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ORIGINAL RESEARCH ARTICLE

Assessment of Preoperative and Intraoperative Risk Factors of Posterior Capsular Opacification

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ABSTRACT

BACKGROUND

Posterior capsular opacification (PCO) is a common complication of cataract surgery, leading to impaired visual acuity and reduced quality of life. Despite advancements in ocular surgical techniques, PCO remains a significant obstacle to achieving optimal visual outcomes. This study investigates the preoperative and intraoperative factors associated with PCO development in patients attending the ophthalmology outpatient department.

METHODS

A hospital based prospective cross-sectional study was conducted among cataract patients attending the ophthalmology outpatient department of a tertiary care hospital for a period of 15 months. Detailed histories, including the type of cataract surgery performed, intraocular lens (IOL) type and placement, and other preoperative and intraoperative parameters, were documented. Patients were monitored for six months post-surgery to evaluate the incidence of posterior capsular opacification (PCO) and identify associated risk factors.

RESULTS

In this study, 71 participants were included, examined, and followed up. Among them, 63.4% had posterior subcapsular cataracts (PSC), with 88.9% developing PCO. Conventional extracapsular cataract extraction was performed in 84.5% of cases, and 94.36% of participants received Poly Methyl Methacrylate (PMMA) IOLs, which had a 79.1% PCO incidence. PCO was observed in 78.3% of patients with IOLs placed in the capsular bag and 90.9% with sulcus placement. Participants with larger capsulorrhexis sizes exhibited slightly higher PCO rates 81.8%. Additionally, 14% of participants developed PCO within one month of cataract surgery, and 21% developed it within months

CONCLUSION

PCO development is influenced by both preoperative (age, steroid use, diabetes) and intraoperative (IOL type, placement, capsulorrhexis size) factors. Using acrylic IOLs, ensuring capsular bag placement, and optimizing surgical techniques can mitigate risk. Early PCO onset, noted in this

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study, highlights the need for close postoperative monitoring, particularly in high-risk patients.

KEYWORDS
Cataract, Posterior Capsular Opacification, IOL, Capsulorrhexis, Surgical Techniques.

INTRODUCTION

Cataracts, dating back to ancient times, are the leading cause of preventable blindness worldwide, responsible for 33.4% of blindness and 18.4% of moderate to severe vision loss, as reported by the Global Burden of Disease Study. The prevalence is much lower in high-income countries (<15%) and significantly higher in low-income countries (>40%).[1] Following successful cataract surgery, posterior capsular opacification (PCO), also referred to as secondary or after cataract, may develop months or even years later on the clear posterior lens capsule.[2] This opacification is primarily caused by the postoperative proliferation of lens epithelial cells within the capsular bag.

Historically, the incidence of posterior capsular opacification (PCO) ranged from 25% to 50%. While modern intraocular lenses (IOLs) and advancements in cataract surgery have significantly reduced this incidence, PCO remains a common side effect following cataract procedures.[3]

Lens epithelial cell proliferation contributes to the pathophysiology of anterior capsular opacification and fibrosis in addition to the traditional PCO that occurs after surgery. There are two types of PCO, fibrous and pearl forms. It is possible for both kinds to coexist at times. There are numerous factors that are thought to increase the incidence of posterior capsular development after surgery. They consist of preoperative variables such as the patient's age. In patients who are young post cataract surgery, PCO is a significant issue, with a frequency that is very close to 100%. It has also been observed to occur more frequently in younger patients after cataract surgery.[4]

A history of prolonged use of antimetabolites or steroids increases the risk of postoperative posterior capsular opacification (PCO), particularly in cases involving posterior subcapsular cataracts caused by steroids. Similarly, long-term exposure to ionizing radiation or the use of antimetabolites significantly elevates the likelihood of PCO development after cataract surgery.[5,6] Cataract grading is a key factor in PCO development, with a higher incidence observed in patients with dense posterior polar cataracts, dense posterior subcapsular cataracts, and especially those with preexisting dense plaques on the posterior capsule[4]. In diabetic patients, the most common cause of impaired visual acuity following cataract surgery is the development of PCO, with individuals with diabetes having a higher incidence of PCO compared to the general population.[7,8-11]

The development of postoperative posterior capsular opacification (PCO) is influenced by several intraoperative factors. Extracapsular cataract extraction (ECCE), a popular and cost-effective procedure introduced in the 1980s, retains the posterior capsule for intraocular lens (IOL) implantation but requires a 10-11 mm sutured incision. For surgeons without access to phacoemulsification machines, small incision cataract surgery (SICS) is a viable alternative. Advances in phacoemulsification and the introduction of foldable IOLs have significantly reduced incision sizes, improving surgical outcomes.[12]

A narrower capsulorrhexis margin than the optic size of the IOL reduces the risk of PCO. Maximizing optic-capsular bag contact further minimizes PCO development.[13,14] Additionally, well-executed hydrodissection and thorough cortical cleansing ensure the removal of cortical material, significantly lowering the risk of postoperative PCO.[15]The type of IOL used also plays a

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crucial role in minimizing PCO. PMMA IOLs are more likely to cause PCO compared to hydrophobic acrylic lenses.[16] Square-edged IOLs are more effective at reducing PCO than traditional round-edged IOLs. Moreover, PCO is more common when the IOL is decentered, compared to when it is placed in the capsular bag.[17]Reducing PCO not only improves visual prognosis but also helps avoid additional procedures like Nd:YAG laser capsulotomies, which can increase discomfort and costs for the patient.

