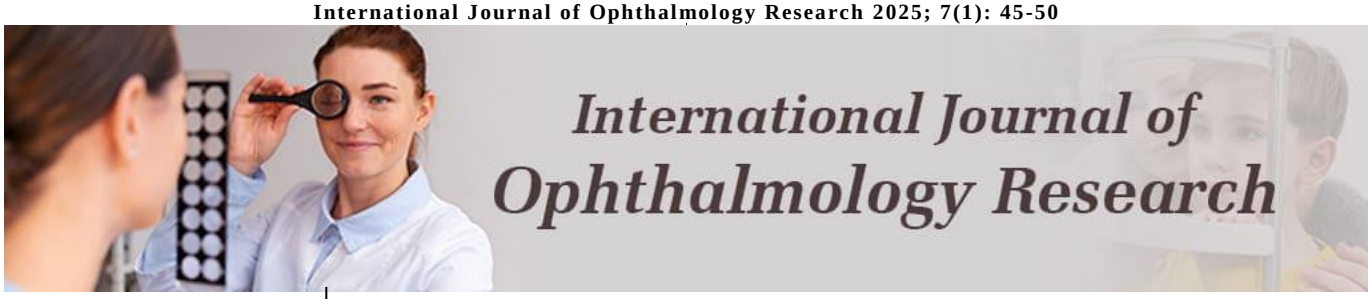

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Tear film changes in post-operative cataract surgery patients

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Abstract
Introduction: The tear film is a multilayered structure covering the corneal surface, serving as a crucial interface between the corneal epithelium and the external environment. Composed of water, mucins, electrolytes, proteins, and lipids, it plays an essential role in corneal protection, wound healing, and maintaining visual acuity. Tear film homeostasis is vital, and disturbances in its quality or volume can result in Dry Eye Syndrome (DES), a multifactorial disease characterized by tear hyperosmolarity, inflammation, and neurosensory abnormalities. DES is commonly observed following cataract surgery. This study aimed to evaluate tear film changes and the occurrence of DES in patients undergoing cataract surgery.
Methods: A prospective observational study was conducted over two months involving 70 eyes of 70 patients aged 40-80 years undergoing cataract surgery under the Mobile Eye Services of CMC Ludhiana. Preoperative and postoperative tear film parameters were assessed using Schirmer's Test II (ST II) and the Ocular Surface Disease Index (OSDI) questionnaire at baseline, 2 weeks, and 4 weeks post-surgery.
Results: Preoperatively, the mean ST II was 18.51±6.51 mm, which significantly reduced to 12.81±5.85 mm at 2 weeks (p<0.001), before improving to 15.46±6.21 mm at 4 weeks (p<0.001). OSDI scores increased from a baseline of 9.61±2.01 to 22.13±6.11 at 2 weeks (p<0.001), then decreased to 17.71±4.45 at 4 weeks (p<0.001). Differences were also noted between surgical techniques, with higher and more persistent OSDI scores in the SICS group compared to phacoemulsification (p=0.004). Final 4 week dry eye incidence was 90% in the present study. Out of the total number of dry eye cases, 88.89% were mild dry eyes, 9.52% were moderate and 1.59% were severe dry eyes, respectively. The study highlights the postoperative impact of cataract surgery, particularly SICS, on tear film dynamics and dry eye incidence.

Keywords: Tear film, dry eye syndrome, cataract surgery

Introduction
The tear film is a 2.5 - 5.5 µm thick pre-corneal covering, made up of water, mucins, electrolytes, proteins and lipids. It consists of 3 layers, firstly the lipid layer (*outer layer*), which is produced by the Meibomian glands and formed by polar and nonpolar lipids. This layer maintains surface tension and prevents evaporation of the other layers. Adjoining it is the aqueous layer (*middle layer*), which is formed by the lacrimal gland and consists of proteins, electrolytes, and water. Its function is to lubricate the eye, wash away particles, and prevent infections by producing antimicrobials. The third layer is the mucin layer (*inner layer)*, which is formed by mucin, electrolytes, and water which is produced by goblet cells, and helps facilitate tear-spreading [1].
The tear film is very important for the protection of the cornea which is credited to its complex structure and composition. It also, however, provides further protection by releasing certain factors which help facilitate wound healing. In addition, the tear film contributes to both good quality of vision and eye comfort by acting as the first refractive element of the eye and by forming a lubricating layer. Sufficient quantity and quality of tears are essential for maintaining a stable tear film, and any imbalance caused by factors like illness, structural changes, or procedures, such as cataract surgeries, can lead to dry eye syndrome (DES) [2].
The Tear Film and Ocular Surface Society Dry Eye Workshop II report (TFOS DEWS II) states the definition of Dry Eyes Syndrome as - 'A multifactorial ocular surface disease characterized by loss of tear film homeostasis and accompanied by ocular symptoms in

