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INCIDENCE OF POSTERIOR CAPSULAR OPACITY IN PATIENTS WITH INTRA OCULAR LENS WITHIN THE BAG VERSUS INTRA OCULAR LENS IN CILIARY SULCUS

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ABSTRACT

Background: PCO is flagged as "The most common long-term complication of cataract surgery with intraocular lens (IOL) placement is posterior capsular opacity (PCO). The location of the IOL, either in the bag or even in the sulcus can also have an impact on the occurrence of PCO.

Objective: To determine the rate of occurrence of posterior capsular opacity in patients receiving either cataract surgery with in-the-bag or sulcus intraocular lens implantation.

Study Design and Setting: The study was a prospective cohort study that was done in Ophthalmology departments, Nishtar Hospital, Multan.

Methodology: 162 patients that had undergone cataract extraction using IOL implantation were registered. Demographic, systemic comorbidities, and risk factors such as diabetes, hypertension, and smoking were documented. All the patients were categorized into two groups based on the IOL placement: in-the-bag and in the sulcus. PCO presence was determined at the 7 months end follow up. Chi-square test was used to analyze data with p 5 -1 being regarded as statistically significant..

Results: The average age of the patients was 59.0 + 7.5 years, 46.3percent males and 53.7percent females. In total, 65 patients (40.1%) had PCO. PCO was also significantly prevalent in the sulcus group as compared to the in-the-bag group (50.6% vs. 29.6%; p = 0.01). Stratified analysis showed statistically significantly higher PCO in the sulcus group with all subgroups (patients aged 35-50 years) 47.5 vs. 27.5 (p = 0.04), diabetics (52.0 vs. 33.3; p = 0.01), hypertensives (54.8 vs. 32.3; p = 0.02), and smokers (52.2 vs. 33.3; p = 0.04).

Conclusion:PCO was much more prevalent in Sulcus IOL implantation than in the-bag. IOL should be placed in the capsular bag to minimize the chances of posterior capsular opacity.

INTRODUCTION

One of the commonest complications after cataract removal is Posterior Capsular Opacity (PCO). It is able to substantively affect the vision and is treated successfully using laser capsulotomy. A better understanding of the underlying pathophysiology has resulted in alteration to surgical procedures and intraocular lens (IOL) designs to mitigate the incidence of PCO[1]. PCO is a secondary cataract, which occurs when the remaining lens epithelial cells (LECs) migrate, proliferate, and differentiate into opacifying the posterior capsule. This causes a cloudy and fibrotic layer to develop behind the lens in place causing blurred vision, haziness and glare. PCO is developed by approximately 20% of patients that undergo the post-cataract surgery, and it is capable of gradually declining visual acuity. When the visual loss begins to hamper everyday work, then there is need to get surgery. Ideally, an intraocular lens ought to have both uveal and capsular biocompatibility in order to reduce these complications.[2]

In one of the studies, the results were established as the outcome of 30 eyes of 30 patients undergoing extracapsular cataract extraction (ECCE) and 12 eyes of 8 patients with phacoemulsification using an anterior chamber IOL (PC-IOL) implants.[3] The outcomes were defined as clinically significant PCO, when the decrease measured at least two lines on the Snellen visual acuity chart. The formation of PCO and fixation of IOL haptics after surgery was assessed by slit-lamp biomicroscopy[4] The haptic position was categorized as either completely intra-capsular bag (B-B), partially intra-capsular bag and intra-sulcus (B-S) or purely intra-sulcus (S-S) [5].

It is important to make sure that the IOL is firmly placed in the capsular bag to reduce the chances of PCO. This is irrespective of the type of surgery or type of lens, complete ablation of lens material such as hydro dissection of the cortical layer plus in-the-bag placement of the IOL is a major contributor in this reduction of PCO. Also, the PCO prevention occurs due to the material and edge design of the IOL.[6]

Indian Ram et al., reported that 11.90 percent of the eyes that underwent phacoemulsification with the in-the-bag IOL fixation developed PCO. They noted an elevated incidence of PCO too when the IOL haptics was partially/wholly out of the bag, but there were no specified figures.[7]Vilhjalmssion et al. (2020) stated a total rate of PCO of 29.6% (37 cases)[8]. Out of these 34 cases (28.6) were in patients who had in-the-bag IOLs and 3 cases (50.0) were in patients who had sulcus-fixated IOLs.[9]

No published Pakistani study has covered this particular comparison, which is why there is a research gap. With the lack of local data and the absence of international research regarding this situation, it should be considered to determine the incidence of PCO among patients with the use of IOLs in the capsular bag and in the ciliary sulcus. This kind of evidence will give ophthalmologists good information on how to optimize IOL placement to gain improved postoperative visual results. This research in Pakistan will add valuable information to the literature in the world and also allow to improve the strategies of reducing PCO during cataract surgery.

