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Vitreoretinal surgery outcomes in patients with lens or lens fragments luxated into the vitreous cavity

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Abstract

To evaluate the clinical characteristics of patients with lens or lens fragments luxated into the vitreous cavity and the visual and anatomical outcomes of pars plana vitrectomy (PPV) in these patients. This retrospective study reviewed the files of patients who had undergone PPV for lens or lens fragments luxation into the vitreous cavity at the Ophthalmology Department at Inonu University, Faculty of Medicine between January 2014-December 2018. Patient age, gender, preoperative and postoperative best corrected visual acuity (BCVA), intraocular pressure (IOP), anterior segment examination and posterior segment examination findings, preoperative and postoperative complications, and postoperative follow-up times were recorded. This study included 43 eyes of 43 total patients, of which 29 (67.4%) were male and 14 (32.6%) were female. Median patient age was 70 (36-89) years. Median preoperative BCVA was 1.7 (0.5-2) logMAR and median final BCVA was 0.8 (0-2) logMAR ($p<0.001$). Median preoperative IOP was 16 mmHg and median postoperative IOP was 14 mmHg ($p=0.001$). Postoperative visual acuity was better in 37 eyes, worse in 4 eyes, and unchanged in 2 eyes. Median postoperative BCVA was significantly better in patients who underwent PPV within three days, while their median preoperative and postoperative IOP were significantly lower (respectively $p=0.019$, $p=0.027$, $p=0.027$). Preoperatively, 13 eyes had shown high IOP, 9 had shown corneal edema, and 3 had shown retinal tears; while, postoperatively, 3 eyes developed retinal detachment and 3 eyes showed high IOP. Median postoperative follow-up time was 8 (3-57) months. PPV achieves successful anatomical and functional outcomes in patients with lens or lens fragments luxated into the vitreous cavity. Early surgical intervention within the first three days can result in better final visual acuity improvement and IOP control.

Keywords: Pars plana vitrectomy, lens, lens fragment, retinal detachment

Introduction

Luxation of lens or lens fragments into the vitreous is a serious complication that may appear at any stage of cataract surgery and is usually encountered during phacoemulsification surgery (PE) [1]. Cataract surgery is typically complicated in the presence of pseudoexfoliation syndrome, small pupil and zonular dialysis; and nuclear or cortical lens materials can luxate into the vitreous during surgery in these patients who develop posterior capsule ruptures and vitreous loss. Further, hereditary disorders that involve zonular problems, such as Marfan syndrome, homocystinuria, and Weill-Marchesani syndrome, as well as conditions in which the eye is enlarged, such as trauma, high myopia, and buphthalmos can cause the lens to luxate into the vitreous [2-5]. Such patients may demonstrate symptoms that threaten vision, such as corneal edema,

glaucoma, intraocular inflammation induced by crystalline lens proteins, cystoid macular edema, epimacular membrane, vitreous hemorrhage, peripheral retinal tears, and retinal and choroidal detachment [6,7]. The incidence rate of these complications varies between 0.2-1.5% across different studies [1,8].

Medical treatment may be adequate when the lens fragments luxated into the vitreous are small. However, pars plana vitrectomy (PPV) is required when large lens fragments luxated into the vitreous cause complications such as uncontrollable high intraocular pressure (IOP), intraocular inflammation or retinal tear/detachment, and endophthalmitis [7]. In PPV, lens fragments luxated into the vitreous are removed using phacofragmatome or the vitrectomy probe after vitreous adhesions are cleared, and an intraocular lens (IOL) implantation is performed either in the same session or in a later session [3,8,9]. This study aims to investigate the clinical characteristics of patients with lens or lens fragments luxated into the vitreous cavity and the visual and anatomical outcomes of PPV in these patients.

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Materials and Methods

This study was approved by Inonu University Health Sciences Non-invasive Clinical Research Ethics Committee (date: 30.07.2019, approval number: 2019/285) and conducted in accordance with the Helsinki Declaration. Files of patients who underwent PPV for lens or lens fragment luxation into the vitreous cavity at the Ophthalmology Department at Inonu University, Faculty of Medicine between January 2014-December 2018 were retrospectively reviewed. Patient age, gender, preoperative and postoperative best corrected visual acuity (BCVA), IOP, anterior segment examination and post-pupil dilation posterior segment examination findings, preoperative and postoperative complications were recorded. Patients with missing data or inadequate follow-up were excluded from the study. Visual acuity was evaluated using the Snellen chart and the data were converted into LogMAR equivalents. IOP was measured using Goldman applanation tonometry. Topical antiglaucoma medications were used for IOP readings of 21 mmHg or higher. B-mode ultrasonography was performed where necessary. Preoperative and postoperative complications such as high IOP, corneal edema/bullous keratopathy, uveitis, retinal tear/detachment were recorded. The length of time between the dislocation of lens or lens fragments into the vitreous cavity and PPV, and postoperative follow-up times were recorded.

