment in a tertiary referral center between January 2013 and January 2016 were evaluated. The study protocol was approved by the Ethics committee and it was conducted in compliance with the latest version of the Declaration of Helsinki.

The following data were collected from the medical records of patients: age, gender, laterality, duration between initial injury and surgery; presence of lens injury, iris injury, retinal detachment or vitreus hemorrhage; entry site of the IOFB (Zone 1 for the cornea, Zone 2 for the sclera up to 5 mm posterior to the limbus, and Zone 3 for the sclera more than 5 mm posterior to the limbus); best-corrected visual acuity (BCVA) in the initial and last visits; ocular trauma score (OTS) which covers presenting visual acuity, the presence or absence of endophthalmitis, globe rupture, perforating injury, retinal detachment and afferent pupillary defect; and details of the surgical procedures. In addition, the localization, number and size of the IOFB in the posterior segment and its association with orbita was clinically evaluated and confirmed by computed tomography, orbital radiographs, and A-B mode ultrasonography before operation.[11]

Surgical Procedures

The surgical procedures were performed by one trained vitreoretinal surgeon (P.Y.) under general or local anesthesia. In cases with traumatic cataract; membran blue was used to better visualize the anterior capsule before capsulotomy when anterior capsule was not intact. Bimanual aspiration was performed when the crystalline lens was soft; phacoemulsification was performed prior to PPV via a 2.8 mm clear corneal tunnel with a standard technique when the crystalline lens was harder. The anterior chamber was refilled with viscoelastic substance, and the IOL implantation was delayed until the end of posterior segment surgery. There were three possibilities: 1) the eye was left aphakic, 2) a foldable hydrophilic acrylic IOL (optic diameter 6 mm, overall diameter 12.50 mm) was implanted in the bag in the event that the posterior capsule was intact, 3) three-piece foldable IOL (optic diameter 6 mm, overall diameter 13.00 mm) was placed in the ciliary sulcus in cases with posterior capsule defects. The corneal incision was sutured with 10-0 nylon, and then 23-gauge PPV and IOFB removal was applied.

The patients who were inappropriate (precence of severe lens, capsule or zonular damage) for phacoemulsification; pars plana lensectomy (PPL) was applied. Using the 23-gauge instruments, the anterior vitreous was firstly cut off, and then lensectomy was performed to extract the traumatic lens and capsule. The eye was left aphakic, and PPV and IOFB removal was applied.

All patients underwent 23-gauge vitrectomy by using the 23-gauge trocar-cannula system (Alcon Laboratories, Inc., Fort Worth, TX, USA). The conjunctiva and sclera were penetrated by a trocar 3.5 or 4 mm posterior to and in parallel with the limbus, depending on the lens status. PPV was performed using a 23-G high-speed vitrector with a cut rate of 5000-7000 per minute (Constellation® Vitrectomy System, Alcon Inc., USA). The vitrectomy was performed from posterior vitreous to vitreous base. The posterior hyaloid was removed using active aspiration in cases without complete posterior vitreous detachment. Triamcinolone acetonide was used to ensure that the posterior hyaloid was lifted and removed in all of the cases. To remove the intraocular foreign body, one of the sclerotomy sites was enlarged like the T or L letters. With the foreign body forceps, the IOFB was removed. During the removal of foreign bodies perfluorocarbon liquid was injected into the vitreous cavity to stabilize and protect macula and retina. The sclerotomy site was sutured after IOFB extraction with an absorbable 6-0-vicryl suture to its initial size. If the foreign bodies were too large to be removed from the sclerotomy site, they were removed from the limbus with corneoscleral incision. Endolaser treatment was applied with a 23-gauge laser probe to the retinal entrance of the foreign body and other retinal breaks. In patients with retinal detachment after the removal of the vitreous with vitrectomy, retina was re-attached with displacement of the subretinal fluid by a heavy tamponad (perfluorocarbon liquid) and endolaser treatment was applied to retinal breaks. The vitreous was then replaced by a tamponade, either silicone oil (1000-5000 cs), or gas (C3F8 or SF6) was used.