MATERIALS AND METHODS:

This prospective cross-sectional study included 71 patients diagnosed with cataracts and experiencing diminished vision. Patients were selected from the Ophthalmology Outpatient Department of R.L. Jalappa Hospital, Kolar, between September 2022 and December 2023. Ethical approval was obtained from the Institutional Ethics Committee, Informed consent was obtained from each study participants after explaining the objective of the study and a copy of the participant information sheet was provided to all participants.

The study included patients of all age groups, particularly those with diabetes or a history of oral steroid use. Exclusion criteria included anterior ocular diseases (uveitis, corneal scarring, ocular trauma), lens subluxation, retinal vascular conditions (BRVO, CRVO), and poor pupil mydriasis (<6 mm).Comprehensive evaluations included Snellen's and Jaeger's visual acuity charts, intraocular pressure measurement (Goldmann Applanation tonometer), slit lamp biomicroscopy, and fundus examination with a 90 D lens. Biochemical tests (HbA1c, RBS, FBS, PPBS), routine blood investigations, and axial length measurement (A-scan biometry) were conducted. Patient data on age, diabetes, cataract grading, steroid use, surgery type, and IOL position were recorded.

Patients underwent either small incision cataract surgery (SICS) or phacoemulsification and were monitored for six months to assess posterior capsule opacification (PCO) development. PCO was graded using Congdon’s criteria, ranging from Grade 0 (no PCO) to Grade 4 (severe opacity hindering fundus observation).The study aimed to evaluate preoperative and intraoperative risk factors influencing PCO development.

RESULTS

This study included 71 participants based on the inclusion and exclusion criteria. Of the total participants, 28 (39.4%) were male and 43 (60.6%) were female, with a male-to-female ratio of 0.65. Most participants were aged 41–60 years (43.7%), followed by those aged 61–80 years (43.7%), <40 years (9.9%), and (2.8%) were >80 years **(Table 1).**

Variable		Number	Percentage
Gender	**Male**	28	39.4
	Female	43	60.6
Age(years)	**<40**	7	9.9
	41–60	31	43.7
	61-80	31	43.7
	>80	2	2.8

Table 1: Demographic Characteristics of Study Participants

In this study Posterior capsular opacification (PCO) was graded using Congdon’s criteria.

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 12, 2024

Grade 0 (no PCO) was observed in 14 cases (19.7%), Grade 1 (mild) in 24 cases (33.8%), Grade 2 (moderate) in 22 cases (31.0%), and Grade 3 (severe) in 11 cases (15.5%)**(Table 2).** The majority of participants (21.1%) developed PCO within six months post-surgery, with 14.08% developing PCO in one month, (40.8%) between 2to 5 months. The average time to PCO development 6 months in participants aged 41–60 years, those and three months in those <40 years**(Table 3).**

Grade of PCO	Frequency	Percentage
Grade 0	14	19.7
Grade 1	24	33.8
Grade 2	22	31.0
Grade 3	11	15.5

Table 2: Distribution of subjects according to grade of PCO

Duration to develop PCO	Incidence of PCO
1 month	14.08
2- 5 months	40.8
6 months	21.1

Table 3: Duration to develop PCO among participants

In this study the Risk factors significantly influenced PCO development. Among non-diabetic participants, 45 (80.4%) developed PCO compared to 12 (80.0%) diabetic participants. Oral steroid use was a strong risk factor, with all users (100%) developing PCO, compared to 77.4% of non-users. PCO incidence was highest in posterior subcapsular cataracts (PSC) at 88.9%, followed by nuclear sclerotic (NS) cataracts (80.0%), posterior polar cataracts (PPC) (75.0%), and mature cataracts (58.8%).Surgical factors also contributed to PCO incidence **(Table 4).**

Risk factors		PCO	No PCO	Incidence of PCO
Diabetes	Yes	45	11	80.4
	No	12	3	80.0
Steroid intake	Yes	9	0	100.0
	No	48	14	77.4
Cataract grading	Posterior Subcapsular Cataracts	40	5	88.9
	Nuclear Sclerotic Cataracts	4	1	80.0
	Posterior Polar Cataracts	3	1	75.0
	Mature cataract	10	7	58.8