which tear film instability and hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities play an etiologic role' [3]. Etiologically, the prevalence of dry eye disease increases with age and affects women more often than men. DES can cause a variety of symptoms including; a sandy, gritty, or foreign body sensation, epiphora, pain, redness, and blurry vision. DES can be classified into 2 categories which is important in order to differentiate and treat them accordingly. Firstly, evaporative dry eye, which is characterized by increased evaporation of the tear film due to deficiency in the lipid component, caused due to dysfunction of the Meibomian glands. The aqueous deficiency dry eye comprises reduced tear production due to various diseases, inflammation, or dysfunction of the lacrimal gland [4, 5].

Dry eyes after cataract surgery are one of the most common signs that patients may display. These signs and symptoms can be caused by various factors, such as disruption of the gland's secretory circuits which cause an interruption in the secretion of the content forming the lipid layer or the aqueous layer. In addition, inflammatory mediators are developed during procedures which may cause corneal and conjunctival cell death. Another important factor is drug-induced disruption, this is due to drugs used in surgery or topical ailments for recovery which can disrupt the lipid layer. Finally, there may be decreased production of mucin due to the destruction of goblet cells during the procedure [6, 7].

An estimated 10 to 12 million cataract cases and 1 to 2 million cataract surgeries are observed annually.[6] It remains the leading cause of visual impairment worldwide. To treat cataracts, procedures such as small incision cataract surgery (SICS) and phacoemulsification are performed commonly. Given its high prevalence and the critical role it plays in improving vision and quality of life, studying the outcomes of cataract surgery such as DES and its effects on the tear film presents an opportunity to better understand its broader impact on public health, while also contributing valuable insights to both clinical practice and policy-making in ophthalmology [8, 9].

A hospital-based study conducted by Rajagopal in Kerala included 120 patients who had undergone SICS. The postoperative Ocular Surface Disease Index (OSDI) values showed that 1 week after surgery, 95 percent of patients had changes in the tear film leading to dry eye syndrome. Furthermore, 4 weeks after surgery, 35 percent of patients had mild dry eyes, 40 percent had moderate dry eye, and 23 percent of patients with severe dry eye. Thus incidence of dry eye syndrome increased 1 week after surgery and peaked at 4 weeks after surgery [10]. In another study which was conducted in a hospital setting by Sahay *et al* in ZMCH, Dahod, a total of 390 patients were enrolled to assess the incidence of dry eye following cataract surgery in rural areas. After three months, the cumulative incidence of dry eyes was seen to be 22.1 percent. Of these 2 percent of patients had severe dry eyes, 67 percent had moderate dry eyes and 31 percent had mild dry eyes [11].

A study by Ishrat et.al in Indore, enrolled 96 patients undergoing cataract surgery who were analyzed for dry eye symptoms. One week after the procedure, it was found that 42% of patients cumulatively going under both small incision cataract surgery (SICS) and phacoemulsification experienced dry eye symptoms. There were 34 and 8 dry eyes in SICS and phacoemulsification groups respectively at one week postoperative follow-up which was statistically significant. These results suggest the importance of the surgical approach chosen which may lead to a variable number of results [12].

Kasetsuwan *et al* in Bangkok showed that dry eye incidence was only 9.8% in 92 patients 1 week post-op. The study suggested that phacoemulsification compared to SICS has a higher incidence of dry eyes post-operatively, which conflicts with other data [13].