At the end of surgery, an absorbable 6-0 or 7-0-vicryl suture was used to close the sclerotomy sites and the conjunctiva. Postoperative examinations were conducted at 1st day, 1st week, and at 1, 3, 6 months after surgery. Anatomical success was considered the total attachment of the retina at the end of the follow-up time. The visual outcomes of patients and prognostic value of preoperative, intraoperative, and postoperative clinical parameters were assessed.

For endophthalmitis prophylaxis, moxifloxacin (400 mg) or ciprofloaxacin (500 mg) was systemically applied to all patients preoperatively and for 7–10 days after surgery. In the cases complicated with endophthalmitis or in suspicious cases, vancomycin 1.0 mg/0.1 cc and ceftazidime 2.2 mg/0.1 cc were injected in the vitreous cavity at the end of surgery.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics 17.0 (IBM Corporation, Armonk, NY, USA). Data was expressed using descriptive statistics (mean, standard deviation, median, minimum, maximum, percentage). Kolmogorov-Smirnov test was used to test for normality of distribution of continuous variables. For the subgroup comparisons of visual acuity scores, Student's t-test was used for two groups, one-way analysis of variance (ANOVA) was used for more than two groups. The significance of correlation between continuous variables was evaluated by the Spearman's Rank correlation test. In order to define the most determining factors for the final visual acuity (logMAR), stepwise multivariate logistic regression analysis was performed by including all of the variables that were indicated as significant in the univariate analysis. The regression coefficients were given with a 95% confidence interval. Statistical level of significance was set to $p<0.05$.

RESULTS

Clinical and Surgical Characteristics

Forty-one eyes of 41 patients were evaluated (40 males, 1 female; mean age 34.6±12.3 years, age range 18–70 years). Of the 41 patients, the right eye was injured in 22 cases (67.2%), and the left one in 19 cases (32.8%). The capsule rupture was recorded in 22 patients (53.7%), iris damage in 18 patients (43.9%), vitreous hemorrhage in 11 patients (26.8%), macular involvement in 11 patients (26.8%), retinal detachment in 9 patients (22.%), and endophtalmitis in 5 patients (12.2%) (Table 1).

The characteristics of the IOFBs were summarized in Table 2. Accordingly, the average IOFB size was 3.0 mm (range, 1–12.0 mm). Of the cases, 32 (78.0%) had metal IOFB. The IOFB locations were the retina in 29 eyes (70.7%) and vitreous in 11 eyes (26.8%). IOFB entry points involved Zone 1 in 24 eyes (58.5%), Zone 2 in 10 eyes (24.4%) and Zone 3 in 7 eyes (17.1%). The mean wound length was 2.8 mm (range 0.5–11.0 mm).

Table 1. *Demographics and clinical characteristics of study patients (n=41)*

Parameter	Result
Age (years), *mean±standard deviation (range)*	34.6±12.3 (18-72)
Gender, *n (%)*	
Male	40 (97.6%)
Female	1 (2.4%)
Side of intraocular foreign body, *n (%)*	
Right eye	22 (53.7%)
Left eye	19 (46.3%)
Time until the operation (days), *mean (range)*	4 (1-16)
Type of operation, *n (%)*	
PPV+PHACO+IOFB removal	26 (63.4%)
PPV+IOFB removal	13 (31.7%)
PPV+PPL+IOFB removal	2 (4.9%)
Ocular trauma score, *median (range)*	59 (29-86)
Retinal detachment, *n (%)*	9 (22.0%)
Endophtalmitis, *n (%)*	5 (12.2%)
Vitreous hemorrhage, *n (%)*	11 (26.8%)
Capsule rupture, *n (%)*	22 (53.7%)
Lens opacity, *n (%)*	
Opaque	22 (53.7%)
Transparent	19 (46.3%)
Macular involvement, *n (%)*	11 (26.8%)
Iris damage, *n (%)*	18 (43.9%)
Recurrent retinal detachment, *n (%)*	6 (14.6%)
Initial visual acuity (logMAR), *n (%)*	1.42±0.58
Final visual acuity (logMAR), *n (%)*	0.83±0.74
Postoperative follow-up duration (months), *mean (range)*	20 (5-40)

PPV, parsplana vitrectomy; PHACO, phacoemulsification; PPL, pars plana lensectomy;
IOFB, intraocular foreign body.

