Patterns of Posterior Capsular Opacification after Phacoemulsification using Foldable (Acrylic Acid) IOL

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ABSTRACT

Purpose: To determine different patterns of posterior capsular opacification after phacoemulsification using foldable (acrylic acid) intraocular lenses.

Methodology: This was cross-sectional study in which 172 patients having senile cataract undergoing phacoemulsification were selected. Patterns of posterior capsular opacification were graded using Sellmen and Lindstrom grading system in the patients who underwent phacoemulsification, using foldable intraocular lens. Examination was done on slit lamp and proforma was filled. SPSS v25.0 was used to enter and analyze the data. Age, gender, and IOL duration were used to stratify the data. The chi-square test was used post stratification, and a $p \leq 0.05$ was considered significant.

Results: There were 97(56.4%) males and 7(43.6%) were females. Mean age of the patients was 54.32±8.654 year. Mean duration of IOL was 14.25±3.42 months. According to posterior capsular opacification pattern distribution, 40(23.3%) had grade-I, while 73(42.4%), 50(29.1%) and 9(5.2%) had grade-II, grade-III and grade-IV respectively. According to the stratification of posterior capsular opacification (PCO) patterns with respect to different variables, no statistically significant difference was observed between gender ($p = 0.712$), age groups ($p = 0.240$), and duration of intraocular lens (IOL) implantation ($p = 0.055$), as all p-values were greater than 0.05.

Conclusion: Post-phacoemulsification cataract surgery posterior capsular opacification incidence can be reduced, though not totally avoided. In the development of posterior capsule opacification, the material of the intraocular lens is a significant variable. Selection of IOL material (Acrylic) goes a long way in minimizing the incidence of post-operative posterior capsular opacification.

Keywords: Posterior Capsular Opacification, Phacoemulsification, Acrylic Acid.

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INTRODUCTION

Posterior capsular opacification (PCO), often referred to as an after-cataract, is the most frequent long-term complication that can occur after cataract surgery involving the implantation of a posterior chamber intraocular lens (IOL).[1] It is likely to be the most common cause of non-refractive decrease in post-operative vision after cataract surgery.[2] Posterior capsular opacification arises due to the persistence of viable lens epithelial cells left within the capsular bag after cataract extraction. These lens epithelial cells migrate, proliferate and undergo fibrous metaplasia with collagen deposition resulting in various patterns of posterior capsular opacification including Elsching pearls, capsular fibrosis and Soemmerring ring. Several factors are believed to influence the rate of posterior capsular opacification, including the patient's age, previous intraocular inflammation, size of the capsulorrhexis, quality of the cortical cleanup, design of the lens implant, modification of the lens surface, and time elapsed since surgery.[3]

Posterior capsule opacification can be avoided by using intraocular lenses with good design and material.[4] Nd:YAG laser capsulotomy is the only definitive treatment for posterior capsular opacification (PCO); however, it is associated with vision-related risks and complications and places a significant financial strain on the healthcare system. The opacification rate is also somewhat influenced by the material of the intraocular lens: hydrogel lenses have the greatest rate, followed by hydrophobic acrylic and polymethylmethacrylate lenses. Systems used for analysis of posterior capsular opacification's patterns vary from subjective grading by observer using slit lamp to much more complex analysis using digital images.[3]

In a study, analysis of posterior capsular opacification done by using sellman and lindstrom grading system on slit lamp examination showed out of 51(100%) cases of posterior capsular opacification, 7.8% had grade one, 58.9% had grade two, 27.45% had grade three, while only 5.8% patients had grade four posterior capsular opacification.[3]

Another study showed out of 92 eyes with posterior capsular opacification, grade one was seen in 55.47% patient, while only 9.78% had grade three posterior capsular opacification which required capsulotomy.[2]

According to my literature search, this study was prompted to cover the gap of local research available on this topic. Posterior capsular opacification also has important implications in the developing world, where it is emerging as a potentially treatable cause of blindness. This study will be identifying different patterns of posterior capsular opacification in relation to the foldable intraocular lens used during phacoemulsification.

