

Visual Outcomes and Risk of Rhegmatogenous Retinal Detachment Following Posterior Capsule Rupture during Cataract Surgery: With vs without Dropped Nuclear Lens Fragments

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Abstract

Background: Cataract surgery is the most frequently performed surgery worldwide. Posterior capsule rupture (PCR) remains one of the most common complications of cataract surgery and a major risk factor for poor visual outcomes. Cataract surgeries complicated by PCR and vitreous loss are managed with anterior vitrectomy at the time of surgery. However, the situation can be further complicated by dropping lens particles into the vitreous cavity necessitating a secondary pars plana vitrectomy (PPV). **Purpose:** To compare the visual outcomes and risk of rhegmatogenous retinal detachment (RRD) between eyes that required anterior vitrectomy (AV) alone for the management of vitreous loss and eyes that required AV and subsequent PPV for the management of dropped nuclear lens fragments (DNLF) following cataract surgery complicated by PCR in a tertiary care teaching hospital in Saudi Arabia. **Methods:** Medical records of patients in whom PCR occurred during phacoemulsification cataract surgery requiring AV or subsequent PPV for DNLF were retrospectively reviewed over a 6-year period from January 2016 to December 2021. **Results:** PCR occurred in 183 (2.3%) of 7757 consecutive eyes that underwent phacoemulsification cataract surgery during the study period. Seven eyes were excluded from analysis for missing data or short follow-up. Of the 176 eyes, 147 eyes (83.5%) were managed with AV alone, and the remaining 29 eyes (16.5%) underwent a secondary PPV for DNLF. After excluding eyes with pre-existing ocular pathology, final best-corrected visual acuity (BCVA) was similar in both groups with a mean of 0.32 logMAR (P = 0.99). Two of 147 eyes (1.4%) in the AV group developed RRD with poor final BCVA whereas none of the eyes in DNLF group developed RRD. **Con-**

Conclusion: The risk of RRD is lower in eyes that required PPV for DNLF than in eyes that were managed with AV alone following PCR during cataract surgery. The poor visual outcomes in eyes that suffered RRD underscore the importance of postoperative retinal examination and early detection of retinal breaks.

Keywords

Cataract Surgery, Posterior Capsule Rupture, Anterior Vitrectomy, Retinal Detachment, Dropped Nucleus

1. Introduction

Cataract surgery is the most frequently performed surgery worldwide, with an estimated 20 million cataract surgeries performed annually [1] [2]. Despite current advances in cataract surgery, posterior capsule rupture (PCR) remains one of the most common complications of cataract surgery and a major risk factor for poor visual outcomes [3]. The incidence of PCR varies in the literature, ranging from 0.98% to 4.7% of cataract surgery cases [4]-[9]. Cataract surgeries complicated by PCR and vitreous loss are managed with anterior vitrectomy at the time of surgery. However, the situation can be further complicated by dropping lens particles into the vitreous cavity necessitating a secondary pars plana vitrectomy (PPV). The reported incidence of dropped nuclear lens fragments (DNLF) ranges from 0.1% to 1.5% of cataract surgery cases [10] [11] [12].

Cataract surgery cases complicated by PCR are at higher risk of developing several potentially serious post-operative complications such as cystoid macular edema, retinal detachment, glaucoma, and endophthalmitis [13]. Retinal detachment is among the most common causes of severe visual loss following complicated cataract surgery, leading to poor visual outcomes in most cases [14]. Retinal detachment occurs in 0.5% - 1% of eyes undergoing phacoemulsification cataract surgery, while it is more prevalent in PCR cases [15]. The risk of developing retinal detachment is 13 - 16 times higher following PCR and vitreous loss compared to cases with intact capsule [16].

The purpose of this study was to compare the visual outcomes and risk of rhegmatogenous retinal detachment (RRD) between eyes that required anterior vitrectomy alone for the management of vitreous loss and eyes that required anterior vitrectomy and subsequent pars plana vitrectomy (PPV) for the management of dropped nuclear lens fragments (DNLF) following PCR during cataract surgery in a tertiary care teaching hospital in Saudi Arabia.

2. Methods

As part of a clinical audit program at our institution, all surgeons are required to report the occurrence of PCR at the conclusion of cataract surgery. Medical records of patients in whom PCR occurred during phacoemulsification cataract

surgery were retrospectively reviewed over a 6-year period from January 2016 to December 2021 at Department of Ophthalmology, King Saud University Medical City, Riyadh, Saudi Arabia. All patients who underwent anterior vitrectomy for PCR and vitreous loss with/without a secondary PPV for DNLF were included in the study regardless of pre-existing ocular pathology. However, eyes with pre-existing ocular pathology such as maculopathy (secondary to diabetes mellitus, myopia, or other vascular diseases), advanced glaucoma, neuropathies, amblyopia, significant corneal pathology, and previous ocular surgeries that would limit the visual potential were excluded from visual outcome analysis. Data collected included patient demographics, preoperative and final postoperative best-corrected visual acuity (BCVA) in logMAR, pre-existing ocular pathology, time interval between cataract surgery and PPV for the management of DNLF, and time interval between cataract surgery and development of RRD. Patients with less than one month of postoperative follow up were excluded from the study.

