Original Article

A 10-year review of the visual outcomes of early versus late pars plana vitrectomy in eyes with dropped lens fragment or nucleus during phacoemulsification

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ABSTRACT

Background: Pars plana vitrectomy (PPV) is a routine surgical option for the removal of dropped lens fragment or nucleus in the vitreous cavity due to complicated cataract surgery; however, its optimal timing is controversial. Therefore, we aimed to determine the visual outcomes of early versus late PPV in eyes with dropped lens fragment or nucleus due to complicated phacoemulsification cataract surgery.

Methods: This descriptive-analytical retrospective study collected data of patients who underwent early (≤ 1 week) versus late (> 1 week) PPV for the management of dropped lens fragment or nucleus resulting from complicated phacoemulsification cataract surgery over a 10-year period at Imam Khomeini Tertiary Referral Hospital, Ahvaz, Iran. Demographic characteristics, the interval between complicated phacoemulsification and PPV, pre- and postoperative intraocular pressures, best-corrected distance visual acuity (BCDVA), and postoperative complications were extracted from each patient's record.

Results: Fifty-one eyes of 51 patients with a mean (standard deviation [SD]) age of 64.66 (6.54) years and a male-to-female ratio of 33 (64.7%) to 18 (35.3%) were included over 10 years. The mean (SD) BCDVA before PPV was 1.87 (0.53) logarithm of the minimum angle of resolution (logMAR), which improved significantly to 0.54 (0.46) logMAR at the final postoperative visit ($P < 0.001$). The mean (SD) BCDVA was significantly better after early PPV than after late PPV (0.41 [0.30] versus 0.62 [0.52] logMAR; $P < 0.05$). There was no significant difference in the final BCDVAs among the three methods of lens fragment removal ($P > 0.05$). The rates of post-PPV complications were as follows: 29 (56.9%) eyes with corneal edema, 16 (31.4%) eyes with uveitis, 10 (19.6%) eyes with cystoid macular edema, 8 (15.7%) eyes with rhegmatogenous retinal detachment, and 8 (15.7%) eyes with other complications (optic nerve atrophy, choroidal neovascularization, vitreous hemorrhage, or epiretinal membrane formation). No significant differences were observed in the rates of complications according to the time interval between complicated phacoemulsification and PPV (all $P > 0.05$). The frequency of corneal edema was significantly higher when removing lens fragments using the trans-limbal method than using the other methods ($P < 0.05$), yet the rates of other complications were comparable among the three methods of lens fragment removal (all $P > 0.05$).

Conclusions: Early PPV and removal of a dropped lens fragment or nucleus resulting from complicated phacoemulsification cataract surgery are recommended to achieve better visual outcomes. Future studies with longer follow-up, greater sample sizes, and analysis of other parameters of visual function, such as contrast sensitivity, visual field, color vision, and stereopsis, could provide more conclusive results and help verify our preliminary findings.

KEYWORDS

crystalline lens nucleus, cataract extractions, postoperative complication, phacoemulsifications, vitrectomy, visual acuities, rhegmatogenous retinal detachment, macular edema

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INTRODUCTION

About half of global blindness is due to cataract [1], and most occurs in developing countries. The only treatment for cataract is surgery, which is associated with a very high success rate [2]. The current global practice for managing cataract-induced reversible visual impairment is phacoemulsification and intraocular lens (IOL) implantation [3].

Displacement of the lens fragment or nucleus into the vitreous cavity is an uncommon but visually threatening complication of cataract surgery. Complications of dropped lens fragment or nucleus include cystoid macular edema (CME), glaucoma, uveitis, corneal edema, rhegmatogenous retinal detachment (RRD), and vitreous hemorrhage [3-5]. Due to the high volume of phacoemulsification surgery in managing cataracts, the incidence of dropped lens fragment or nucleus into the vitreous is significant. However, some cases escape diagnosis, particularly if the pieces are small [4]. In general, the prevalence of this complication is estimated as 0.18% to 1.1% [6, 7].

Small pieces of the lens fragment in the vitreous can be treated with medication; however, pieces larger than 2 mm usually require surgery [8]. Pars plana vitrectomy (PPV), which is the preferred method of removing a dropped lens fragment or nucleus from the vitreous cavity due to complicated cataract surgery, is quite effective in reducing complications such as uveitis and glaucoma and can improve visual acuity [8, 9].

