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Research Article

# Evaluation of Intra-Operative Complications and Post-Operative Visual Outcomes Following Phacoemulsification Cataract Surgery in Eyes with Primary Posterior Polar Cataract

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## Abstract

**Objective:** To evaluate the incidence of intraoperative complications and postoperative clinical outcomes following phacoemulsification in eyes with primary posterior polar cataract.

**Study design:** A prospective, observational study.

**Methodology:** 60 eyes of 43 patients with primary posterior polar cataract who underwent phacoemulsification cataract surgery over a period of 1 year, were observed for pre-operative morphological grading of posterior polar cataract (PPC) based on Vasavada classification system, the incidence of complications during the surgery (like posterior capsular rent (PCR), vitreous prolapse requiring anterior vitrectomy, nucleus or nuclear fragment drop, and aphakia) along with the special intraoperative techniques used to minimize those complications. The postoperative visual outcome achieved was also documented.

**Results:** Out of 60 eyes, 53 eyes (88.13%) had Grade 1 PPC with intact posterior capsule, and 7 eyes (11.8%) had Grade 2 PPC with pre-existing posterior capsule rent (PCR). The overall rate of PCR was 13.33% with rate of "on table" PCR being 3.33%. The special techniques used to prevent "on table" PCR were inside-out hydrodelineation, layer by layer phacoemulsification of nucleus and visco-dissection for epinucleus separation and removal. Vitrectomy was required in just 6.66% cases. Nucleus drop was not encountered in any case. No eye was left aphakic and intra-ocular lens was placed in the bag in 52 (86.66%) eyes and in the sulcus in 8 (13.33%) eyes . The post-operative best corrected visual acuity (BCVA) achieved was 6/9 or better at postoperative day 30 in 91.66% eyes overall.

**Conclusion:** PPC is a high-risk surgery due to inherent poor posterior capsule integrity resulting in the increased rate of complications as compared to other cataract morphologies and the use of special techniques during the surgery can reduce the incidence of these complications and help achieve good postoperative visual outcomes.

**Keywords**: Cataract; Phacoemulsification; Polar Cataract; Hydrodelineation

## Introduction

Cataract is the leading cause of blindness and visual impairment in the world, amounting for up to 51% of the blindness worldwide [1]. It occurs in a variety of morphologic configurations, including lamellar (or zonular), polar, sutural (or stellate), coronary, cerulean, nuclear, capsular, complete and membranous. Posterior polar cataract (PPC) is a clinically distinctive form of congenital cataract that is characterized as white, well defined, discoid plaque-like onion ring shaped (whorled) opacity that maybe present axially in front of, or on the posterior capsule [2]. Its incidence ranges from 3 to 5 in 1000 [3]. It is found to be bilateral in 65–80% of the cases [4]. There is no sex predilection in general. If unilateral and present since birth, PPC may present with amblyopia. Posterior capsule (PC) can be already thin and fragile or it might be tightly adherent to the opacity, such that even minimal traction onto the opacity during phacoemulsification can lead to capsular rupture [4]. The most severe tears occur during attempted emulsification of nucleus [5]. The incidence has been reported to vary from 26% to 36% [6].

Hence, in this study we primarily evaluated the incidence of intra-operative complications in surgically challenging posterior polar cataract, and the best visual outcome which could be achieved with intra-ocular lens (IOL) implantation in our patients.

## Methodology

We conducted a prospective, observational study in the Department of Ophthalmology of Rajindra Hospital, Government Medical College, Patiala. Ethical approval was taken from the institute's ethical committee before starting the study. Informed written consent was taken from the subjects after explaining the type, and purpose of the study and need for follow up. Total of 43 patients who were diagnosed with primary posterior polar cataract in one or both eyes over a period of 1 year were enrolled in the study.