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 26 (IBM Corp., Armonk, NY). Descriptive statistics were presented as percentages and frequencies. Chi-square test was used to compare demographic variables between the two groups. A two-tailed *t* test was conducted to compare means between the two groups. A *p*-value < 0.05 was considered statistically significant.

The study was approved by the Institutional Review Board (IRB) at King Saud University Medical City, Riyadh, Saudi Arabia. This study adhered to the ethical principles outlined in the Declaration of Helsinki and the Health Insurance Portability and Accountability Act.

3. Results

One hundred eighty-three of 7757 consecutive eyes that underwent cataract surgery during the study period were reported to have PCR, giving an incidence of 2.3%. Of the 183 eyes, seven eyes were excluded from analysis for missing data or short follow-up. One hundred seventy-six cases had a minimum follow-up of 4 weeks and were included in analysis. Of the 176 eyes, 147 eyes (83.5%) were managed with anterior vitrectomy alone at the time of cataract surgery for vitreous loss, and the remaining 29 eyes (16.5%) underwent a secondary PPV for DNLF. Of the 176 eyes, 22 eyes with pre-existing ocular comorbidity were excluded from visual outcome analysis.

Table 1 summarizes the baseline characteristics and visual outcomes of the included eyes. There were no significant differences between the two groups. After excluding eyes with pre-existing ocular pathology, final BCVA was similar in both groups with a mean of 0.32 logMAR (*P* = 0.99). Final BCVA of 0.3 logMAR or better was achieved in 79.7% of eyes in the anterior vitrectomy group and 73.1% of eyes in the DNLF group (*P* = 0.45). In the DNLF group, the mean time for a secondary PPV for the removal of DNLF following the initial cataract

surgery was 19.45 days; 13/29 eyes had early PPV within 2 weeks following the initial cataract surgery and 16/29 eyes had late PPV after 2 weeks. After excluding eyes with pre-existing pathology, the final BCVA was similar in both groups with a mean of 0.36 logMAR in early PPV group and 0.28 logMAR in late PPV group ($P = 0.60$). Four of 29 eyes (13.7%) in the DNLF group were noted to have retinal tears during PPV and were treated accordingly. Almost 90% of patient in both groups had sulcus intra-ocular lens implantation.

Two of 147 eyes (1.4%) in the anterior vitrectomy group developed RRD with poor final BCVA. **Table 2** shows the demographic and visual outcomes of the 2 eyes that developed RRD. None of the eyes in DNLF group developed RRD.

Table 1. Baseline characteristics and visual outcomes of the included eyes.

Variable	Anterior vitrectomy (n = 147)	DNLF (n = 29)	Statistical significance
Age, mean in years (range)	65.5 (30 - 92)	66.2 (51 - 93)	$P = 0.76$
Female gender, n (%)	88 (59.9)	18 (62.1)	$P = 0.82$
Mean preoperative logMAR BCVA (range)*	0.83 (0 - 2.30)	0.96 (0.18 - 2.30)	$P = 0.32$
Mean postoperative logMAR BCVA (range)*	0.32 (0 - 2.30)	0.32 (0 - 1.80)	$P = 0.99$
Percentage of patients with final logMAR BCVA of 0.3 or better*	79.7	73.1	$P = 0.45$
Mean time to PPV for DNLF removal, days (range)	Not Applicable	19.45 (0 - 175)	
The presence of retinal tears identified during PPV for DNLF removal, n (%)	Not Applicable	4 (13.7)	
Number progressing to RRD, n (%)	2 (1.4)	0	$P = 0.52$
Mean time to development of RRD, months (range)	8 (6 - 10)	Not Applicable	
Sulcus intraocular lens, n (%)	134 (91.2)	27 (93.1)	
Capsular bag intraocular lens, n (%)	6 (4.1)	0	
Anterior chamber intraocular lens, n (%)	0	0	
Scleral fixated intraocular lens, n (%)	4 (2.7)	1 (3.4)	
Aphakia, n (%)	3 (2)	1 (3.4)	

BCVA: Best-corrected visual acuity; DNLF: Dropped nuclear lens fragments; PPV: Pars plana vitrectomy; RRD: Rhegmatogenous retinal detachment; (*): 22 eyes with pre-existing ocular pathology were excluded from visual outcome analysis.

Table 2. Demographic and visual outcomes of the two eyes that were managed with anterior vitrectomy and progressed to develop RRD.

Age (years)	Gender	Eye	Pre-existing ocular pathology	Pre-operative BCVA (logMAR)	IOL choice	Onset of RRD (months)	Macula status	Final BCVA (logMAR)
61	Female	Left	None	0.70	Sulcus	6	OFF	2.30
72	Male	Left	None	1.00	Sulcus	10	OFF	1.80

BCVA: Best-corrected visual acuity; IOL: Intra-ocular lens; RRD: Rhegmatogenous retinal detachment.

4. Discussion

This study aimed to evaluate the visual outcomes and risk of RRD following cataract surgery complicated by PCR and managed with anterior vitrectomy for vitreous loss with/without subsequent PPV for DNLF in a tertiary care teaching hospital in Saudi Arabia.