All patients underwent 20-gauge (G) or 23-G PPV. The surgical approach was decided intraoperatively according to the size and hardness of the lens remnants. Trocars were inserted 3.5 mm posterior to the limbus, in the inferotemporal, superotemporal and superonasal quadrants and, following core vitrectomy (DORC, Zuidland, Netherlands), perfluorodecalin was administered to the posterior pole over the optic disc in order to preserve the macula. In cases where the entire lens or large lens fragments were luxated into the vitreous, the lens or lens fragments were floated to the anterior chamber using perfluorodecalin after vitrectomy and extracted via corneal incision. Soft and small lens remnants were mechanically fragmented between the vitrectomy probe (ocutome) and light source after the vitreous bands around the lens were cutted and aspirated with the ocutome. Where necessary, endolaser photocoagulation was performed and silicone or gas (SF6) endotamponade was administered after surgery.

IOL implantation was performed either in the same session as PPV or in a later session. The IOL was implanted into the sulcus in patients with adequate capsule support and by scleral fixation in patients without adequate capsule support. A subconjunctival gentamycin-dexamethasone injection was administered at the end of the operation.

Statistical Analysis

Normality of data was evaluated using the Shapiro-Wilk test. Since the data were non-normal, they were summarised in the form of median, minimum and maximum values. The Wilcoxon matched-pairs test was used in the comparison of preoperative and postoperative data. The Mann-Whitney U test was used in the pairwise comparison of independent groups. The level of significance was considered as 0.05 for all analyses.

Results

This study included 43 eyes of 43 total patients, of which 29 (67.4%) were male and 14 (32.6%) were female. Median patient age was 70 (36-89) years. The right eye was affected in 25 cases (58.1%) and the left eye in 18 cases (41.9%). 16 eyes (37.2%) underwent 20-G PPV and 27 eyes (62.8%) 23-G PPV. The nucleus was cleared using the ocutome in 36 patients, and the lens material was floated using liquid perfluorocarbon and extracted via a limbal incision in 7 patients. Median time between the luxation of lens or lens fragments into the vitreous and PPV was 3 (0-90) days. While 28 eyes underwent PPV within three days, 15 eyes underwent PPV later than 3 days. PPV was performed in the same session in three patients who showed this complication during PE surgery, later than 2 weeks in two eyes (30th and 90th days). The patient who underwent PPV on the 30th day had been undergoing conservative treatment but a PPV surgery was planned since the secondary complications could not be controlled. The patient who underwent PPV on the 90th day had presented late. Median postoperative follow-up time was 8 (3-57) months.

The review of the etiological causes of lens or lens fragments luxation into the vitreous revealed PE surgery in 29 eyes (67.4%), trauma in 11 eyes (25.6%), spontaneous luxation, extracapsular and intracapsular cataract extraction surgery in one eye each (2.3%). Of the patients who underwent PPV, 33 (86.7%) were aphakic and 10 (23.3%) were pseudophakic. Ten of the 33 eyes that had not been implanted with an IOL during the primary surgery underwent IOL implantation into the sulcus in the same session as PPV, while one eye underwent IOL implantation by scleral fixation. Of the 22 eyes that had been left aphakic in PPV and had been planned to undergo a secondary IOL implantation, 10 underwent IOL implantation by scleral fixation in a second session, while 4 underwent IOL implantation into the sulcus. On the other hand, a secondary IOL implantation was not performed in 8 eyes due to various reasons and correction by spectacles was recommended. Four eyes were administered silicone oil endotamponade at the end of PPV surgery, one eye received SF6 gas tamponade, and five eyes underwent laser endophotocoagulation. Clinical characteristics of the patients are presented in Table 1.