After a sufficient vitrectomy, especially around the nucleus fragment, and the release of vitreous connections, three methods can be used to remove a dropped lens fragment or nucleus: smaller and softer fragments are usually removed using a vitrectomy cutter, relatively large and hard pieces are removed using the phacofragmentome, and large and very hard pieces are removed through the limbal incision [7-10]; however, its optimal timing is controversial [4, 7].

We aimed to evaluate the visual outcomes of early versus late PPV for the management of dropped lens fragment or nucleus in the vitreous cavity due to complicated phacoemulsification cataract surgery.

METHODS

In this descriptive-analytical retrospective study, we recruited patients who had complicated phacoemulsification with dropped lens fragment or nucleus into the vitreous and underwent early or late three-port PPV with 20- or 23-gauge probes for nucleus or lens fragment removal [8, 9] between January 2012 and December 2021 at the Imam Khomeini Tertiary Referral Hospital, southwest Iran. We excluded eyes with previous ocular diseases, such as advanced diabetic retinopathy or advanced glaucoma, that could independently affect visual function.

The study protocol was reviewed and approved by the ethics committee of the Ahvaz Jundishapur University of Medical Sciences (ethics code: IR.AJUMS.HGOLESTAN.REC.1399.144). The tenets of the Declaration of Helsinki and the principles of confidentiality of patient information were observed in all steps of this study. All participants provided written informed consent for phacoemulsification and consequent PPV surgeries.

The following data were collected from patients' medical records: demographic characteristics, the time interval between complicated phacoemulsification cataract surgery and PPV, the technique used to remove the dropped lens fragment or nucleus, best-corrected distance visual acuity (BCDVA) before PPV and at the last postoperative follow-up visit in logarithm of the minimum angle of resolution (logMAR) notation, the type of implanted IOL and its position within the eye, intraocular pressure (IOP) before PPV and at the last postoperative follow-up visit, and any relevant postoperative complications, including corneal edema, CME, intraocular infection or inflammation, RRD, optic nerve atrophy, choroidal neovascularization, vitreous hemorrhage, and epiretinal membrane formation.

Based on the time interval between PPV [8, 9] and complicated phacoemulsification cataract surgery, the patients were allocated to one of two groups: early PPV (≤ 1 week) or late PPV (> 1 week). In terms of the technique used to remove the dropped lens fragment or nucleus, patients were allocated to one of three groups: removal by vitrectomy probe, phacofragmentation, or through limbal incision [7-10].

All participants underwent a detailed slit-lamp examination (Slit Lamp, Haag Streit, BQ900, Bern, Switzerland) to assess the anterior and posterior segments. BCDVA was measured using an E-chart and was converted to logMAR notation for statistical evaluation. IOP was measured in mmHg using a Goldmann Applanation Tonometer (Haag-Streit diagnostic applanation tonometer AT 900®/870 18, Koeniz, Switzerland). Anterior uveitis was diagnosed if the anterior chamber cell reaction was ≥ + 2 [11].

Statistical analysis was performed using IBM SPSS Statistics for Windows (version 24.0; IBM Corp., Armonk, NY, USA). Normality of the data distribution was assessed using the Kolmogorov – Smirnov test. The mean, standard deviation (SD), median, interquartile range (IQR), frequency, and percentage were used to present the data. Mann – Whitney U and Kruskal–Wallis tests were used to compare quantitative variables between two groups and between more than two groups, respectively. The chi-square test was used to compare qualitative variables. The Wilcoxon signed-rank test was used to compare the results before and after surgery. Statistical significance was considered as a P-value < 0.05.

RESULTS

Fifty-one eyes of 51 patients with a mean (SD) age of 64.66 (6.54) years and a male-to-female ratio of 33 (64.7%) to 18 (35.3%) were included. The demographic data and characteristics of the participants are summarized in Table 1. The mean (SD, median) BCDVA before PPV in all included eyes was 1.87 (0.53, 1.70) logMAR, which reached 0.54 (0.46, 0.40) logMAR at the last postoperative follow-up visit, indicating a significant improvement after PPV ($P < 0.001$).