Table 4: preoperative risk factors to develop PCO

In this study Participants with intraocular lenses (IOLs) placed in the sulcus had a higher PCO incidence (90.9%) than those with IOLs placed in the capsular bag (78.3%). Capsulorrhexis size was another factor, with a PCO incidence of 77.8% in participants with a medium capsulorrhexis and 81.8% in those with large capsulorrhexis size. Surgical methods influenced outcomes, with 84.5% of participants undergoing small incision cataract surgery (SICS) and 15.5% undergoing phacoemulsification. Among participants with PMMA IOLs (94.4%), 79.1% developed PCO, while none of the 5.6% with acrylic IOLs showed signs of PCO **(Table 5).**

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 12, 2024

Variables		PCO	No PCO	Incidence of PCO
	SICS	60	46	76.7
Surgical method	Phacoemulsification	11	11	100.0
IOL type	PMMA	67	53	79.1
	Acrylic	4	0	0.0
	Capsular bag	47	13	78.3
IOL implantation	Ciliary sulcus	10	1	90.9
	Medium	21	6	77.8
Capsulorrhexis size	Large	36	8	81.8

Table 5: Intraoperative risk factors to develop PCO

DISCUSSION

Cataracts, resulting from opacification of the lens proteins, remain the leading cause of preventable blindness globally. While modern cataract surgery techniques, including intraocular lens (IOL) implantation and lens extraction, have significantly improved visual outcomes, posterior capsular opacification (PCO) continues to be a major barrier to full visual rehabilitation. PCO, often developing months or even years after surgery, significantly reduces visual acuity, contrast sensitivity, and impairs crucial daily functions such as mobility in low-light conditions.

In our study, the incidence of PCO varied significantly across different age groups, with younger patients (under 40 years) exhibiting the highest risk, with 100% of individuals in this group developing PCO. This finding aligns with the in vitro study by Sundelin et al,[18] which similarly reported a higher incidence of PCO in younger patients. Further reinforcing this trend, the study by Tokko et al.[19] confirmed the correlation between age and the need for YAG capsulotomy, emphasizing that younger patients have a higher likelihood of PCO development. These findings underline age as a critical risk factor for PCO post-cataract surgery.

In addition to age, our study identified other significant risk factors, including diabetes and oral steroid use. Both non-diabetic and diabetic patients showed a similarly high PCO incidence, further highlighting the role of diabetes in PCO development. Furthermore, the study's findings corroborate existing literature, such as that of Ebihara Y et al[20] and Kiziltoprak H et al,[21] which reported a higher risk of PCO in diabetic individuals. Oral steroid use was also strongly associated with PCO, with all patients who had taken oral steroids developing the condition. This finding is consistent with the research by Mamidipudi R et al,[22] which linked steroid-induced posterior subcapsular cataracts (PSC) to an increased risk of PCO.

Cataract grading also played a pivotal role in PCO development. Posterior subcapsular cataracts (PSC) showed the highest incidence of PCO, which aligns with findings from V. Vinod Mootha et al[23]and underscores the importance of cataract morphology in predicting PCO risk. Similarly, the use of PMMA IOLs was linked to a higher risk of PCO, in contrast to hydrophobic acrylic IOLs, which have a lower incidence of PCO development, as reported by Suresh K. Pandey et al[24] and Ye Rin Kwon et al.[25]

Surgical factors such as IOL placement and capsulorrhexis size also influenced PCO outcomes. IOLs placed in the sulcus had a higher incidence of PCO (90.9%) compared to those placed in the capsular bag (78.3%). Additionally, a larger capsulorrhexis size (6 mm) was associated with a slightly higher PCO incidence (81.8%) compared to a medium-sized capsulorrhexis (5.5 mm), which had a 77.8% incidence. These findings highlight the importance

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 12, 2024

of careful intraoperative decision-making in minimizing PCO risk.

PCO typically develops within the first six months after surgery, with a peak incidence between 151 and 180 days post-surgery. The early onset of PCO emphasizes the importance of close monitoring during the first few months following cataract surgery. The relatively lower number of cases observed after 180 days suggests that PCO development stabilizes over time, though some cases may have a delayed onset. This underscores the need for continued long-term follow-up and additional research to better understand the long-term progression of PCO.

CONCLUSION

This study emphasizes the importance of preoperative and intraoperative factors in the development of PCO following cataract surgery. Significant research indicates that younger people, particularly those under 40, are more likely to have PCO. Significant pre-operative risk variables such as oral steroid use, diabetes, and cataract grade are uncontrollable; however, intra-operative risk factors such as size of capuslorrhexis, appropriate hydrodissection, and thorough cortical wash are modifiable. According to recent research, placing an IOL in a bag lowers PCO formation when compared to sulcus implantation. In our study 57 out of 71 cases had developed PCO with in 6 months while 10 cases has developed PCO in 1 month post-surgery out of which 2 case have significant PCO. ll things considered, the findings of this study provide useful information to improve patient outcomes after cataract surgery and reduce the occurrence of PCO. Clinicians can apply specific approaches to stop PCO from developing and raise the standards of care for patients undergoing cataract surgery by considering risk factors both before and after surgery.

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