Table 1. Clinical characteristics of the patients

Characteristics of the cases		n	%
Male		29	67.4
Female		14	32.6
Etiological reasons	PE	29	67.4
	Trauma	11	25.6
	Other reasons	3	7
Lens situation in primary surgery	Pseudophakic	10	23.3
	Aphakia	33	76.7
PE: Phacoemulsification			

In our series, 19 eyes (44.2%) had preexisting ocular disorders. The ocular comorbidities identified in our cases included proliferative diabetic retinopathy in five eyes, choroidal detachment in three eyes, optic atrophy in three eyes (one due to trauma, two due to high IOP), retinal tears in three eyes, glaucoma in two eyes (one of these eyes also had central retinal vein occlusion (CRVO)), trauma-related macular scar in one eye, macular atrophy due to age-related

macular degeneration (AMD) in one eye, and uveitis due to the luxation of lens fragments into the vitreous in one eye. Median preoperative IOP was 16 mmHg (8-58) and median postoperative IOP was 14 mmHg (9-28) ($p=0.001$). Prior to PPV, 13 eyes (30.2%) had shown an IOP higher than 21 mmHg. Patients with high IOP underwent PPV after the IOP was controlled with medical treatment. Also, 9 eyes (20.9%) had preoperatively shown corneal edema; edema was resolved with medical treatment in 8 of these eyes, while one eye developed bullous keratopathy and penetrating keratoplasty (PK) was recommended. During postoperative follow-up, 3 eyes (7%) developed retinal detachment (RD) and 3 eyes (7%) showed high IOP, which could be controlled with medical treatment. RD surgery performed on the three eyes with RD achieved anatomical success. None of the patients manifested findings of hypopyon or endophthalmitis, either preoperatively or postoperatively.

Median preoperative BCVA was 1.7 (0.5-2) logMAR and median final BCVA was 0.8 (0-2) logMAR ($p<0.001$). In the postoperative period, visual acuity was better in 37 eyes (86%), worse in 4 eyes (9.3%), and unchanged in 2 eyes (4.7%). The evaluation of the four eyes that showed reduced vision revealed postoperative RD in two eyes, glaucoma and CRVO in one eye, and macular atrophy

due to AMD in one eye. Of the two eyes that showed unchanged acuity of hand motion, one had had choroidal detachment and had developed RD after PPV, and the other had developed bullous keratopathy after PPV and was recommended PK.

Median postoperative BCVA was significantly better in patients who underwent PPV within three days compared with those operated later than 3 days, while their median preoperative and postoperative IOP were significantly lower (respectively $p=0.019$, $p=0.027$, $p=0.027$). Patients who were operated later than 3 days showed a longer median follow-up time than those operated within three days, with statistical significance ($p=0.019$). Table 2 shows the comparison of the cases who underwent PPV within three days and those operated later than 3 days. Final BCVA did not show statistically significant differences according to the use of 20-G or 23-G PPV, presence of ocular comorbidities, presence of trauma as the etiological cause, and whether or not an IOL was implanted in the primary surgery (respectively $p=0.088$, $p=0.065$, $p=0.631$, $p=0.944$). Although eyes that underwent 23-G PPV and eyes with no ocular comorbidities demonstrated a better final BCVA compared to their preoperative BCVA, this difference did not reach statistical significance.

Table 2. The comparison of the cases who underwent PPV within three days and those operated later than 3 days

	Time of PPV								p
	≤3 days				>3 days				
	n	Median	Minimum	Maximum	n	Median	Minimum	Maximum	
Age (year)	25	70.0	44.0	89.0	18	70.5	36.0	80.0	0.579
Postop. BCVA (logMAR)	25	1.7	0.5	1.9	18	1.8	0.5	2.0	0.365
Preop. IOP (mmHg)	25	0.7	0.0	1.4	18	1.1	0.0	2.0	0.019
Preop. IOP	25	14.0	8.0	50.0	18	18.0	12.0	58.0	0.027
Postop. IOP (mmHg)	25	14.0	10.0	18.0	18	16.0	9.0	28.0	0.027
Follow-up time (month)	25	6.0	3.0	42.0	18	15.5	3.0	57.0	0.019