MATERIAL AND METHODS

This study was designed as a prospective cohort study and was conducted in both the in-patient and out-patient departments of Ophthalmology, Nishtar Hospital, Multan. The duration of the study was seven months following the approval of the synopsis, comprising a three-month trial period and a four-month follow-up phase. A total of 162 patients, with 81 patients in each group, were included. The sample size was calculated using the WHO calculator (www.openepi.com) with 80% power of the test and a 95% confidence level, while considering the expected frequency of posterior capsular opacity (PCO), which was reported in 28.6% of cases with an intraocular lens (IOL) placed within the bag and in 50.0% of cases with an IOL implanted in the ciliary sulcus.[9] Patients

were recruited using a non-probability consecutive sampling technique.

All patients undergoing cataract surgery with IOL implantation, of either gender, aged between 30 and 70 years, with no pre-existing macular pathology and who were willing to provide informed consent and comply with follow-up visits, were included in the study. Exclusion criteria comprised a history of previous ocular trauma or surgery, pre-existing ocular diseases such as glaucoma, uveitis, or retinal disorders, complicated cataract surgeries including posterior capsule rupture, retinal detachment confirmed on fundus examination and B-scan, and advanced diabetic retinopathy or diabetic macular edema confirmed by OCT.

The research was commenced with the consent of Ethical Review Committee of Nishtar Hospital, Multan. All the participants provided informed consent and their anonymity was preserved. One hundred and sixty two patients meeting the inclusion criteria were recruited including 81 patients in the in-the-bag IOL group and 81 patients in the ciliary sulcus IOL group. Demographic characteristics such as age, gender, diabetes mellitus, smoking history and hypertension were noted. Before surgery, a consultant ophthalmologist made the decision as to whether IOL is placed in the capsular bag or the ciliary sulcus.. All cataract surgeries were performed by the same surgeon with ten years of experience to minimize bias. Postoperatively, all patients received moxifloxacin and dexamethasone eye drops six times daily for four weeks. Patients were followed at one week, one month, three months, and seven months after cataract surgery. At the end of the seven-month follow-up, the presence of PCO was assessed according to the operational definition. For patients diagnosed with PCO, appropriate management, such as YAG laser capsulotomy, was offered based on clinical evaluation. All data were documented in a structured proforma.

Posterior capsule opacification (PCO) was defined as the presence of both a decrease in Snellen visual acuity of two or more lines and an aggregate of cells or fibrosis on the posterior capsule, confirmed on slit-lamp examination by a consultant ophthalmologist. Diabetes mellitus was defined by the presence of any of the following blood sugar levels, either documented in the previous medical records within the last two years or detected during the present hospital admission: random blood sugar greater than 200 mg/dl, or fasting blood sugar greater than 126 mg/dl. Smoking history was defined as a history of smoking at least 100 cigarettes in a lifetime, with the individual either continuing to smoke or having quit within the last 12 months, in which case the patient was labeled as a smoker. Hypertension was defined as a systolic blood pressure ≥140 mmHg or a diastolic blood pressure ≥90 mmHg, or a documented history of hypertension requiring the use of antihypertensive medication

Data were entered and analyzed using SPSS version 25. Mean and standard deviation were calculated for quantitative variables such as age. Frequencies and percentages were determined for categorical variables including gender, diabetes mellitus, smoking history, hypertension, and the presence of PCO. The two study groups were compared in terms of incidence of PCO. The Shapiro-Wilk test was used to determine the normality of the numerical data. Normally distributed data were tested with parametric tests. Chi-square test was used to test categorical variables and a p-value less than 0.05 was regarded as statistically significant. The incidence of PCO was further compared between the groups after stratification by age, gender, diabetes mellitus, smoking history, and hypertension, using the Chi-square test again, with statistical significance set at $p < 0.05$.