In the past, limited studies examining the relationship between the variations in the incidence of dry eye syndrome following different cataract surgery techniques like small incision cataract surgery and phacoemulsification, have been conducted in the state of Punjab. While cataract surgery is essential for restoring vision, the diverse outcomes regarding tear film stability and DES development across surgical methods raise concerns about postoperative quality of life. By investigating these variations, this study aims to provide evidence-based insights that will guide ophthalmic surgical practices, optimize patient care, and improve postoperative management to minimize DES-related complications.

Material and Methods

This was a prospective observational study conducted over a period of two months involving 70 eyes of 70 patients aged 40-80 years undergoing cataract surgery under the Mobile Eye Services of CMC Ludhiana.

All the clinical tests described below, including Schirmer Test II, and OSDI, were performed preoperatively and postoperatively at designated time intervals (1 day preop, 2 week and 4 weeks post op). The results were recorded in the protocol provided and analyzed to assess changes in tear film stability, tear production, and subjective symptoms of dry eye before and after cataract surgery.

Schirmer Test II (STII): This test quantifies tear secretion by measuring how much the tear film wets a filter paper strip over a set period. It is essential for evaluating lacrimal gland function and determining whether tear production is sufficient. A normal Schirmer Test II result is more than 10 mm of wetting after 5 minutes. Lower values suggest reduced tear secretion and may indicate dry eye syndrome.

Grading:	1 - MILD	2 - MODERATE	3 - SEVERE
ST(II)	10 - 5 mm	4 - 3 mm	2 or less mm

Ocular Surface Disease Index (OSDI): OSDI is a subjective questionnaire used to gauge the severity of dry eye symptoms from the patient's perspective. It provides valuable insight into the functional impact of dry eye on daily life and visual comfort. The OSDI questionnaire is provided to the patient in a quiet, distraction-free environment. The patient is asked to complete the questionnaire, which consists of 12 questions that assess dry eye symptoms, including discomfort, visual disturbances, and environmental triggers. Each question is scored on a scale of 0 (none) to 4 (all the time), with the patient evaluating the frequency of symptoms they have experienced over the last week. The scores are then calculated and categorized to assess the severity of dry eye disease.

Grading:	1 - MILD	2 - MODERATE	3 - SEVERE
OSDI	12-22	23-32	33-100

Results

A total of 70 eyes of 70 patients were included in the study. Each eye was taken to be a single case. Study subjects falling in the age group of 40-80 years presenting to the Mobile Eye Services of Department of Ophthalmology CMC, Ludhiana and undergoing surgery were included in this study

Age Distribution

The study subjects in our study group were in the age group of 40-80 years. Majority of the subjects belonged to the age group 60-69 years (52.9%), followed by 70-80 years (27.1%), 50-59 years (21.4%) and 40-49 years (17.1%) respectively. The mean age was found to be 60.57 with standard deviation of 9.07 years. (Fig 1.)