The mean preoperative logMAR BCVA was 1.42±0.58 and the median OTS was 59 (range 29–86). The surgical operation was performed 4 days (range 1-16 days) after injury on average, and 7 patients (17.0 %) underwent IOFB removal within 24 hours of the injury. The patients were followed up for a mean of 20 months (range 5-40 months) postoperatively. 23-gauge PPV and IOFB removal combined with phacoemulsification surgery was applied in 26 of 41 (63,4%) eyes; 23-gauge PPV and IOFB removal combined with PPL was applied 2 of 41 (4.2%) eyes and 23-gauge PPV and IOFB removal was applied 13 of 41 (31,7%) eyes. Totally in 16 of 26 (57.1%) combined with phacoemulsification cases, intraocular lens implantation could be achieved. In 11 of 26

Table 2. *Characteristics of intraocular foreign body (n=41)*

Parameters	Result
Size, *mean (range)*	3.0 (1.0-12.0)
Location, *n (%)*	
Retina	29 (70.7%)
Vitreous	11 (26.8%)
Ciliary body	1 (2.4%)
Type, *n (%)*	
Metal	32 (78.0%)
Stone	4 (9.8%)
Wood	2 (4.9%)
Glass	2 (4.9%)
Plant	1 (2.4%)
Zone, *n (%)*	
1	24 (58.5%)
2	10 (24.4%)
3	7 (17.1)
Wound length (mm), *n (%)*	2.8 (0.5-11.0)

combined cases intraocular lens implanted in the bag, in 5 of 26 combined cases intraocular lens implanted in the sulcus, and 10 eyes of 26 combined cases were left aphakic. In 37 eyes of 41 patients endotamponade was used. As endotamponade, silicone oil was injected in 21 patients (51.2%), SF6 in 10 patients (24.3%), and C3F8 in 6 patients (14.6%). At last follow-up visit, anatomic success was obtained in 95.2 % of eyes. Two (4.8%) of 41 eyes had bulbus phthisis at the end of the follow-up, one had endophthalmitis, and one had recurrent retinal detachment with PVR.

Clinical Factors Affecting Visual Outcome

The initial BCVA significantly increased at the last evaluation after surgical operation (1.42±0.58 and 0.83±0.74, respectively, p<0.001, Table 1). Twenty-two patients (53.6%) achieved a visual acuity of 20/50 or better, and in 12 patients (29.2%), the final BCVA was <20/200.

The final visual acuity (logMAR) of the patients' with respect to demographic and clinical characteristics are given in Table 3. Since the study population contained only one female patient, the effect of gender on final visual acuity was not evaluated. Similarly, the effects of location of IOFB other than retina or vitreous, and the type of IOFB other than metal or stone on visual acuity were not analyzed due to low number of cases. The univariate analysis showed that laterality of IOFB (right/left), IOFB located in vitreous, metallic type of IOFB, zone, presence of capsule rupture lens opacity or iris damage, and type of surgical operation had no significant effect on the final visual acuity (p>0.05 for all, Table 3). However, cases with IOFB in retina, non-stone type of IOFB, retinal detachment, recurrent retinal detachment, endophtalmitis, and macular involvement had significantly lower final visual acuity (p<0.05 for all, Table 3).

Table 3. *The final visual acuity with respect to patients' demographic and clinical characteristics*