STUDY RESULTS

The mean age of the study participants was 59.0 ± 7.5 years. A total of 92 patients (56.8%) were aged ≤ 60 years while 70 patients (43.2%) were aged above 60 years. There were 75 males (46.3%) and 87 females (53.7%). Diabetes mellitus was present in 49 patients (30.2%), whereas 113 patients (69.8%) were

non-diabetic. A history of smoking was observed in 43 patients (26.5%), while 119 patients (73.5%) had no smoking history. Hypertension was found in 73 patients (45.1%), whereas 89 patients (54.9%) were non-hypertensive, as shown in Table 1.

At the final follow-up of 7 months, posterior capsular opacity (PCO) was detected in 65 patients (40.1%), while 97 patients (59.9%) had no PCO. Among patients with intraocular lens placed in the bag, 24 (29.6%) developed PCO and 57 (70.4%) did not. In contrast, in the sulcus group, 41 patients (50.6%) developed PCO and 40 (49.4%) had no PCO. This difference between the two groups was statistically significant (p = 0.01), as shown in Table 2.

On stratification, it was observed that patients aged 30–50 years had a higher incidence of PCO in the sulcus group (47.5%) compared to the in-the-bag group (27.5%) (p = 0.04), and a similar trend was noted in patients aged >50 years with PCO rates of 53.7% versus 31.7% respectively (p = 0.03). Among males, PCO was present in 47.5% of the sulcus group compared to 30.0% in the in-the-bag group (p = 0.05), while among females it was 53.7% versus 29.3% respectively (p = 0.02). Diabetic patients with sulcus IOL placement had a higher PCO rate (52.0%) compared to those with in-the-bag placement (33.3%) (p = 0.01), and non-diabetic patients also showed a significantly higher incidence in the sulcus group (50.9% vs. 28.6%; p = 0.02). Similarly, smokers in the sulcus group had a higher PCO rate (52.2%) compared to the in-the-bag group (33.3%) (p = 0.04), and non-smokers also demonstrated significantly more PCO in the sulcus group (50.9% vs. 28.8%; p = 0.01). Among hypertensive patients, PCO occurred in 54.8% of the sulcus group compared to 32.3% in the in-the-bag group (p = 0.02), while among non-hypertensive patients it was 48.0% versus 28.6% respectively (p = 0.03), as shown in Table 3.

Table 1. Demographic Characteristics of Study Participants (n = 162)

Variable	n (%) / Mean ± SD
Age (years)	
Mean±SD	59.0 ± 7.5
Age ≤ 60	92 (56.8%)
Age > 60	70 (43.2%)
Gender	
Male	75 (46.3%)
Female	87 (53.7%)
Diabetes Mellitus	
Yes	49 (30.2%)
No	113 (69.8%)
Smoking History	
Yes	43 (26.5%)
No	119 (73.5%)
Hypertension	
Yes	73 (45.1%)
No	89 (54.9%)

Table 2. Posterior Capsular Opacity (PCO) at Final Follow-up (7 months) between Groups

Group	PCO Present	PCO Absent	Total	p-value
In the Bag	24 (29.6%)	57 (70.4%)	81	0.01*