The morphological characteristic used to diagnose primary posterior polar cataract was: Cataract that is characterized as white, well defined, discoid plaque-like onion ring shaped (whorled) opacity that maybe present axially in front of, or on the posterior capsule with no secondary cause for cataract like corticosteroid use, trauma, drugs or systemic illnesses (Figure 1 and 2). Patients with active ocular diseases and those who experienced non-PPC related intraoperative or postoperative complications were excluded from the study.

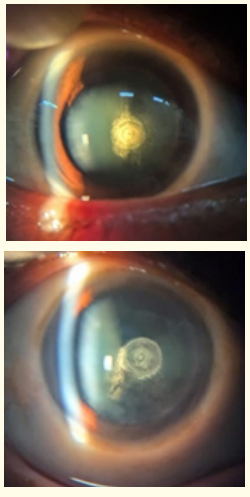

**Figure 1:** Whorled opacity of posterior polar cataract as seen on direct illumination on slit-lampbiomicroscopy.

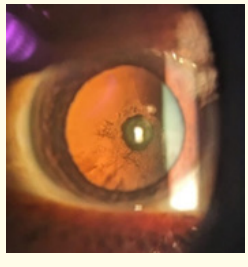

**Figure 2:** Posterior polar cataract as seen in retroillumination on slit-lamp biomicroscopy.

After taking relevant history of symptoms and past ocular and systemic illnesses, each patient was pre-operatively assessed for uncorrected visual acuity (UCVA) and best corrected visual acuity (BCVA) using Snellen's chart; detailed slit-lamp examination was performed with dilated pupils which included grading of the cataract according to Vasavada's classification, note about presence of concomitant nuclear or cortical cataract, documentation of signs

of any active ocular inflammation if present; intraocular pressure (IOP) was measured using Non-Contact Tonometry (NCT), biometry was done and posterior segment examination was done using indirect ophthalmoscopy. In cases with advanced nuclear sclerosis, only the cases with confirmed presence of PPC were included in the study. We used Vasavada classification [7] because it takes into consideration the integrity of posterior capsule. It is as follows:

- Grade 1 – PPC with imminent (eyes that are at risk of) posterior capsule dehiscence
- Grade 2 – PPC with pre-existing posterior capsular defect
- Grade 3 – spontaneous dislocation of lens

The intraoperative evaluation was done in terms of complications encountered (which included posterior capsular rent (PCR), vitreous prolapse into anterior chamber, vitrectomy, nucleus or nuclear fragment drop, and aphakia) and foldable/non-foldable IOL implantation in the bag/sulcus. Post-operative visual outcomes were recorded on Snellen's acuity chart and causes of decreased visual acuity were analysed. The visual outcomes for different grades and complications were compared.

### Surgical technique

All the surgeries were performed by experienced surgeons. Written informed consent was taken from all the patients before surgery. Patients were counselled for the risk of posterior capsular dehiscence and nucleus drop with the possibility of aphakia and vitreoretinal intervention. All the cases underwent phacoemulsification surgery under local anaesthesia (facial and per-bulbar block). Position of the main port was either superior/temporal based on surgeon's preference. Continuous Curvilinear Capsulorrhexis was performed using a cystitome made from 26-gauge needle under a dispersive (Chondroitin Sulfate) ophthalmic viscosurgical device. Hydrodissection was avoided in all the cases, rather controlled "inside out hydrodelineation" was done using minimal fluid. In this, the cannula was introduced directly into the substance of the nucleus and fluid was pushed to create a plane of hydrodelineation with minimal disturbance to the capsular bag. The "layer by layer" technique of phacoemulsification was used for soft cataracts (Nuclear Sclerosis grade 1-2), whereas "stop and chop" technique was used for harder cataracts (Nuclear Sclerosis grade 3-4). The phacoemulsification machine parameters were as follows: Continuous mode, 35 ml/min Flow rate, 350 mmHg vacuum, 45% Ultrasound power. The bottle height was maintained at 70 cm for all the cases. After nucleus removal, "viscodissection" was performed to separate epinucleus and cortex followed by irrigation and aspiration of epinuclear plate and cortex. In some cases, pre-existing posterior capsular defect was documented which had previously been graded as grade 1 (intact PC) on slit lamp examination. Bimanual automated vitrectomy was performed in cases where PC ruptured with disturbance of the anterior vitreous phase. Either hydrophobic foldable/non foldable polymethylmethacrylate (PMMA) IOL was placed in the bag or in the sulcus respectively depending on the capsular bag integrity. All the patients were started post-operatively on an antibiotic steroid regimen of 6 weeks duration with weekly tapering doses. Every case was assessed post-operatively for IOL stability and centration, and corneal oedema using slit-lamp biomicroscope; IOP measurement using NCT; UCVA and BCVA assessment on post-operative day (POD) 7, 30, 90 and 180 using Snellen's acuity chart; best corrected near visual acuity assessment; and astigmatism measurement using autorefractometer.