		Final visual acuity (logMAR)	p
Laterality of IOFB	Right eye	0.82±0.75	0.902†
	Left eye	0.85±0.75	
Foreign body in vitreous	No	0.92±0.82	0.079†
	Yes	0.58±0.38	
Foreign body in retina	No	0.49±0.40	0.016†
	Yes	0.97±0.81	
Metallic type IOFB	No	0.80±0.71	0.887†
	Yes	0.84±0.76	
Stone type IOFB	No	0.88±0.77	<0.001†
	Yes	0.40±0.00	
Zone	1	0.80±0.71	0.405‡
	2	0.67±0.76	
	3	1.16±0.84	
Retinal detachment	No	0.61±0.62	<0.001†
	Yes	1.61±0.60	
Endophthalmitis	No	0.70±0.67	<0.001†
	Yes	1.80±0.45	
Vitreous hemorrhage	No	0.69±0.68	0.047†
	Yes	1.21±0.80	
Capsule rupture	No	0.66±0.59	0.156†
	Yes	0.98±0.84	
Lens opacity	Opaque	0.99±0.83	0.144†
	Transparent	0.65±0.59	
Macular involvement	No	0.44±0.35	<0.001†
	Yes	1.91±0.30	
Iris damage	No	0.66±0.63	0.100†
	Yes	1.06±0.83	
Recurrent retinal detachment	No	0.66±0.64	<0.001†
	Yes	1.83±0.41	
Type of operation	PPV+PHACO+IOFB removal	0.96±0.82	0.209‡
	PPV+IOFB removal	0.53±0.37	
	PPV+PPL+IOFB removal	1.05±1.34	

† Student's t test, ‡ One-Way ANOVA.
PPV, parsplana vitrectomy; PHACO, phacoemulsification; PPL, pars plana lensectomy;
IOFB, intraocular foreign body.

The results of Spearman's Rank correlation analysis revealed that the final visual acuity (logMAR) was positively correlated with IOFB size (R=0.648, p<0.001), wound length (R=0.578, p<0.001), time until the operation (R=0.388, p=0.012), and initial visual acuity (R=0.674, p<0.001). On the other hand, ocular trauma score (R=-0.751, p<0.001) was negatively correlated with the final visual acuity (logMAR) (Table 4).

In the stepwise multivariate logistic regression analysis, the predictive factors for the final visual acuity (logMAR) was determined by including all of the significant variables in the univariate analysis, and then by applying correction according to the initial visual acuity. The result of this analysis showed that macular involvement, OTS score, and vitreous hemorrhage were the independent significant predictors of the final visual acuity (Table 5). In other words, presence of macular involvement (β=0.974, p<0.001) and vitreous hemorrhage (β=0.215, p=0.049) decrease, and higher OTS (β=-0.017, p=0.007) increases the final visual acuity.

DISCUSSION

Ocular traumas are severe injuries that can result in significant visual loss. IOFBs present in 18-41% of ocular injuries.[12] IOFBs are mostly located in posterior segment, and the treatment of choice for these IOFBs is PPV.[13] The visual outcome of IOFBs is based on various patient or foreign body-related factors.[12] Recent advances in vitreoretinal surgical techniques and internal tamponade agents provided improvement in the visual outcome of PPV for the removal of IOFBs located in posterior segment.[1,9,10,14-16] However, endophtalmitis, retinal detachment, and proliferative vitreoretinopathy in long-term are still important complications of surgical management of ocular injuries.[1] In order to increase surgical comfort, accelerate healing time, shorten surgical time, reduce corneal astigmatism and reduce inflammation smaller port size of the instruments, like 23-gauge, has been preferred recently.[17,18] Although, use of 23-gauge vitrectomy is common for vitreoretinal disease in current clinical practice, the studies on the outcomes of 23-gauge PPV are limited in the literature.[10,19] More studies are needed for the common use of 23-gauge vitrectomy in the clinical practice of removal of IOFB located in posterior segment.

Traumatic cataract associated with IOFB is a common problem with a prevalance ranging from 44% to 66%.[20] In our series, we planned to apply 23-gauge PPV with phacoemulsification in appropriate cases with traumatic cataract.[19,21] Phacoemulsification was applied in 26 eyes, but in 2 eyes that were inappropriate for phacoemulsification, PPL was applied, which has also been shown to be an effective and safe surgical option for IOFB.[22] In some previous studies, vitrectomy combined with phacoemulsification was reported to increase the fibrin reaction in anterior chamber.[23] In our study, we applied 23-gauge PPV with phacoemulsification in 63.4% of cases, and none of the patients had severe inflammatory reactions that could not be controlled with topical treatment. We also did not encounter any other complication related with combined procedure.