METHODOLOGY

This study was cross-sectional study conducted on patients who have undergone surgery for senile cataract by means of phacoemulsification and minimum of 12 months have passed since phacoemulsification at the Department of Ophthalmology, Layton Rehmatullah Benevolent Trust Hospital, Lahore. Patients having rigid foldable (acrylic acid) IOL implanted during phacoemulsification. Sample size of 172 was calculated by taking confidence level as 95% and margin of error as 3.5% and taking expected percentage of grade IV opacification as 5.8%.[3] 172 patients both males and females with the age range of 40 to 70 years were sampled using a non-probability consecutive sampling technique from February, 2022 to August, 2022. Patients were excluded if they had a posterior capsular rent; a history of ocular trauma, laser treatment, or corneal pathology; existing ocular disorders including uveitis, pterygium, glaucoma, or vitreoretinal disease; or if their surgical records indicated any complications. Approval of the topic was taken from the Institutional Review Board, ethical review committee and College of Physicians and Surgeons Pakistan.

Patterns of posterior capsular opacification were graded using Sellmen and Lindstrom grading

system[3,5] in the patients who underwent phacoemulsification, using foldable intraocular lens. Examination was done on slit lamp and proforma was filled. To avoid observational bias, the examination was done by the same clinician. Data were entered and analyzed by SPSS v25.0. Age was presented as mean and standard deviation. For qualitative variables like patterns of posterior capsular opacification and gender, frequency tables and percentages were used. Data were stratified for age, gender and duration of IOL. Post-stratification, Chi-square test was applied and $p \leq 0.05$ was considered significant.

RESULTS

Total 172 cases having senile cataract undergoing phacoemulsification were selected for this study. There were 97(56.4%) males and 75(43.6%) were females. Mean age of the patients was 54.32±8.654 year. Age distribution of the patients was done and two groups were made, age group 40-50 years and age group 51-70 years, 66 (38.4%) patients were in 40-50 years age group and 106(61.6%) in 51-70 years age group.

Table-1: Frequency distribution of gender

Gender	Frequency	Percent
Male	97	56.4
Female	75	43.6
Total	172	100.0

Mean duration of IOL was 14.25±3.42 months. According to duration of IOL distribution, 104(60.5%) had duration of IOL for ≤15 months, while 68(39.5%) had for >15 months (Table-2).

Table-2: Frequency distribution of duration of IOL

Duration of IOL	Frequency	Percent
=15 months	104	60.5
>15 months	68	39.5
Total	172	100.0

According to posterior capsular opacification pattern distribution, 40(23.3%) had grade-I, while 73(42.4%), 50(29.1%) and 9(5.2%) had grade-II, grade-III and grade-IV respectively (Table-3).

Table-3: Frequency distribution of posterior capsular opacification pattern

Posterior capsular opacification pattern	Frequency	Percent
Grade-I	40	23.3
Grade-II	73	42.4
Grade-III	50	29.1
Grade-IV	9	5.2
Total	172	100.0

According to stratification of posterior capsular opacification pattern with respect to different variables, no significant difference was observed between gender, age groups and duration IOL ($p<0.05$) (Table-4 to 6).

Table-4: Stratification of posterior capsular opacification pattern with respect to gender

Gender	Posterior capsular opacification pattern				Total	p-value
	Grade-I	Grade-II	Grade-III	Grade-IV		
Male	25	39	27	6	97	0.712
	25.8%	40.2%	27.8%	6.2%	100.0%	
Female	15	34	23	3	75	
	20.0%	45.3%	30.7%	4.0%	100.0%	
Total	40	73	50	9	172	
	23.3%	42.4%	29.1%	5.2%	100.0%	

Table-5: Stratification of posterior capsular opacification pattern with respect to age