The mean (SD) BCDVA after PPV according to the IOL position and the method of nucleus or lens fragment removal was not significantly different at the last follow-up (all $P > 0.05$) (Table 2). Although the final mean BCDVA using the vitrectomy probe for lens removal was slightly better than that of the other two methods, the difference was not statistically significant ($P > 0.05$) (Table 2).

Comparing the outcomes and complications of PPV in the early versus late PPV groups, final BCDVA was significantly better in eyes that underwent early PPV ($P < 0.05$). However, the mean final IOP and rates of corneal edema, CME, RRD, uveitis, and other complications such as optic nerve atrophy, choroidal neovascularization, vitreous hemorrhage, and epiretinal membrane formation were comparable between the two groups (all $P > 0.05$) (Table 3).

Comparing the rates of complications between the methods of dropped lens fragment or nucleus removal revealed a significant difference in the rate of corneal edema, such that corneal edema was observed in 100% of patients with the trans-limbal removal method ($P < 0.05$). However, the rates of other postoperative complications were comparable among the three methods (all $P > 0.05$) (Table 4).

Table 1. Characteristics of study participants

Variable		
Age (y), Mean ± SD (Range)		64.66 ± 6.54 (48 to 87)
Sex (Male / Female), n (%)		33 (64.7) / 18 (35.3)
History of NPDR, n (%)		3 (5.9)
BCDVA before PPV (logMAR), Mean ± SD, Median (IQR)		1.87 ± 0.53, 1.70 (1.70 – 0.70)
Follow-up time (m), Mean ± SD, Median (Range)		23.14 ±16.72, 19 (2 to 84)
Time between complicated phacoemulsification and PPV (d), Mean ± SD, Median (Range)		14.16 ± 12.86, 9 (0 to 60)
IOP before PPV (mmHg), Mean ± SD, Median (IQR)		17.64 ± 9.55, 14 (12 – 18)
Final IOL position, n (%)	**IOL in the bag** **IOL in the sulcus** **Artisan** **Aphakia**	4 (7.8) 26 (51.0) 19 (37.3) 2 (3.9)
Nucleus removal method, n (%)	**Vitrectomy probe** **Phacofragmentation** **Trans-limbal delivery**	22 (43.1) 23 (45.1) 6 (11.8)

Abbreviations: y, years; SD, standard deviation; n, number of participants; %, percentage; NPDR, non-proliferative diabetic retinopathy; BCDVA, best-corrected distance visual acuity; PPV, pars plana vitrectomy; logMAR, logarithm of the minimum angle of resolution; IQR, interquartile range; m, months; d, days; IOP, intraocular pressure; mmHg, millimeters of mercury; IOL, intraocular lens; Artisan, iris fixed anterior chamber intraocular lens.

Table 2. Comparison of final visual outcomes after PPV according to the IOL position and the method of dropped lens fragment or nucleus removal

Variable		The final BCDVA (logMAR), Mean ± SD, Median (IQR)	*P*-value
Lens position	**IOL in the bag (n = 4)**	0.38 ± 0.22, 0.31 (0.22 – 0.62)	IOL in the bag versus IOL in the sulcus: $P = 0.746$ IOL in the bag versus Artisan: $P = 0.250$ IOL in the sulcus versus Artisan: $P = 0.057$
	IOL in the sulcus (n = 26)	0.48 ± 0.56, 0.40 (0.22 – 0.52)	
	Artisan (n = 19)	0.58 ± 0.35, 0.52 (0.40 – 0.70)	
Nucleus removal method	**Vitrectomy (n = 22)**	0.47 ± 0.27, 0.40 (0.28 – 0.52)	Vitrectomy versus phacofragmentation: $P = 0.972$ Vitrectomy versus trans-limbal: $P = 0.259$ Phacofragmentation versus trans-limbal: $P = 0.414$
	Phacofragmentation (n = 23)	0.59 ± 0.64, 0.40 (0.22 – 0.70)	
	Trans-limbal (n = 6)	0.54 ± 0.13, 0.52 (0.40 – 0.70)	

Abbreviations: PPV, pars plana vitrectomy; IOL, intraocular lens; BCDVA, best-corrected distance visual acuity; logMAR, logarithm of the minimum angle of resolution; SD, standard deviation; IQR, interquartile range; n, number of eyes; Artisan, iris fixed anterior chamber intraocular lens.