We used OTS to predict the visual outcome of our cases. OTS has been commonly applied for the assessment of severity of ocular trauma in clinical studies.[24,25]

High visual and anatomical success rate has been reported after the removal of posterior segment IOFBs by PPV.[19,26-28] Yuksel et al.[19] applied 23-gauge PPV for the removal of posterior segment IOFB in 36 cases. They reported that mean BCVA improved significantly from 1.44 logMAR to 0.78 logMAR (p=0.007) after 23-gauge PPV.[19] Similarly, in our series BCVA improved from preoperative 1.42 logMAR to 0.83 logMAR at last evaluation after surgical removal. In the few published studies on the use of small gauge (23- or 25-) PPV, it was found to be a safe and efficient procedure

Table 4. *Spearman's Rank correlation coefficient (R) for the relation between the final visual acuity and patients' demographic and clinical characteristics*

	Final visual acuity
Age (years)	R=0.147 p=0.360
IOFB size (mm)	R=0.648 p<0.001
Wound length (mm)	R=0.578 p<0.001
Ocular trauma score	R=-0.751 p<0.001
Time until the operation (days)	R=0.388 p=0.012
Initial visual acuity (logMAR)	R=0.674 p<0.001

IOFB, intraocular foreign body.

Table 5. *Predictors of final visual acuity in stepwise multivariate logistic regression analysis*

	Regression coefficient (β)	95% confidence interval		p
		Lower	Upper	
Macular involvement	0.974	0.665	1.283	<0.001
OTS score	-0.017	-0.029	-0.005	0.007
Vitreous hemorrhage	0.215	0.001	0.430	0.049
Initial visual acuity	0.024	-0.251	0.300	0.859

OTS: Ocular trauma score

for the removal of IOFB located in the posterior segment providing significant improvement in visual acuity.[9,10,19,29] Similarly, in our series, 53.6% of patients achieved a visual acuity of 20/50 or better.

Previous studies reported that the clinical predictors of good visual outcome for IOFBs are the initial visual acuity, anterior segment IOFB, absence of lens injury, and corneoscreal entry site; while size of IOFB, lower OTS, retinal detachment at presentation, endophthalmitis, proliferative vitroretinopathy, uveal prolapse, relative afferent pupillary defect, and posterior segment IOFB are associated with poor visual outcome.[27,30-35] On the basis of the previous reports, we evaluated the prognostic value of the following clinical and foreign body-related variables: side and zone of the injury; size, number, location, and type of IOFB; wound length; OTS; time until operation; presence of retinal detachment, endophthalmitis, capsule rupture, lens opacity, macular involvement, iris damage at first presentation; initial visual acuity; type of operation; and recurrent retinal detachment. Among these variables, IOFB in retina, non-stone type of IOFB, retinal detachment, recurrent retinal detachment, endophthalmitis, and macular involvement had significantly lower final visual acuity in the univariate analysis. In the Spearman's Rank correlation analysis, the final visual acuity was negatively correlated with IOFB size, wound length, time until the operation, and initial visual acuity; and positively correlated with OTS. Finally, in the stepwise multivariate logistic regression analysis; macular involvement, OTS score, and vitreous hemorrhage were the independent significant predictors of the final visual acuity. The prognostic factors with significant effect on the final visual acuity are in line with the previous reports.[27,30-35] However, some prognostic factors that had no significant effect on the final visual acuity in logistic regression analysis of our study, such as size of IOFB and initial visual acuity, had been previously reported as the significant prognostic factors in cases with IOFB.[27,30-35] We think that these differences from literature are based on the limitations of our study, which are its small sample size and retrospective design. Nevertheless, the present study contributes to the limited studies in literature on the 23-gauge vitrectomy for the removal of IOFB located in posterior segment, suggesting that smaller port size instruments can be used effectively and safely in PPV.

In conclusion, 23-gauge transconjuctival PPV is an effective and safe surgical procedure for the removal of IOFB retained in the posterior segment. The macular involvement, vitreous hemorrhage, and ocular trauma score are prognostic factors affecting the final visual acuity.

DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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