### Statistical analysis

Mean (Standard Deviation) and frequency (percentage) were given for continuous and categorical variables. The Chi-square test, Paired-t test and Fisher's exact test was used for comparison of proportions. Visual acuity obtained from Snellen's chart was converted into logarithm of minimum angle of resolution (logMAR) values and Wilcoxon – signed rank test was used to compare pre- and post-operative visual acuity. A p value below 0.05 was considered significant.

## Results

### Demographic profile and grading

A total of 60 eyes of 43 patients were enrolled in this study. The mean age of the patients at the time of presentation was 54.58 ± 12.26 years (range 19-77 years). Out of 43 patients, the percentage of female patients was 61.90% (27 out of 43) and percentage of male patients was 38.09% (16 out of 43). Out of 60 eyes, 30 were right eyes (50%) and 30 were left eyes (50%). 25 (58%) patients were diagnosed with PPC in both eyes at the time of the presentation whereas 18 (42%) were diagnosed with unilateral cataract. Out of 25 patients with bilateral cataract, 17 were operated for

both eyes at our institute during the course of the study. Of the 60 eyes, Grade 1 cataract was present in 88.13% eyes (53 out of 60); Grade 2 in 11.8% (7 out of 60) but no eye had Grade 3 PPC i.e. subluxated lens. However, intra-operatively, only 6 eyes had pre-existing capsular dehiscence. 1 eye, although graded as grade 2 on slit-lamp examination pre-operatively, the posterior capsule was intact when observed intra-operatively while opacity removal. It might be the wrinkled posterior capsule which appeared as if torn on slit-lamp.

## Complications

The most common intra-operative complication documented in our study was PCR which occurred in 8 (13.33%) out of 60 eyes. Out of these 8 eyes, 6 had pre-existing PC dehiscence as documented pre-operatively on slit-lamp examination, however, in remaining 2 eyes, it occurred intra-operatively. Therefore, the rate of "on-table PCR" in our study was 2 (out of 60 eyes), i.e. 3.33%. When grades of PPC were compared, the rate of PCR was 3.77% in Grade 1 and 85.71% in Grade 2 (statistically significant difference with $p < 0.00001$, Fisher's exact test). There was vitreous prolapse into the anterior chamber in 4 out of 8 (6.66%) eyes which was managed by automated anterior vitrectomy procedure. No case had intra-operative nucleus or nuclear fragment drop into the vitreous requiring vitreoretinal surgical intervention. We were able to implant the IOL in all the eyes and no eye was left aphakic. The foldable hydrophobic single piece IOL was implanted in the capsular bag in 52 (86.66%) out of 60 eyes and in rest of the 8 (13.33%) eyes, a non-foldable 6.00 mm PMMA IOL was implanted in the sulcus due to doubtful capsular integrity following PCR. On long term follow-up, delayed posterior segment complication of cystoid macular edema was present in 1 case out of 60 and the patient was managed by thrice daily administration of Nepafenac 0.1% eye drops. No incidence of retinal detachment was reported in any case.