Age groups	Posterior capsular opacification pattern				Total	p-value
	Grade-I	Grade-II	Grade-III	Grade-IV		
40-50 years	13	31	21	1	66	0.240
	19.7%	47.0%	31.8%	1.5%	100.0%	
51-70 years	27	42	29	8	106	
	25.5%	39.6%	27.4%	7.5%	100.0%	
Total	40	73	50	9	172	
	23.3%	42.4%	29.1%	5.2%	100.0%	

Table-6: Stratification of posterior capsular opacification pattern with respect to duration of IOL

Duration of IOL	Posterior capsular opacification pattern				Total	p-value
	Grade-I	Grade-II	Grade-III	Grade-IV		
=15 months	30	37	30	7	104	0.055
	28.8%	35.6%	28.8%	6.7%	100.0%	
>15 months	10	36	20	2	68	
	14.7%	52.9%	29.4%	2.9%	100.0%	
Total	40	73	50	9	172	
	23.3%	42.4%	29.1%	5.2%	100.0%	

DISCUSSION

Posterior capsule opacification (PCO), often referred to as a "secondary cataract," remains the most frequent complication following cataract surgery. It occurs when lens epithelial cells (LECs) migrate, proliferate, and differentiate, leading to opacification of the posterior capsule. PCO often results in notable visual disturbances, especially when the central visual axis is affected. Although there have been improvements in surgical methods, intraocular lens design, and pharmacological approaches to prevent PCO, it continues to pose a considerable challenge for both patients and healthcare systems. [6]

Posterior capsular opacification (PCO) develops in approximately 20–50% of patients within 2 to 5 years after cataract surgery. The incidence of PCO has reportedly decreased in recent years, although there is not enough evidence to support this claim[7] and the reported decrease could just be the result of PCO developing later in life.[7,8,9] Infants and children exhibit a markedly higher rate and earlier development of posterior capsular opacification, carrying the risk of amblyopia as a complication. [10,11] In standard phacoemulsification surgery, the physician removes the cataractous lens material, removes a portion of the anterior capsule through capsulorrhexis and inserts an artificial intraocular lens into the preserved capsular bag.When remaining LECs on the remaining anterior capsule experience three separate processes— proliferation and subsequent migration of cells toward the posterior lens capsuleand normal and aberrant differentiation—PCO results. The buildup of LECs causes the intact posterior lens capsule to become opacified, which impairs vision. [11]

The only surgical treatment for PCO that works is neodymium-doped yttrium aluminum garnet (Nd:YAG) laser capsulotomy.[12,13] This procedure is common and generally safe, but it may occasionally result in complications like endophthalmitis, retinal detachment, and increased intraocular pressure. Healthcare systems are heavily burdened financially by the necessity of performing Nd: YAG capsulotomies as a result of PCO. The costs of the treatment itself, follow-up appointments, and handling any related issues that might emerge from the procedure are the reasons behind this.[13,14]

Hydrophilic acrylic with a high water content, hydrophobic acrylic with a low water content, and hydrophobic silicone hydrogel are all commonly used IOL materials. While certain studies have indicated that hydrophobic materials may reduce the incidence of PCO, this effect has not been validated by meta-analytic studies.[15]

The majority of research on adults has shown that those with hydrophilic acrylic IOLs have greater PCO rates than those with hydrophobic ones; although, several of these studies have also included hydrophilic acrylic IOLs with round corners.[16]

In current study 172 individual eyes included, there were 97(56.4%) males and 75(43.6%) were females. Mean age of the patients was 54.32±8.654 year. Mean duration of IOL was 14.25±3.42 months. According to posterior capsular opacification pattern distribution, 40(23.3%) had grade-I, while 73(42.4%), 50(29.1%) and 9(5.2%) had grade-II, grade-III and grade-IV respectively. According to stratification of posterior capsular opacification pattern with respect to different variables, no significant difference was observed between gender, age groups and duration IOL ($p>0.05$).