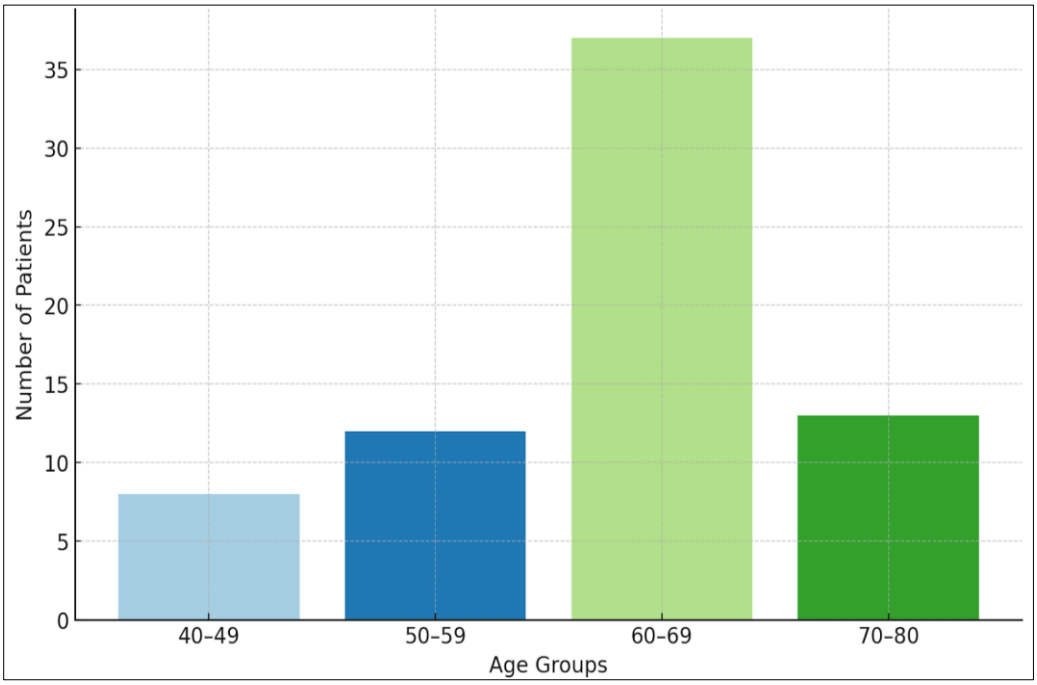

Fig 1: Age distribution

Gender Distribution

In our study, a male predominance was seen. Among 70 study subjects, 43 (61.4%) patients were male and 27 (38.6%) were female. (Fig. 2)

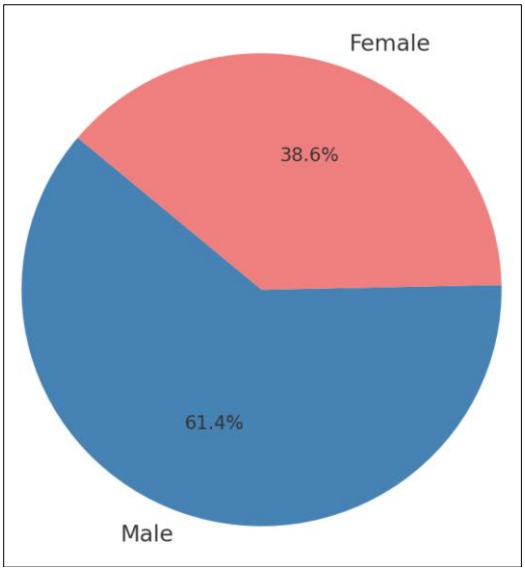

Fig 2: Gender Distribution

Pre Operative ST II

In our study, preoperatively, the mean ST II (Schirmer's Test) score was found to be 18.51±6.51 mm. (Fig. 3) (Table 1)

Post Operative ST II

A significant reduction in tear secretion and an increase in dry eye symptoms were observed at 2 weeks postoperatively. The mean ST II score dropped to 12.81±5.85 mm (p<0.001). By 4 weeks, the ST II score slightly improved to 15.46±6.21 mm (p<0.001) (Fig. 3), These differences across time points were statistically significant, indicating a postoperative alteration in tear film, particularly within the early recovery phase. (Table 1)

