Original Article

Visual and Anatomical Outcomes of Pars Plana Vitrectomy for Dropped Nucleus after Phacoemulsification

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Abstract

Purpose: To determine the prognostic factors and visual and anatomic outcomes of pars plana vitrectomy (PPV) in patients with dropped nucleus following complicated phacoemulsification (PE).
Methods: The records of patients with complicated PE who underwent PPV to remove posteriorly dislocated nucleus fragments from January 2011 to December 2014 were retrospectively reviewed.
Results: Of 43 patients, 36 patients (36 eyes) were included with mean age of 73 ± 9.5 years and mean follow-up duration of 23.8 ± 15.3 (range 4–53) months. The mean interval between cataract surgery and PPV was 11.5 ± 9.6 (range 1–45) days. The pre-PPV mean best-corrected visual acuity (VA) was 1.04 ± 0.24 logMAR, which improved to 0.46 ± 0.18 logMAR ($P < 0.001$). Pre-PPV VA ≥20/200 was significantly associated with good final VA ≥20/40 ($P = 0.002$). Implantation of intraocular lens (IOL) at the time of complicated PE and complicated course after PPV were significantly associated with poor visual outcome of <20/40 ($P = 0.041$ and $P < 0.001$, respectively). However, the timing of PPV, route of nucleus removal, and final IOL status were not significantly associated with the visual outcome. The most frequent causes of poor visual outcome were optic atrophy, cystoid and/or diabetic macular edema, history of rhegmatogenous retinal detachment, and pre-existing eye disease (age-related macular degeneration).
Conclusion: PPV for dropped nucleus was associated with improved VA. Better pre-PPV VA was associated with good visual outcome, while inserting IOL at the time of complicated PE, and complicated course after PPV were associated with poor visual outcome.

Keywords: Dropped Nucleus; Phacoemulsification; Pars Plana Vitrectomy; Visual Outcome

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INTRODUCTION

Phacoemulsification is currently the most common surgical technique used for cataract extraction. Loss of nucleus or

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lens fragments into the vitreous cavity is one of the most serious complications of phacoemulsification and may occur during any stage of surgery.[1] This complication can result in sight-threatening outcomes because of elevated intraocular pressure (IOP), corneal edema, uveitis, rhegmatogenous retinal detachment (RRD), and other sequelae.[2-4] Nucleus fragment drop usually happens when phacoemulsification is performed by inexperienced surgeons, but may also occur when performed by experienced operators. The reported incidence rate ranges between 0.3% and 1.1%.[1,5]

Pars plana vitrectomy (PPV) and release of vitreous adhesions from the dropped nucleus, followed by removal of the dislocated lens fragments using a phacofragmatome or vitrectomy probe is the most effective solution.[6]

The final visual outcome after PPV for dropped nucleus has been reported to be ≥20/40 in 44%–71.3% of patients.[7-10] The aims of this study were to evaluate the visual and anatomic outcomes of PPV for dropped nucleus and if possible to determine the prognostic factors affecting the final visual outcome.

METHODS

The study protocol was approved by the Institutional Review Board and Ethics Committee of Shahid Beheshti University of Medical Sciences. The medical records of all patients who were referred after complicated phacoemulsification and underwent PPV for dropped nucleus from January 2011 to December 2014 at our two tertiary referral hospitals (Imam Hossein Medical Center and Torfeh Medical Center) were retrospectively reviewed. Patients were included if they had complete data and at least 3 months of follow-up. Patients with traumatic cataract, traumatic lens subluxation, or advanced proliferative diabetic retinopathy were excluded.

The patients' demographics and pre-PPV parameters, including age, sex, best-corrected visual acuity (BCVA), IOP, presence of corneal edema, inflammation of the anterior chamber, and anterior uveitis (anterior chamber reaction of 3+ cells or more), gauge of the instruments used, size of the dropped nucleus, presence of RRD, and the interval between complicated cataract surgery and PPV were recorded.

All patients underwent standard 20-gauge or 23-gauge 3-port PPV with complete release of the vitreous strands surrounding the retained lens material. The dropped nucleus was removed from the vitreous cavity using a vitrectomy probe or a phacofragmatome. Use of perfluorocarbon liquid during surgery and tamponade at the end of the procedure were according to the surgeon's preference. Intraoperative and postoperative complications, including vitreous hemorrhage, formation of retinal breaks, and retinal detachment were recorded.