The mean age of the 1039 participants in Xiaoxun Gu's study was 66.68 ± 11.43 years, and 42.06% of

them were men. Three months following cataract surgery, 29.93% of patients had early-onset PCO, and 31 patients (2.98%) had PCO of grades three and four. Individuals with complex cataracts were more likely to develop PCO than those with age-related cataracts, particularly those who had undergone prior pars plana vitrectomy (PPV) surgery (P<0.001).[17]

In a study by H Vijaya Pai et al., 90 eyes from 90 individuals were used to compare the posterior capsular opacification following the implantation of three different intraocular lenses composed of hydrophobic acrylic with a square-edge design. Clinical grading and scoring were applied to the PCO using the EPCO 2000 program. Age, gender, or the concomitant presence of systemic disease did not significantly alter the PCO. The median PCO scores for groups 1, 2, and 3 were 0.035, 0.045, and 0.085, respectively. The groups' variations in PCO grade and score were statistically significant (P < 0.001).[18]

After cataract surgery with ECCE or phacoemulsification, posterior capsule opacification (PCO) is the most frequent late complication. This condition is typically caused by the migration and proliferation of residual lens epithelial cells. The prevalence of posterior capsule opacification varies greatly and appears to be declining with the design and positioning of IOLs nowadays. Age, extent of the capsulorrhexis, cortical cleanup quality, implant capsular fixation, implant design, surface modification of the lens, and time after surgery are some of the factors believed to affect this rate. Opacification rates are also somewhat influenced by the IOL material: hydrogel IOLs have the greatest rate, followed by PMMA, silicone, and hydrophobic acrylic.(3) IOL opacifications may be linked to a variety of systemic and ocular conditions.[19]

Dr. P. Sharmila et al. conducted a study with one hundred patients with including both Type 1 and Type 2 diabetes mellitus to evaluate the effects of PCO formation on visual acuity after the implantation of acrylic foldable IOLs and rigid polymethyl methacrylate (PMMA) IOLs. Two patient groups were identified: Group A had an implant of a 13.5mm PMMA IOL. Group B received 13.0mm acrylic IOL implants. According to the results of their study, intraocular lens surgery for cataracts has provided good visual results. However, this benefit may be short-term because the most common consequence after traditional cataract surgery is the development of PCO, which affects visual acuity. Their investigation found that the rate of moderate to severe PCO grades was lower with Acrylic IOL than with PMMA IOL; this difference was both statistically and clinically significant. When compared to PMMA, the visual outcome with Acrylic IOL was good; this was also clinically and statistically significant.[20]

In another study, analysis of posterior capsular opacification done by using sellman and lindstrom grading system on slit lamp examination showed out of 51(100%) cases of posterior capsular opacification, 7.8% had grade one, 58.9% had grade two, 27.45% had grade three, while only 5.8% patients had grade four posterior capsular opacification.[3]

Another study showed out of 92 eyes with posterior capsular opacification, grade one was seen in 55.47% patient, while only 9.78% had grade three posterior capsular opacification which required capsulotomy.[2]

CONCLUSION

Post-phacoemulsification cataract surgery posterior capsular opacification incidence can be reduced, though not totally avoided. An intraocular lens material is considered a critical determinant in the development of posterior capsule opacification. Selection of IOL material (Acrylic) goes a long way in minimizing the incidence of post-operative posterior capsular opacification.

Conflict Of Interest: None to declare

Ethical Approval: The study was approved by the Institutional Review Board / Ethical Review Board No 2/Admn/Ex-Cer/LRBT-2022 dated 05.01.2022.

Authors' Contributions:

Anam Younas: Concept, Design, Data acquisition, Data analysis, Statistical analysis, Manuscript review

Aleena Nadeem: Literature search, Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing.

Ali Nauman: Concept, Literature search, Data acquisition.

Nabila Zulfiqar: Data analysis, Manuscript review.

Manzra Shaheen: Design, Manuscript review.

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