## Visual acuity

The mean UCVA improved statistically significantly from pre-operative value of 0.82 ± 0.32 logMAR to post-operative value of 0.28 ± 0.19 logMAR on the POD7, value of 0.13 ± 0.12 logMAR on POD30, 0.12 ± 0.11 logMAR on POD90 and POD180 ($p < 0.00001$, Wilcoxon-Signed Rank test). Similarly, statistically significant improvement was seen between mean pre-operative BCVA (0.13 ± 0.12 logMAR) and POD7 BCVA values (0.19 ± 0.16 logMAR), POD30 (0.06 ± 0.09 logMAR) BCVA values, and POD90 and POD180 (0.059 ± 0.086 logMAR) BCVA values ($p < 0.00001$, Wilcoxon-Signed Rank test). Post-operative Best corrected Near Vision Acuity values (0.11 ± 0.005 logMAR) were also statistically significantly ($p < 0.0001$, Wilcoxon-Signed Rank test) better than the pre-operative BCNVA values (0.16 ± 0.11 logMAR).

Out of 53 eyes with Grade 1 cataract, final BCVA was 6/9 or better in 50 (94.33%) eyes and out of 7 eyes with Grade 2 cataract, final BCVA of 6/9 or better was achieved in 5 (71.4%) eyes. On comparison, no statistically significant difference was found between BCVA achieved in different grades ($p = 0.0992$, Fischer's exact test). The BCVA of 6/9 or better at POD180 was achieved in 92.30% eyes in cases without PCR and in 87% eyes in cases with PCR; but the difference was not significant ($p = 0.5241$, $p > 0.05$ by Fisher's exact test).

## Other post-operative outcomes

Corneal edema on slit lamp examination was observed in 11 (18.33%) out of 60 eyes out of which, 8 eyes were those in which PCR occurred intra-operatively and 3 eyes were the ones with nuclear sclerosis of grade 4. Corneal edema in these eyes can be explained by prolonged duration of surgery. These patients were started on Sodium Chloride 5% w/v with 6 hourly dosing and the

| Intra-operative Complications | Frequency (Percentage) |
|---|---|
| **PCR incidence** | |
| Total | 8 (13.33%) |
| "On table" PCR | 2 (3.33%) |
| Grade 1 PPC | 2 out of 53 (3.77%) |
| Grade 2 PPC | 6 out of 7 (85.71%) |
| **Vitreous Prolapse** | 4 (6.66%) |
| **Vitrectomy** | 4 (6.66%) |
| **Nuclear drop** | 0 (0%) |
| **Aphakia** | 0 (0%) |
| **In the bag IOL** | 52 (86.66%) |
| **In the sulcus IOL** | 8 (13.33%) |

**Table 1:** Intra-operative complications and IOL Implantation.

edema resolved by POD14 in all the eyes. The final BCVA of 6/9 or better was achieved in all the eyes except one. The difference between mean pre-operative astigmatism (-0.90 ± 0.71) and post-operative astigmatism (-0.875 ± 0.48) was not statistically significant (p = 0.76, Paired-t test). Similarly, no statistically significant difference (p = 0.6184, Paired t-test) was observed between mean pre-operative IOP (16.50 ± 2.83) and post-operative IOP values (16.38 ± 2.06) as measured by NCT.

| | | | | | | **p-value (Wilcoxon-Signed Rank Test)** |
|---|---|---|---|---|---|---|
| UCVA | Pre-op | POD7 | POD30 | POD90 | POD180 | |
| | 0.82 ± 0.32 | 0.28 ± 0.19 | 0.13 ± 0.12 | 0.12 ± 0.11 | 0.12 ± 0.11 | <0.00001 |
| BCVA | Pre-op | POD7 | POD30 | POD90 | POD180 | |
| | 0.13 ± 0.12 | 0.19 ± 0.16 | 0.06 ± 0.09 | 0.059 ± 0.086 | 0.059 ± 0.086 | <0.00001 |
| BCNVA | Pre-op | Post-op | | | | |
| | 0.16 ± 0.11 | 0.11 ± 0.005 | | | | <0.00001 |
| | | 6/9 or better BCVA (percentage) | | | | p- value (Fisher's exact test) |
| Grade wise comparison of BCVA | | | | | | |
| | Grade 1 | 94.33% | | | | 0.0992 |
| | Grade 2 | 71.4% | | | | |
| Comparison of BCVA in eyes with and without PCR | | | | | | |
| | Without PCR | 92.30% | | | | 0.5241 |
| | With PCR | 87% | | | | |