Sulcus	41 (50.6%)	40 (49.4%)	81	
Total	65 (40.1%)	97 (59.9%)	162	

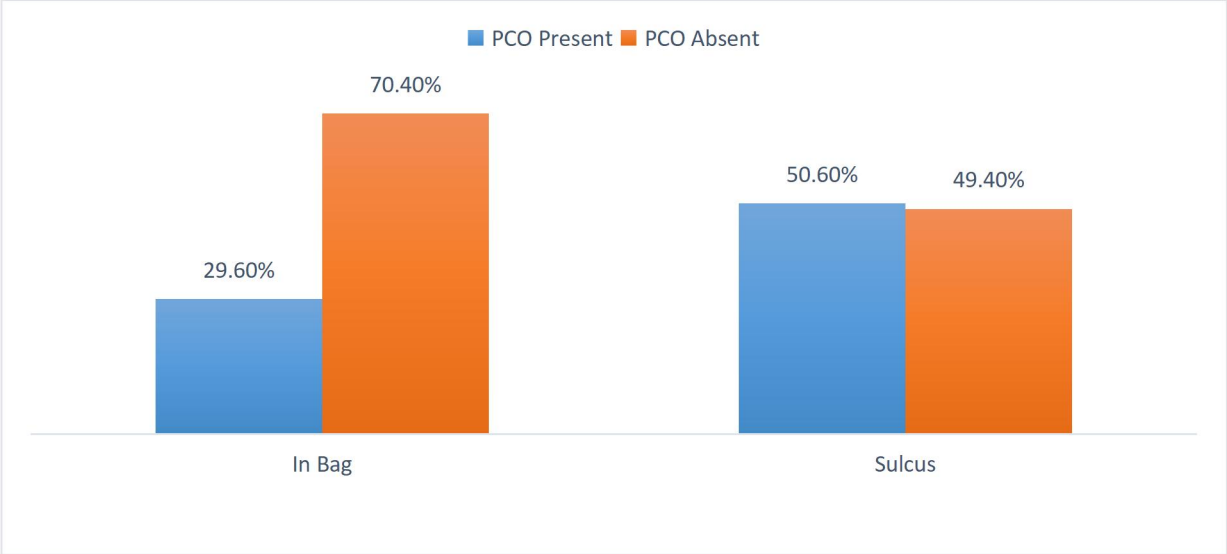

Fig 1:Posterior Capsular Opacity (PCO) at Final Follow-up (7 months) between Groups

Table 3. Stratification of Posterior Capsular Opacity (PCO) by Demographic and Clinical Factors between Groups

Variable	Category	Group	PCO Present	PCO Absent	p-value
Age	30–50 years	In the Bag	11 (27.5%)	29 (72.5%)	0.04*
		Sulcus	19 (47.5%)	21 (52.5%)	
	>50 years	In the Bag	13 (31.7%)	28 (68.3%)	0.03*
		Sulcus	22 (53.7%)	19 (46.3%)	
Gender	Male	In the Bag	12 (30.0%)	28 (70.0%)	0.05*
		Sulcus	19 (47.5%)	21 (52.5%)	
	Female	In the Bag	12 (29.3%)	29 (70.7%)	0.02*
		Sulcus	22 (53.7%)	19 (46.3%)	
Diabetes	Diabetic	In the Bag	8 (33.3%)	16 (66.7%)	0.01*
		Sulcus	13 (52.0%)	12 (48.0%)	
	Non-Diabetic	In the Bag	16 (28.6%)	40 (71.4%)	0.02*
		Sulcus	28 (50.9%)	27 (49.1%)	
Smoking	Smoker	In the Bag	7 (33.3%)	14 (66.7%)	0.04*
		Sulcus	12 (52.2%)	11 (47.8%)	
	Non-Smoker	In the Bag	17 (28.8%)	42 (71.2%)	0.01*
		Sulcus	29 (50.9%)	28 (49.1%)	
Hypertension	Hypertensive	In the Bag	10 (32.3%)	21 (67.7%)	0.02*
		Sulcus	17 (54.8%)	14 (45.2%)	
	Non-Hypertensive	In the Bag	14 (28.6%)	36 (71.4%)	0.03*
		Sulcus	24 (48.0%)	26 (52.0%)	

DISCUSSION

Cataract remains the leading cause of reversible blindness worldwide, with intraocular lens (IOL) implantation being the standard treatment after cataract extraction.[10] PCO or secondary cataract is the most frequent postoperative complication, which can affect the postoperative visual performance of a patient due to various factors, such as surgical methods, comorbidities of patients, and the location of IOL. The fixation of in-the-bag IOL is mostly linked with a reduced risk of PCO, and the location of the sulcus could lead to cell proliferation on the rear capsule. It is significant to identify such risk factors at an early stage to optimize surgical results and decrease the necessity to use Nd:YAG capsulotomy.12 This research was aimed at comparing the incidence of PCO in patients who underwent in-the-bag versus sulcus IOL implantation.