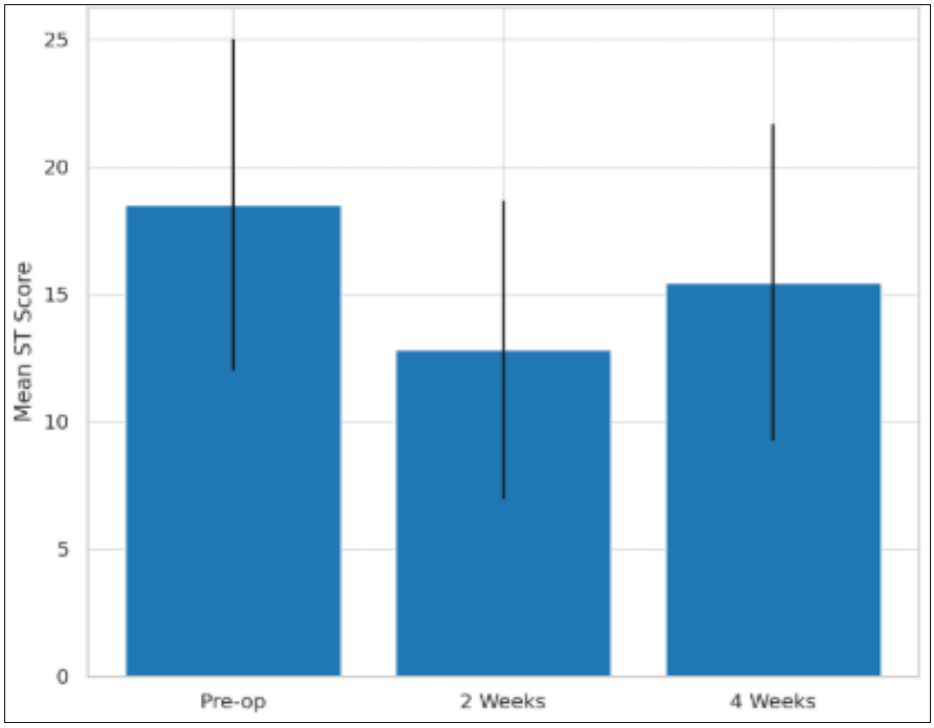

Fig 3: ST II Scores

Pre Operative OSDI Scores

In our study, the mean OSDI (Ocular Surface Disease Index) score preoperatively was 9.61±2.01 with a p value < 0.001, indicating that the subject is experiencing no significant dry eye symptoms. (Fig. 4) (Table 1)

Post Operative OSDI Scores

The mean OSDI score increased significantly to 22.13±6.11 (p<0.001) at 2 weeks. At 4 weeks post op, the OSDI score decreased to 17.71±4.4, showing partial recovery but not returning to baseline levels. (Fig. 4) (Table 1)

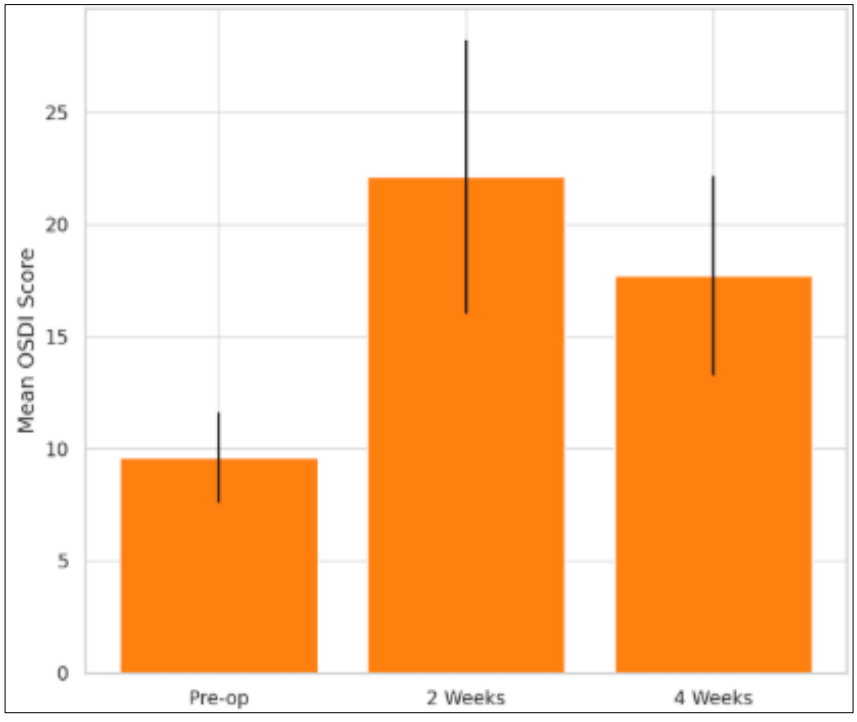

Fig 4: OSDI Scores

PHACO vs SICS

A total of 63 SICS and 7 Phacoemulsification cases were observed. Further analysis of postoperative outcomes based on the type of surgery revealed no statistically significant difference in ST II values between the SICS and phacoemulsification groups at 2-week (p=0.91), or 4-week intervals (p=0.53). (Fig. 5) (Table 2)

However, significant differences were seen in the OSDI scores between these groups. At 2 weeks, patients in the SICS group had a significantly higher mean OSDI score (22.81±5.98) compared to the phacoemulsification group (16±3.31), with a significant p-value of 0.004. (Fig. 5) (Table 2)

Similarly, at 4 weeks, OSDI scores remained higher in the SICS group (18.21±4.37) compared to the phaco group (13.28±2.36), and this difference was also statistically significant with a p value of 0.005. These findings suggest that subjective symptoms of dry eye were more pronounced and persistent in the SICS group. (Fig. 5) (Table 2)