**Table 2:** Visual Acuity Analysis (Snellen's acuity converted to logMAR values).

| Authors | Technique | Total number of eyes in series | PCR rate % (No. of eyes) |
|---|---|---|---|
| Osher., *et al.* [4] | Low power, low infusion, slow-motion phaco (+hydrodissection) | 31 | 26% (8) |
| Vasavada and Sing [6] | Delineation | 25 | 36% (9) |
| Hayashi., *et al.* [2] | Delineation | 28 | 7.1% (2) |
| Lee and Lee [15] | Delineation | 25 | 8% (2) |
| Vasavada and Raj [16] | Inside out delineation | 25 | 8% (2) |
| Das., *et al.* [17] | Chip and Flip for soft cataracts, Stop and chop for Hard cataracts | 81 | 31% (25) |
| Haripriya., *et al.* [18] | Low- infusion and low- vacuum settings | 8 | 12.5% (1) |
| Malhotra., *et al.* [19] | V or lambda sculpting, viscodissection of epinucleus | 80 | 7.5% (6) |
| Current study | Inside out hydrodelineation, layer by layer phacoemulsification for soft cataracts, stop and chop for hard cataracts and viscodissection of epinucleus | 60 | 13.33% (8) Pre-existing in 6 eyes Intraoperative in 2 eyes "On table" PCR = 3.33% |

**Table 3:** Comparison of rates of PCR between our study and previously published studies.

## Discussion

Posterior polar cataract is a surgical challenge because of the lens opacity which might be tightly adherent to the posterior capsule, rendering its removal difficult without causing any inadvertent damage to the capsule. The capsule associated with this is usually very thin and fragile, it may even be deficient in that area in up-to 20% cases according to few studies [4,8]. In our study, it was found to be deficient in 10% cases.

In our study, no demographic profile (age, gender, eye) was found to be significantly associated with this type of cataract or with the rate of complications. The most common complication that we encountered was posterior capsule rupture. It occurred in 8 eyes out of total 60. The overall percentage of this complication came out to be 13.33%. Out of 8 eyes, 6 (10%) eyes had pre-existent PC dehiscence whereas in 2 (3.33%) eyes, PCR occurred intra-operatively. The point in surgery where PCR occurred most commonly was either during nucleus emulsification or during epinucleus or cortex removal. Two such cases from our study are described here: In case no. 1, we performed inside-out hydrodelineation to ensure an appropriate thickness epinuclear cushion so as to not disturb the polar opacity during nucleus emulsification. Subsequently, nucleus was removed systematically in layers followed by epinucleus until only cortex remained along with the polar opacity which was tightly adherent to the posterior capsule. While removing cortex using bimanual irrigation aspiration, the posterior capsule gave way creating a rent. A dispersive (chondroitin sulphate) viscoelastic substance was immediately injected to push down the anterior vitreous phase and maintain its integrity followed by slow removal of the opacity and the remaining cortex. Due to the dispersive viscoelastic substance, there was no vitreous prolapse. We implanted a 6.0 mm PMMA IOL in the sulcus afterwards and removed the viscoelastic substance using bimanual I/A. No vitreous was seen in anterior chamber and the case was closed after adequate port hydration, closure of main port by a single suture of 10-0 nylon, formation of AC with air and subconjunctival antibiotic-steroid injection. In case no. 2, hydrodelineation was done while avoiding hydrodissection. The nucleus was emulsified using horizontal chop technique. While epinucleus was being removed using the Ultrasound 3 setting of the machine, the rent occurred in the posterior capsule. Then the cortex was removed using the manual Simcoe's cannula taking care not to put traction on the posterior capsule. Due to disturbance of the vitreous and its prolapse into the anterior chamber, automated bimanual anterior vitrectomy of the anterior vitreous phase was performed. A 6.0 mm non foldable PMMA IOL was then implanted in the sulcus because of lack of capsular support. Ultimately whole of the viscoelastic substance was removed manually using Simcoe's cannula. Pilocarpine was injected intra-camerally to induce pupillary constriction and was washed off afterwards. Ports were hydrated, main port was closed with a single suture of 10-0 nylon, AC was formed with air and subconjunctival antibiotic-steroid injection was given before bandaging the eye.