In the current research, the cumulative percentage of posterior capsular opacity (PCO) was 40.1 per cent at 7 months, and the rate of PCO is much higher in the group of ciliary sulcus (50.6) than in the group of in-the-bag (29.6) ($p = 0.01$). The results align with the fact that the fixation of sulcus predetermines the increase in capsular bag instability and the further proliferation of cells. The mean follow-up of 6.81 +/- 1.82 years presented by Zhao et al. (2017) and the difference between the mean fixation of the sulcus (longer) and in-the-bag (better) indicated that the former had significantly greater vertical IOL decentration, tilt ($p = 0.01$-0.02), iris-IOL contact ($p = 0.001$), peripheral anterior synechia ($p = 0.03$), and secondary glaucoma. Although their study was long-term, it reinforces our finding that sulcus placement has more complications, including higher rates of capsular changes.[13]

Younas et al. (2025) observed that among 172 patients, mean age was 54.32 ± 8.65 years, with 56.4% males and 43.6% females, and PCO patterns ranged from grade I (23.3%) to grade IV (5.2%). They reported no significant association of PCO with age ($p = 0.240$), gender ($p = 0.712$), or duration of IOL implantation ($p = 0.055$).[14] In contrast, our stratified analysis revealed significant associations across multiple variables: for example, PCO was higher in sulcus versus bag fixation in diabetics (52.0% vs. 33.3%, $p = 0.01$), hypertensives (54.8% vs. 32.3%, $p = 0.02$), and smokers (52.2% vs. 33.3%, $p = 0.04$). This suggests that our population exhibited stronger demographic and systemic risk associations compared to their cohort. Moin et al. (2019) reported that in 358 eyes, PCO-related visual decline occurred in 23.4% of PMMA IOL cases and 6.2% of hydrophobic acrylic IOL cases, with only 6% and 1.5% respectively requiring Nd:YAG capsulotomy.[15] Similarly, Wanage (2024) found PCO incidence significantly higher in hydrophilic IOLs (38.0%) than hydrophobic (10.0%, $p = 0.0007$), with Nd:YAG required in 32% versus 6% respectively ($p = 0.0011$). These results align with our observation that material and placement site directly influence PCO development, supporting the notion that in-the-bag fixation with hydrophobic material remains the safest option.[20]

Sahu et al. (2019) reported that 26.08% developed PCO within 12–36 months, and early onset was most common in younger patients (<20 years, mean 3 months). Similarly, our subgroup analysis revealed that younger patients (30–50 years) had significantly higher PCO in sulcus placement compared to bag placement (47.5% vs. 27.5%, $p = 0.04$). This highlights that age-related regenerative potential influences PCO development regardless of surgical site.[16]

In terms of Nd:YAG requirement, Lee et al. (2023) demonstrated higher capsulotomy rates in hydrophilic MI60 lenses (31.7%) compared to hydrophobic SN60WF (7.9%), ZCB00 (10.06%), and MX60 (10.57%) ($p < 0.001$),[19] while Parajuli et al. (2019) reported mean IOP rise from 15.40 ± 2.71 mmHg to 19.04 ± 3.50 mmHg post-capsulotomy, with 24.44% developing raised IOP. Our study did not extend to Nd:YAG rates or IOP rise, but the higher

baseline incidence of PCO in the sulcus group indicates a likely greater burden of future interventions.[18] Finally, Baig et al. (2021) found 2.08% late IOL dislocations after phacoemulsification, more common in older age (50–75 years).[17] This supports Zhao et al. (2017) and our findings, that sulcus fixation may predispose to greater instability, leading not only to PCO but also late dislocation.[13]

This study provides valuable comparative data on the incidence of PCO in two different IOL placements using a well-defined sample size. Standardized diagnostic criteria for PCO were applied by consultant ophthalmologists, ensuring reliable outcome assessment. The stratified analysis across subgroups (age, diabetes, hypertension, smoking) strengthens the validity of findings. However, the study was limited by a relatively short follow-up period of 7 months, which may underestimate late-onset PCO. Being a single-center study, the results may not be generalizable to wider populations. Lack of randomization between groups is another limitation that may introduce selection bias.

CONCLUSION

Sulcus IOL implantation was associated with a significantly higher risk of posterior capsular opacity compared to in-the-bag placement. Careful surgical planning should prioritize capsular bag fixation to improve long-term visual outcomes. Further multicenter studies with longer follow-up are recommended to validate these findings.

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