Each surgical procedure was performed by one of the three experienced vitreoretinal surgeons (HN, ME, or AR). Betamethasone eye drops every 2–4 hours being tapered over one month, chloramphenicol eye drops every 6 hours for one week, and homatropine eye drops every 8 hours for 2 weeks were administered after surgery.

Post-PPV parameters, including BCVA, IOP, anatomic results, final IOL status, and complications during follow-up were recorded.

BCVA was measured using the Snellen acuity chart and then converted to the logarithm of the minimum angle of resolution (logMAR) for the purposes of statistical analysis. A final BCVA of ≥20/40 was considered a good visual outcome and <20/40 as a poor outcome. The causes of a poor visual outcome were sought.

Data were analyzed using IBM SPSS Statistics for Windows version 21.0 software (released 2012, IBM Corp., Armonk, NY, USA). Normality of the distribution of the quantitative data was checked using a Q-Q plot and the Kolmogorov-Smirnov test. Wilcoxon signed-rank test was used to evaluate the changes in each group. Mann-Whitney test was used to compare the ordinal and quantitative non-normally distributed variables between two groups. Chi-squared and Fisher's exact tests were used to compare nominal variables between two groups. P values <0.05 were considered statistically significant. Simple and multiple logistic regression models were used to obtain the raw and adjusted associations of the pre-PPV, intraoperative PPV, and post-PPV variables with the final visual outcomes.

RESULTS

Of the 43 patients identified to have undergone surgery for retained lens material, 36 eyes from 36 patients had complete information recorded and were included. The 36 patients (19 men, 17 women) had a mean age of 73.0 ± 9.5 (range 42–91) years. The mean interval between complicated cataract surgery and PPV was 11.4 ± 9.2 (range 1–45) days. Sixteen patients underwent surgery in the first week after cataract surgery (≤7 days) and the others after this time [Table 1].

At presentation, IOP higher than 25 mmHg and retinal breaks with concurrent RRD were present in 6 (16.7%) and 4 eyes (11.1%), respectively. There was shallow macular detachment in all 4 cases of RRD. No patient was on anti-glaucoma medication at the time of presentation. Neither hypopyon nor endophthalmitis was observed in any cases. Polymethyl methacrylate (PMMA) IOL had been implanted in the ciliary sulcus in 11 (30.6%) eyes and the other eyes had been left aphakic. Seven patients (19.4%) had vitreous in the anterior chamber; 4 (57.1%) of them had an IOP >25 mmHg. However, only 2 (6.9%) of 29 eyes that underwent appropriate anterior vitrectomy during complicated phacoemulsification had a high IOP at presentation (P = 0.008, odds ratio = 18, 95% confidence interval 2.3–143.3).

Standard 3-port PPV was performed using 20-gauge and 23-gauge probes in 25 (69.4%) and 11 eyes (30.6%), respectively. A 3-piece foldable posterior chamber IOL was implanted in 16 eyes (44.4%) and an artisan aphakia iris claw lens in 9 eyes (25%) [Table 2].

Silicone oil was injected at the end of PPV in 4 patients (11.1%) who had concurrent RRD; a 3-piece IOL was implanted in 2 of these patients, an aphakic artisan iris claw lens was implanted at the time of PPV in 1 patient, and 1 patient was left without an IOL. At the final follow-up visit, the retina was attached and the IOP was <25 mmHg in all 4 patients, 3 of whom (8.3%) were on anti-glaucoma medication. Silicone oil was removed in all 4 cases.

The mean pre-PPV BCVA was 1.04 ± 0.24 (range 0.3–1.3) logMAR which improved to 0.46 ± 0.18 (range 0.1–1.0) logMAR at the final visit (P < 0.001). The pre-PPV visual acuity (VA) was <20/40 in 35 eyes (97.2%) and <20/200 in 13 eyes (36.1%). At the final visit, VA improved to ≥20/40 in 12 eyes (33.3%, P < 0.001). Only one eye (2.8%) had a final VA <20/200 (P < 0.001) [Table 3]. Eight eyes in this series had a pre-existing eye disease (RRD and age-related macular degeneration, 4 eyes each). Excluding the eyes with pre-existing disease, 12 patients (43%) had a final VA ≥20/40, 16 (57%) had a final VA <20/40, and no patient had a VA <20/200.