Although phacoemulsification surgery has turned out to be a very safe surgery for cataracts but in the subset of posterior polar cataract, a higher incidence of intra-operative complications has been recorded. The incidence of PCR has been reported to be between 26%-36% [4,6,9]. Similarly, the rate of vitreous loss following PCR has been reported to be between 1%-13.7% [10-13]. The incidence of a more serious ocular complication like nucleus or nuclear fragment drop has been reported to be between 0% - 18% [14]. In our study, the rate of these complications was relatively lower as we used a combination of techniques: inside-out hydrodelineation, layer by layer technique of phacoemulsification and viscodissection of epinucleus. The overall rate of PCR was 13.33%, rate of "on-table" PCR was 3.33%, vitreous prolapse was seen in 6.66% cases whereas no cases had nucleus drop and no case was left aphakic.

Attempts have been made by ophthalmic surgeons all over the world to test out new techniques and manoeuvres which could decrease the rate of PCR in this notorious type of cataract. Comparison of observations of those studies with our study is shown in Table 3.

From results of our study, following conclusions can be drawn safely: maintenance of low fluidics helps in reducing sudden fluctuations intra-ocularly, avoiding hydrodissection prevents undue stress over posterior capsule by the wave of fluid, hydrodelineation results in an epinuclear cushion beneath the nucleus which prevents fluctuations inside the chamber from reaching the posterior capsule while nucleus emulsification, emulsifying nucleus in layers helps the surgeon to have better control over the whole process, removal of epinucleus and cortex should always be done from pe-

riphery to the centre so as to protect the most fragile area till the end, OVDs are a surgeon's friend as they work as shock absorbers and also help in maintaining the integrity of anterior vitreous phase in case of a rent, and whenever in doubt regarding capsular integrity, it is always advisable to put a PMMA non-foldable lens in the sulcus.

We were able to achieve final BCVA of 6/9 or better in 55 out of 60 eyes in our study. The rest of the 5 eyes had final BCVA of 6/12 on Snellen's acuity chart. Incidence of corneal oedema was 18.33% and it resolved by POD14 in all the eyes. This implies that excellent post-operative visual acuity results can be obtained and patients do benefit from surgical intervention despite higher rates of complications.

The limitations of our study included lack of pre-operative AS-OCT imaging of each case which has proved to be sensitive (87.5-100%) and specific (62-94.9%) [20-22] in detecting posterior capsular integrity prior to surgical intervention and relatively small sample size and limited follow up of the study .

## Conclusion

Present study demonstrated that posterior polar cataract is indeed a high-risk morphology of cataract which is associated with higher rates of intra-operative complications. The way to tackle these complications lies in, firstly, meticulous pre-operative assessment as it helps one to document certain characteristics of PPC which point towards increased risk of posterior capsular rupture and other complications like vitreous prolapse, nucleus drop and aphakia. Secondly, gentle manoeuvring intra-operatively along with use of a specialized technique at each step also reduces the complication rate considerably. One needs to understand that speed is not the answer when it comes to posterior polar cataract. The most important thing is gentle and delicate handling of each structure so as to not put unnecessary traction on posterior capsule at any step. Good visual outcomes can be achieved despite relatively higher complication rate. So, possibility of complications should not deter the surgeon from undertaking such challenging cases.

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