Table 3. Comparison of outcomes and complications of early versus late PPV

Variable	Early PPV (n = 21)	Late PPV (n = 30)	*P*-value
Initial BCDVA (logMAR), Mean ± SD, Median (IQR)	1.99 ± 0.51, 2.00 (1.70 – 2.60)	1.80 ± 0.54, 1.70 (1.30 – 2.07	0.272
Final BCDVA (logMAR), Mean ± SD, Median (IQR)	0.41 ± 0.30, 0.40 (0.22 – 0.46)	0.62 ± 0.52, 0.52 (0.40 – 0.70)	**0.019**
Final IOP (mmHg), Mean ± SD, Median (IQR)	11.23 ± 3.68, 12 (11 – 13)	12.70 ± 6.65, 12 (11 – 15)	0.690
Corneal Edema, n (%)	9 (42.9)	20 (66.7)	0.091
CME, n (%)	4 (19.0)	6 (20.0)	0.933
RRD, n (%)	1 (4.8)	7 (23.3)	0.073
Uveitis, n (%)	7 (33.3)	9 (30.0)	0.801
Others, n (%)	1 (4.8)	7 (23.3)	0.073

Abbreviations: PPV, pars plana vitrectomy; BCDVA, best-corrected distance visual acuity; logMAR, logarithm of the minimum angle of resolution; SD, standard deviation; IQR, interquartile range; IOP, intraocular pressure; mmHg, millimeters of mercury; n, number of eyes; %, percentage; CME, cystoid macular edema; RRD, rhegmatogenous retinal detachment; Others, optic nerve atrophy, choroidal neovascularization, vitreous hemorrhage, or epiretinal membrane formation. *P*-value < 0.05 is shown in bold. Note: early PPV, pars plana vitrectomy ≤ 1 week after complicated phacoemulsification in eyes with dropped lens fragment or nucleus; late PPV, pars plana vitrectomy > 1 week after complicated phacoemulsification in eyes with dropped lens fragment or nucleus.

Table 4. Comparison of complications after pars plana vitrectomy among the three methods of dropped lens fragment or nucleus removal

Complications	Trans limbal (n = 6)	Phacofragmentation (n = 23)	Vitrectomy probe (n = 22)	*P*-value
Corneal edema, n (%)	6 (100.0)	14 (60.9)	9 (40.9)	**0.030**
CME, n (%)	2 (33.3)	7 (30.4)	1 (4.5)	0.061
RRD, n (%)	1 (16.7)	2 (8.7)	5 (22.7)	0.432
Uveitis, n (%)	3 (50.0)	9 (39.1)	4 (18.2)	0.184
Others, n (%)	1 (15.7)	3 (13.0)	4 (18.2)	0.892

Abbreviations: n, number of eyes; %, percentage; CME, cystoid macular edema; RRD, rhegmatogenous retinal detachment; Others, optic nerve atrophy, choroidal neovascularization, vitreous hemorrhage, or epiretinal membrane formation. *P*-value < 0.05 is shown in bold.

DISCUSSION

All participants experienced significant improvement in BCDVA after PPV for dropped lens fragment or nucleus due to complicated phacoemulsification cataract surgery. However, the mean final BCDVA was significantly better after early PPV than after late PPV. The three lens fragment removal methods had comparable final BCDVAs. The rates of post-PPV complications did not differ significantly according to the time interval between complicated phacoemulsification and PPV.

Dropped lens fragment or nucleus is a dangerous complication of cataract surgery, especially phacoemulsification, potentially causing serious eye damage. PPV is the conventional treatment for this complication. In the present study, the mean BCDVA, and IOP elevation after PPV significantly improved; these findings are consistent with those of previous studies [4, 12-17].

We found a significantly better visual outcome with early PPV than with late PPV. Some studies have shown that PPV to remove the remaining nuclear fragments in the first week after complicated cataract surgery leads to better visual results [16, 18]. In contrast, other studies did not show better visual outcomes with earlier vitrectomy [4, 7, 14, 19, 20]. However, conservative management has good visual results in some circumstances [21].

In a systematic review and meta-analysis, Vanner and Stewart [22] compared the risk of clinical outcomes for same-day versus delayed PPV for managing dropped lens fragment or nucleus in the vitreous cavity during complicated cataract surgeries. The clinical outcomes did not differ based on the time interval. They recommended that same-day PPV may be unnecessary as long as prompt delayed PPV could be performed, which was defined as 3 to 7 or perhaps 14 days after complicated cataract surgery [22]. This inference may partly support our results of better visual outcomes in eyes that underwent PPV within 1 week of complicated phacoemulsification cataract surgery.