Univariate regression analysis was performed to identify pre-PPV variables associated with a good visual outcome. A pre-PPV VA ≥20/200 and the patient being left aphakic at the end of cataract surgery were significantly associated with a good final visual outcome (P = 0.002 and P = 0.041, respectively). The interval between complicated phacoemulsification and PPV had no significant impact on the final visual outcome (P = 0.246) [Table 4]. Intraoperative variables, including use of a phacofragmatome or vitrectomy probe to remove the retained lens material and final IOL status were not associated with the visual outcome (P > 0.05). However, in the eyes with a complicated course after PPV (e.g. development of epiretinal membrane, cystoid macular edema, or optic atrophy), the likelihood of achieving a final BCVA ≥20/40 was significantly less in the univariate analysis (P < 0.001) [Table 5]. We used a backward stepwise selection method to determine the factors associated with a final BCVA ≥20/40 in a multiple logistic regression model that considered preoperative, intraoperative, and post-PPV variables. The only significant variable in the model was the patient being left aphakic (odds ratio 13.2, 95% confidence interval 1.24–140.7, P = 0.033).

The primary cause of low vision in the patients with a final VA <20/40 was optic atrophy (7 eyes), epiretinal membrane (3 eyes), cystoid and/or diabetic macular

Table 1. Baseline patient demographics and clinical characteristics

Variable	Value
Patients (n)	36
Age (years)	
Mean±SD	73±9.5
Median (range)	73.5 (42-91)
Sex	
M (%)	19 (52.8%)
F (%)	17 (47.2%)
Follow-up (months)	
Mean±SD	24.2±15.8
Median (range)	18.5 (4-53)
Interval between cataract	
Mean±SD	11.4±9.2
surgery and PPV (days)	
Median (range)	8.5 (1-45)
Corneal edema at presentation	
n (%)	15 (41.7%)
Postoperative uveitis at presentation	
n (%)	20 (55.6%)
IOP >25 mmHg at presentation	
n (%)	6 (16.7%)
Implantation of IOL at the end of cataract surgery	
n (%)	11 (30.6%)
Retinal detachment at presentation	
n (%)	4 (11.1%)

IOL, intraocular lens; IOP, intraocular pressure; PPV, pars plana vitrectomy; SD, standard deviation

Table 2. Intraoperative and post-pars plana vitrectomy variables

Variable	n (%)
Gauge of instrument used for vitrectomy	
20	25 (69.4%)
23	11 (30.6%)
Size of dropped nucleus	
≥1/4 to <1/2	18 (50.0%)
≥1/2 to <3/4	18 (50.0%)
Manner of nucleus	
Vitrectomy probe	23 (63.9%)
Removal	
Phacofragmatome	13 (36.1%)
Patients on anti-glaucoma medication at their last visit	
Yes	3 (8.3%)
No	33 (91.7%)
Final IOL status	
3 piece*	16 (44.4%)
Artisan**	9 (25%)
PMMA	11 (30.6%)

*3-piece foldable posterior chamber IOL. **Artisan aphakia iris claw lens. IOL, intraocular lens; PMMA, poly methyl methacrylate; PPV, pars plana vitrectomy

Table 3. Best corrected log MAR visual acuity at presentation and final visit

	Pre- PPV	Last visit	Change	P-within‡
BCVA				
Mean±SD	1.04±0.24	0.46±0.18	−0.58±0.15	<0.001
Median (range)	1 (0.3-1.3)	0.45 (0.1-1)	−0.6 (−0.8, −0.2)	
BCVA				
<20/200 *n* (%)	13 (36.1%)	1 (2.8%)		<0.001
≥20/200 to<20/40 *n* (%)	22 (61.1%)	23 (63.9%)		
≥ 20/40 *n* (%)	1 (2.8%)	12 (33.3%)		

‡Based on Wilcoxon signed-rank test. BCVA: Best-corrected visual acuity; PPV: Pars plana vitrectomy

Table 4. Pre-pars plana vitrectomy variables associated with good or poor visual outcomes in univariate analysis