BCVA: Best Corrected Visual Acuity, IOP: Intraocular Pressure

Discussion

Pars plana vitrectomy is a safe and successful method for the removal of posteriorly luxated lens or lens fragments and the prevention of potential complications, and it is recommended to be performed within the first 7-21 days [10,11]. In most cases, intraocular inflammation is controlled, IOP is reduced, and sight is improved by PPV. In PPV, techniques such as ultrasonic phacofragmentation, mechanical crushing, and limbal extraction are utilized in order to remove the posteriorly luxated lens or lens fragments. Mechanical crushing is preferred particularly in the case of soft nuclear fragments and small hard fragments, and these crushed fragments are then removed using the ocutome [12,13]. Perfluorocarbon liquids are used to float the lens fragments luxated into the vitreous to remove them via the limbal route, to prevent intraoperative damage by the dropping of the fragments onto the retina, and to protect the retina from ultrasonic waves during the use of phacofragmatome [12,13]. In our series, perfluorodecalin was used in all eyes, specifically to protect the macula; and while

the ocutome was used to remove the lens or lens fragments in 36 cases, nuclear materials were extracted via limbal incision by floating them using liquid perfluorocarbon in 7 patients.

There is no consensus on the optimal time of PPV surgery for the removal of lens and lens fragments luxated into the vitreous. Some authors have reported that operating the patients in the early period is associated with lower complication rates and better visual outcomes, whereas others have argued that early surgery does not make a difference in terms of complications and the visual prognosis, and that surgery can be delayed in order to allow for spontaneous posterior vitreous detachment and softening of lens fragments [14-16]. One study reported that, in cases of lens fragments luxation into the vitreous during cataract surgery, better visual acuity and fewer complications were achieved in patients who underwent PPV in the same session as cataract surgery compared with those who underwent PPV later [16]. Further, another study reported that delayed vitrectomy was linked to poorer visual outcomes and higher ocular complication rates [17].

It can be preferred to perform PPV in the same session in patients aged 65 or older with lens fragments luxated into the vitreous since posterior vitreous detachment is more probable, and to perform PPV in a second session no later than 3 weeks in younger patients [18]. In our series, PPV was performed within a median time period of 3 (3-90) days and eyes that were operated in the same session or within three days demonstrated a significantly better final BCVA compared with others ($p=0.019$). However, we think that, the fact that median follow-up times of patients who were operated later than three days were significantly longer than those who were operated within three days may have influenced the results of these patients who were typically in the elderly age group. 23-G PPV offers a shorter operative time and earlier visual rehabilitation than 20-G vitrectomy. However, it was reported to be comparable to the 20-G vitrectomy system in terms of its effect on visual acuity [14]. Accordingly, the present study did not determine any difference between 20-G and 23-G vitrectomy with regard to the final BCVA.

After the removal of the posteriorly luxated nucleus by PPV, an IOL can be implanted into the sulcus or anterior chamber, or by scleral fixation, either in the same session or a different session. Certain authors recommend IOL implantation to be performed during the first operation, whereas those who use the limbal route for nucleus removal do not recommend IOL implantation during the first session [14,18]. IOL implantation in the same session can be preferred in patients with small dislocated nuclear material and patients exposed to less surgical trauma, while it is a more appropriate approach to perform IOL implantation in a later session in patients exposed to more surgical trauma and in patients with inadequate capsule support [14]. However, performing IOL implantation in the same session as PPV is associated with earlier visual rehabilitation. A study conducted in our country reported that 62.5% of the patients underwent IOL implantation into the sulcus or anterior chamber or by scleral fixation in the same session [3]. In the present study, 11 (33.3%) of the 33 eyes that had not been implanted with an IOL during the primary surgery were implanted with an IOL in the same session as PPV; 10 of these underwent IOL implantation into the sulcus and one underwent IOL implantation by scleral fixation in the same session as PPV.

According to various studies, 43-75% of these patients achieve a final visual acuity of 20/40 or better after PPV [19-22]. Eyes that manifest a better BCVA at admission can achieve better final visual outcomes, while those with preexisting ocular disorders demonstrate limited improvement after PPV [19,23]. Presence of optic atrophy, CME and/or diabetic macular edema, macular hole, and a history of rhegmatogenous retinal detachment (RRD) and/or macular degeneration are the most common causes of low vision (BCVA <20/40) after PPV in these patients [19,20]. In our study, patients who showed reduced or unchanged vision were found to either have ocular comorbidities or to have developed complications. Eyes that show fewer intraoperative or postoperative complications such as corneal edema, glaucoma, uveitis and RRD after complicated cataract surgery are more likely to achieve a better visual acuity [19]. In the present study, eyes with ocular comorbidities showed a poorer postoperative BCVA than others, however, this difference did not reach statistical significance. Of the four patients who demonstrated reduced vision, two had developed RD postoperatively, one had had glaucoma and CRVO, and one had had macular atrophy due to AMD. Of the

two eyes that showed unchanged acuity of hand motion, one had had preoperative choroidal detachment and had postoperatively developed RD, and the other had developed bullous keratopathy after PPV and was recommended PK.