In general, the presence or absence of a significant difference in BCDVA according to the time interval from cataract surgery to PPV may be due to differences in patient conditions. For example, eyes with more severe inflammation and increased IOP are more likely to undergo earlier PPV [23]. Thus, the optimal timing for PPV should be individualized and depends on the volume of the remaining nuclear fragments, the hardness of the nucleus, the condition of the patient's eye, and access to the retinal surgeon [7, 13]. It has been suggested that in some cases, if possible, PPV be performed concurrently in the complicated cataract surgery session [24]. If this is not possible, it is best performed within 3 weeks [4, 21] or within the first week [17].

In this study, the mean final BCDVA did not significantly differ according to the IOL position, although the improvement in vision was less in aphakic eyes. Likewise, in other studies, the IOL position did not affect the final visual outcome [7, 20, 25].

Al-Amri et al. reported complications after PPV in 36 patients with nucleus drop, including uveitis (54%), corneal edema (43.2%), vitritis (40.5%), and RRD (3.7%) [4]. In a similar study, Oruc et al. detected corneal edema (49.4%) and uveitis (67%) but reported no cases of glaucoma, RRD, or CME [18]. The most common complications in the current study were corneal edema (56.9%), uveitis (31.4%), CME (19.6%), and RRD (15.7%). However, no significant difference was observed in the rates of complications according to the time interval between complicated phacoemulsification and PPV. Likewise, the final BCDVA did not significantly differ based on IOL position.

Except for the higher rate of corneal edema in the trans-limbal nucleus extraction method, the rates of other complications were similar among the three methods of lens removal in our study. Corneal edema occurred in 100% of patients whose lens fragments or nucleus was removed using the trans-limbal method; however, it did not affect final visual acuity. The lowest rate of corneal edema was observed with the vitrectomy probe method [10], which is not possible in all cases and is used only in those with small and soft nuclear fragments in the vitreous. Other studies have reported a similar lack of association between the incidence of complications and the method of removing dropped nucleus or lens fragments [7, 14].

Differences in the characteristics of patients under study, such as age, baseline BCDVA, previous eye problems, different methods of lens removal, and different follow-up periods may cause some differences in results [14, 26]. Less manipulation and shorter operation time reportedly reduce the incidence of corneal edema and uveitis and improve the patient's final vision [14]. We found no significant difference in the final BCDVA or the majority of complications among the three lens removal techniques. However, details of the operations were not documented in all patient records, which is a shortcoming of the retrospective design of this study.

This study reported cases of dropped lens fragment or nucleus due to complicated phacoemulsification cataract surgeries that were performed over 10 years in an educational tertiary referral center in southeast Iran, finding early PPV and removal of lens fragments to be advantageous for a better visual outcome. The long study period is one of its limitations, as it causes differences in the method of operation, level of documentation, and surgeons' skills. We could not evaluate the effect of surgical conditions in the primary complicated phacoemulsification cataract surgery on the final results. Further prospective studies are required to confirm the findings of this study and to identify other parameters, including preexisting chronic eye conditions and events during complicated phacoemulsification, that influence the final visual outcome and the occurrence of complications after PPV surgery. Future studies that include other parameters of visual function, such as contrast sensitivity, visual field, color vision, and stereopsis, could provide more conclusive results and help verify our findings.

CONCLUSIONS

PPV performed less than 1 week after complicated phacoemulsification cataract surgery with a dropped lens fragment or nucleus had a better visual outcome. Corneal edema was more common in the trans-limbal lens extraction method; however, it did not affect the final visual acuity. Future studies with longer follow-up, larger sample sizes, and other parameters of visual function, such as contrast sensitivity, visual field, color vision, and stereopsis, could provide more conclusive results and help verify our findings.

ETHICAL DECLARATIONS

Ethical approval: The study protocol was reviewed and approved by the ethics committee of the Ahvaz Jundishapur University of Medical Sciences (ethics code: IR.AJUMS.HGOLESTAN.REC.1399.144). All participants provided written informed consent for phacoemulsification and consequent PPV surgeries.
Conflict of interest: None.

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