Variable	Total†	Final BCVA‡		*P*
		<20/40	≥20/40	
Interval between cataract surgery and PPV				
≤7	16 (44.4%)	9 (56.3%)	7 (43.8%)	0.246*
>7	20 (55.6%)	15 (75.0%)	5 (25.0%)	
Pre-PPV BCVA				
<20/200	13 (36.1%)	13 (100.0%)	0 (0.0%)	0.002**
≥20/200	23 (63.9%)	11 (47.8%)	12 (52.2%)	
Dropped nucleus size				
>1/4 to ≤1/2	18 (50.0%)	14 (77.8%)	4 (22.2%)	0.157*
>1/2 to ≤3/4	18 (50.0%)	10 (55.6%)	8 (44.4%)	
IOL implantation at the end of cataract surgery				
No	25 (69.4%)	14 (56.0%)	11 (44.0%)	0.041*
Yes	11 (30.6%)	10 (90.9%)	1 (9.1%)	
RRD at presentation				
Yes	4 (11.1%)	4 (100.0%)	0 (0.0%)	0.278**
No	32 (88.9%)	20 (62.5%)	12 (37.5%)	
IOP >25 mmHg at presentation				
Yes	6 (16.7%)	4 (66.7%)	2 (33.3%)	1**
No	30 (83.3%)	20 (66.7%)	10 (33.3%)	

†The percentages are presented in all cases. ‡The percentage is presented within each variable stratum. *Based on the Chi-square test. **Based on Fisher's exact test. BCVA, best-corrected visual acuity; IOL, intraocular lens; IOP, intraocular pressure; PPV, pars plana vitrectomy; RRD, rhegmatogenous retinal detachment

edema (4 eyes), a history of RRD (4 eyes), corneal edema and IOL subluxation (1 eye each), and age-related macular degeneration (4 eyes).

DISCUSSION

PPV is the preferred management for dropped nucleus after complicated cataract surgery. In most cases, removal of lens fragments leads to improvement in VA and reduces inflammation and IOP.

The mean BCVA in our patients improved significantly after PPV, which is consistent with previous reports.[7-9] However, the percentage of eyes that achieved a final VA ≥20/40 was lower than in previous reports. Excluding eyes with pre-existing disease, 43% of eyes in this study had a final VA ≥20/40, which is comparable to other reports (44%–75%).[3,7,9-13] Pre-existing eye disease has been associated with less improvement in VA after PPV,[10,14] as is seen in the current study. Twenty-three eyes (63.9%) in this study achieved a final VA between 20/200 and 20/40, which is better than in previous series (13%–37%).[3,7,9-13] Only 1 patient (2.8%) had a VA <20/200 at the final visit, which is less than the previous reports of 5%–37%.[3,10,11,13] The timing of PPV did not have any significant effect on the final VA outcome [Table 3], which is again consistent with previous reports.[10,15-17] This may reflect selection bias; for example, eyes with severe inflammation, markedly elevated IOP, or larger nuclear fragments are often referred earlier and undergo earlier PPV, whereas eyes with smaller nuclear fragments and controlled IOP are likely to be referred later. Therefore, more severe cases usually receive earlier treatment.[18] In contrast with the above-mentioned studies, other researchers found that delayed vitrectomy correlated with poor visual outcomes[8] and was associated with higher ocular complication rates.[19]

In the present study, eyes with better BCVA at presentation had significantly better final visual

Table 5. Intraoperative and post-pars plana vitrectomy variables associated with good or poor visual outcomes in univariate analysis

Variable	Total†	Final BCVA‡		*P*
		<20/40	≥20/40	
Manner of nucleus removal				
Vitrectomy probe	23 (63.9%)	15 (65.2%)	8 (34.8%)	>0.99**
Phacofragmatome	13 (36.1%)	9 (69.2%)	4 (30.8%)	
Final IOL status				
3-piece acrylic foldable IOL	16 (44.4%)	8 (50.0%)	8 (50.0%)	0.093**
Artisan aphakia iris claw lens	9 (25.0%)	6 (66.7%)	3 (33.3%)	
PMMA	11 (30.6%)	10 (90.9%)	1 (9.1%)	
Complicated course				
No	12 (33.3%)	0 (0.0%)	12 (100.0%)	<0.001*
Yes	24 (66.7%)	24 (100.0%)	0 (0.0%)	

†The percentages are presented in all cases. ‡The percentage is presented within each variable stratum. *Based on the Chi-square test. **Based on Fisher's exact test. BCVA, best-corrected visual acuity; IOL, intraocular lens; PMMA, poly methyl methacrylate; PPV, pars plana vitrectomy

outcomes. Specifically, 12 eyes (52.2%) with an initial BCVA ≥20/200 had a final VA ≥20/40, while all patients with an initial BCVA <20/200 had a final VA <20/40. Patients with better VA after complicated cataract surgery were more likely to have fewer intraoperative or postoperative complications, including corneal edema, glaucoma, uveitis, and RRD. Therefore, they had a greater likelihood of achieving a better final VA.