Although some publications have reported that the final condition of the lens has no effect on the visual outcomes, eyes with posterior chamber or anterior chamber IOL were reported to achieve better visual outcomes than eyes left aphakic [24-26]. Performing IOL implantation during complicated cataract surgery can complicate the PPV needed for lens fragments luxated into the vitreous, thus, performing IOL implantation during vitrectomy is deemed to be safer [26]. Moreover, not implanting an IOL during complicated cataract surgery is associated with less manipulation and a shorter operative time, which can result in better final visual outcomes by causing fewer complications such as corneal edema, inflammation, uveitis, and cystoid macular edema [19]. This study did not determine a difference between patients who underwent IOL implantation during the primary surgery and those left aphakic in terms of the final BCVA. In addition, long-term follow-up is important in these cases as one study has reported that visual acuity shows particular improvement in the long term [27]. In one study, 87.5% of patients showed better visual acuity, while 12.5% showed unchanged visual acuity [3]. In the present study, final visual acuity was better in 37 eyes (86%), worse in 4 eyes (9.3%), and unchanged in 2 eyes (4.7%).

In patients with lens or lens fragments luxation into the vitreous, various complications may be encountered before or after PPV surgery. Preoperative complications include high IOP, uveitis, corneal edema, retinal tears or detachment; while postoperative complications include RD, CME, optic neuropathy, vitreous hemorrhage, epiretinal membrane and corneal edema, or bullous keratopathy [6,7,19,28,29]. Studies have shown that 16.7-52% of these eyes manifest high IOP (≥ 25 mmHg) at admission [19,24,25]. Effective anterior vitrectomy lowers the risk of high IOP by reducing the risk of uveitis and trabeculitis [19,24]. In the present study, 13 eyes (30.2%) showed an IOP higher than 21 mmHg before PPV, while 3 eyes (7%) showed high IOP postoperatively. Different results have been reported as to the presence of RD in these patients. Although some studies did not report RRD after PPV [19,30], a study conducted by Moore et al. that included a large patient series composed of 343 patients reported RRD after PPV in 19 patients (5.5%) [31]. Meanwhile, another study determined RD preoperatively, but not postoperatively [19]. In the recent years, rates of RRD after PPV have demonstrated a downward trend due to the use of smaller-gauge PPV and the availability of more advanced equipment [24]. In the present study, 3 eyes (7%) had postoperatively developed RRD and anatomical success was achieved in these eyes by RD surgery. Also, of the 9 eyes (20.9%) with preoperative corneal edema; eight recovered with medical treatment, while one eye developed bullous keratopathy and PK was recommended.

Trauma-related lens dislocation may lead to various pathologies such as hyphema, cataract, iridodialysis, vitreous hemorrhage, retinal detachment, and choroidal rupture. In these cases, PPV allows the surgeon to address posterior segment pathologies in the same session. In trauma-related lens luxation, 56.7% to 90% of patients show improved visual acuity after PPV [32-34]. In the

present study, 9 (81.8%) patients with trauma as the etiological cause showed visual acuity improvement, while one (9.1%) showed unchanged and one (9.1%) showed poorer visual acuity.

PPV offers notable anatomic and functional success in patients with lens or lens fragments luxated into the vitreous cavity. The limitations of this study are that the severity of corneal edema and uveitic reactions could not be graded, the sizes of luxated lens fragments could not be specified, and that a retrospective design was adopted. Early surgical intervention within three days may allow better final visual acuity gains and IOP control in these patients.

Conflict of interests

The authors declare that they have no competing interests.

Financial Disclosure

All authors declare no financial support.

Ethical approval

This study was approved by Inonu University Health Sciences Non-invasive Clinical Research Ethics Committee (date: 30.07.2019, approval number: 2019/285) and conducted in accordance with the Helsinki Declaration.

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