The incidence of PCR during phacoemulsification cataract surgery is variable in the literature. Our PCR rate of 2.3% is comparable to the published rates. **Table 3** summarizes the rates of PCR in the recent literature.

Interestingly, the mean final BCVA was similar in eyes that were managed with anterior vitrectomy alone for vitreous loss and eyes that required a secondary PPV for DNLF, with a mean of 0.32 logMAR in both groups. Naderi *et al.* reported the same finding of comparable final BCVA between the two groups with a mean of 0.30 logMAR in the anterior vitrectomy group and 0.32 logMAR in the DNLF group [4]. Therefore, cataract surgeons should be reassured that even if the cataract surgery is complicated by DNLF, patients can achieve good visual outcomes.

Retinal tears following anterior vitrectomy for PCR occur secondary to the anterior movement of vitreous resulting from PCR that induces traction on the vitreous with a subsequent retinal tear. Jakobsson *et al.* showed that the risk of RRD increases by 10-fold in eyes with PCR, leading to poor visual outcomes in most cases [14]. Understanding that excessive pulling on the vitreous can result in retinal breaks in addition to mastering the skill of anterior vitrectomy are crucial for all cataract surgeons to decrease the risk of retinal tears or detachment and improve the visual outcomes. Also, meticulous postoperative examination of the retina is essential in complicated cataract surgery cases to detect retinal breaks and manage the condition in a timely manner. Our rate of 1.4% of RRD in the anterior vitrectomy group occurring within a median time of 8 months is lower than rates reported in the literature. Naderi *et al.* reported a RRD rate of 4.86% within a median time of 11 months [4]. Day *et al.* reported a RRD rate of 3.27% within a median time of 44 days [17]. Daniel *et al.* reported a high rate of RRDs of 6.39% within a median time of 8 months [18].

Table 3. Rates of posterior capsule rupture in recent literature.

Study	Country	Number of cases	PCR rate (%)
Ti, 2014 [9]	Singapore	55,567	1.9
Tsinopoulos, 2015 [5]	Greece	1335	4.7
Kahawita, 2015 [8]	Australia	3740	2.6
Kim, 2017 [7]	New Zealand	500	2.6
Akkach, 2019 [6]	Australia	13,124	1.0
Naderi, 2020 [4]	United Kingdom	20,235	0.98

PCR: posterior capsule rupture.

In our study, none of the eyes that required a secondary PPV for DNLF developed RRD, although 4/29 eyes (13.7%) were found to have retinal tears during PPV for the management of DNLF. Our findings are consistent with Naderi *et al.* where none of 55 eyes in the DNLF group progressed to develop RRD, in which 9/55 eyes (16.3%) were found to have retinal tears during the subsequent PPV [4]. Our findings are also comparable to Lashgari *et al.* where none of 36 eyes with DNLF went on to develop RRD, in which 4/36 eyes (11.1%) were found to have retinal tears during PPV [19]. Ryoo *et al.* also showed similar findings in which none of 32 eyes in the DNLF group developed RRD [20]. This finding of lack of progression to RRD in eyes with DNLF in addition to the comparable visual acuity outcomes to eyes without DNLF should be reassuring for cataract surgeons.

Timing between cataract surgery and PPV for the management of DNLF has been an area of debate [10] [11] [21]. The mean time between the initial cataract surgery and PPV for DNLF in our cohort was 19.45 days. In our study, eyes that underwent early PPV within 2 weeks following the initial cataract surgery had similar final BCVA to eyes that underwent late PPV after 2 weeks from the initial cataract surgery. Our finding is comparable to a retrospective study on 20 eyes with DNLF that showed no correlation between inter-surgery time and the final BCVA or retinal detachment rate [22]. On the other hand, a systemic review and meta-analysis on 43 studies showed better visual outcomes and lower risk of post-operative retinal detachment in eyes underwent early PPV for the management of DNLF [10].

There are some limitations to our study. Information about the type (co-axial vs bimanual), machine and settings of anterior vitrectomy were not documented in the operative report for most patients. Thus, this variable could not be analysed. The rate of RRD in our study could be underestimated as some patients might have presented to other hospitals. The data was collected retrospectively and was dependent on the quality of documentation.

5. Conclusion

In summary, our study showed that the risk of RRD is lower in eyes that required PPV for DNLF than in eyes that were managed with anterior vitrectomy alone for vitreous loss following PCR during cataract surgery. The poor visual outcomes in eyes that suffered RRD underscore the importance of postoperative retinal examination and early detection of retinal breaks following complicated cataract surgery.

Author Contribution

First Author: Literature review, data collection, data analysis and drafting the manuscript. Second and Third Authors: conception and design of the study, overall review and editing of the manuscript. All authors read and approved the final version of the manuscript.

Ethical Approval

The study was approved by the Institutional Review Board (IRB) at King Saud University, Riyadh, Saudi Arabia. This study adhered to the ethical principles outlined in the Declaration of Helsinki as amended in 2013.

Consent

Patients signed an informed consent prior to enrollment in the study.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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