In previous studies, using a fragmatome to remove retained lens fragments was associated with a significantly worse visual outcome[10] as well as an increased risk of RRD, albeit not statistically significant.[10,20] In the present study, there was no significant association between use of a phacofragmatome and a poor visual outcome or an increased risk of RRD. This might be explained by the use of better instruments and performing complete vitrectomy before using a fragmatome.

Margherio et al reported significant differences in final visual outcomes according to lens status. Eyes with posterior chamber IOL had better vision than those with anterior chamber IOL, and both groups had better vision than aphakic patients. This finding was attributed to the degree of complications encountered at the time of cataract surgery, for which lens status would be a marker.[7] In our series, the final status of the lens did not have any impact on the visual outcome, as in two previous studies.[16,21] Our patients who were left aphakic at the time of cataract surgery had a significantly better final visual outcome in both univariate and multivariate analyses. Rose et al reported similar findings.[22] Although Watts et al reported no association between insertion of an IOL at the time of complicated cataract surgery and the final visual outcome, they believed that IOL implantation at the time of phacoemulsification made vitrectomy more difficult and that insertion of the IOL into the ciliary sulcus at the end of corrective vitrectomy was safe.[23] We suggest that less manipulation and the shorter operating time in eyes that were left aphakic during phacoemulsification caused less corneal edema, inflammation, uveitis, and retinal problems such as cystoid macular edema, thus contributing to a better final visual outcome.

In the present study we did not find a significant association between the size of the retained lens fragments and the final visual outcome or ocular complication rates.

In our study, elevated IOP (≥25 mmHg) was detected in 6 eyes (16.7%) at presentation. This complication has been reported in 25%–52% of cases in other series.[16,20,21] We found a statistically significant difference in the prevalence of elevated IOP at presentation between patients who had undergone appropriate anterior vitrectomy and those who had not. A similar association was reported by Ho et al[16] The residual vitreous in the anterior chamber increases the risk of uveitis and trabeculitis, and therefore, may contribute to IOP elevation.

In this study, retinal breaks and RRD were found in 4 eyes (11.1%) before PPV; however, no new retinal breaks or subsequent RRD were found after PPV. Tajunisah and Reddy reported no RRD after PPV in their patients,[24] while in a large series, Moore et al reported RRD in 19 (5.5%) of 343 patients after PPV for retained lens fragments.[25] Another study identified RRD in 3.1% of patients.[26] Ho et al noticed that the older studies had higher rates of RRD after PPV than the more recent series.[16] This may be related to the use of smaller-gauge PPV and the availability of better equipments in recent years.

We found optic atrophy, cystoid and/or diabetic macular edema, and a history of RRD or age-related macular degeneration to be the most common causes of low vision (BCVA <20/40) after PPV. Previous studies have also cited retinal detachment and macular problems, such as macular edema, macular hole, and age-related macular degeneration, as the reasons for decreased VA.[9,10] Scott et al reported cystoid macular edema as the most common cause of decreased final vision after PPV and advocated aggressive treatment of macular edema in these patients.[18]

Optic atrophy was detected in 7 eyes in our series. Three of these 7 cases had silicone oil endotamponade for a long period. Silicone oil has been demonstrated to cause degeneration of the optic nerve.[27] Furthermore, post-PPV optic neuropathy may be caused by mechanical trauma to the optic nerve during induction of posterior vitreous detachment.[28] Reduced ocular perfusion pressure and systemic hypotension during PPV may be responsible for posterior ischemic optic neuropathy.[29]

Since PE complicated with nucleus drop is not very common, a small sample size cannot be avoided. This holds true in our study even though it covered a four-year period.

In conclusion, PPV for posteriorly dislocated lens fragments was associated with improved VA in this study. Leaving the eyes aphakic at the time of primary cataract surgery and a better pre-PPV VA were significantly associated with better final visual outcomes. A complicated course after PPV reduces the likelihood of obtaining a good VA; therefore, long-term follow-up is recommended. Further prospective trials that include more cases may improve our ability to determine the visual outcome and its predictors after PPV for cataract surgery complicated by dropped nucleus.

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Conflicts of Interest

There are no conflicts of interest.

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