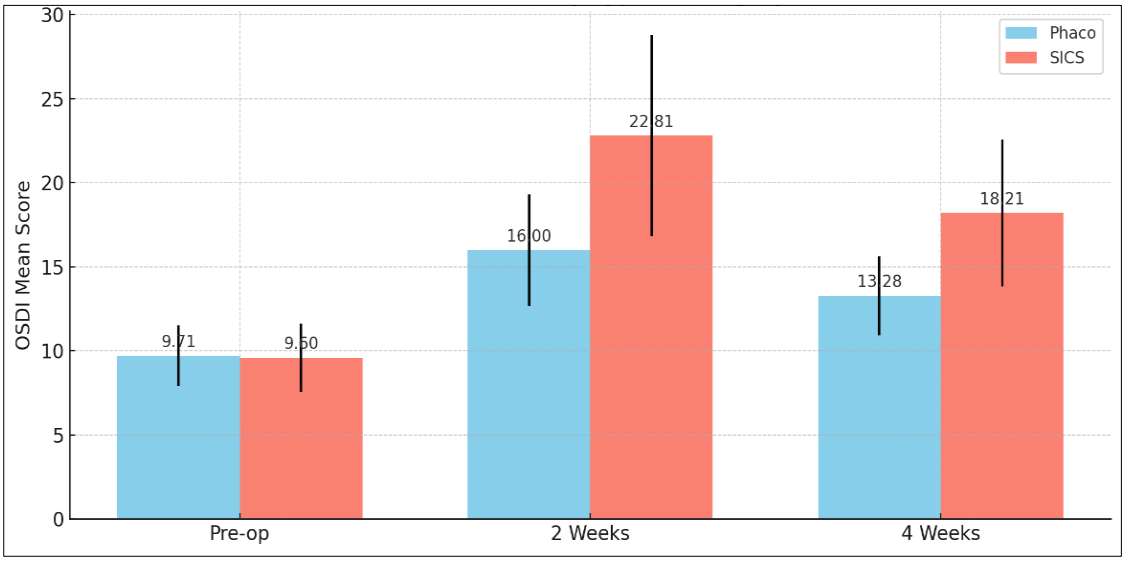

Fig 5: Comparison of OSDI Scores by Type of Surgery

Incidence Of Dry Eyes

The OSDI assessment score was evaluated for dry eyes. Final 4 week dry eye incidence was 90% in the present study. Out of the total number of dry eye cases 88.89% were mild dry eyes, 9.52% were moderate and 1.59% were severe dry eyes.

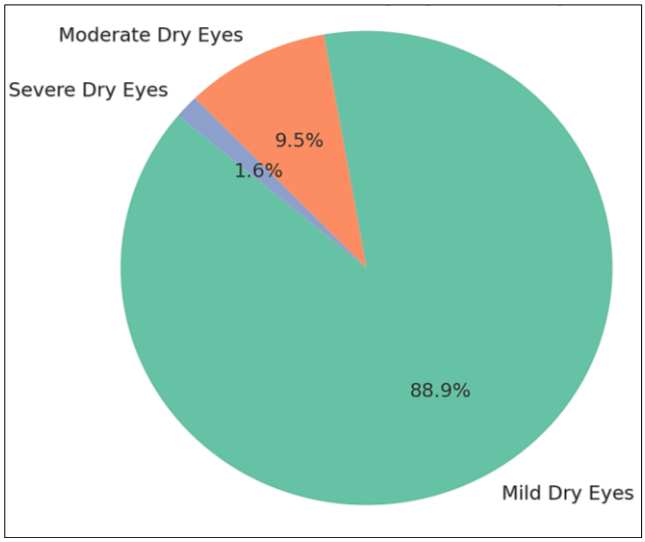

Fig 6: Dry eye incidence

Discussion

A total of 70 eyes in 70 study subjects within the age group 40-80 years who presented to the Mobile Eye Services of the Department of Ophthalmology, CMC Ludhiana were included in this study. Each eye was taken to be a single case.

Age Distribution

In this study, the age of the patients ranged from 40 to 80 years with a mean age of 60.57±9.07 years. The majority of the subjects (52.9%) belonged to the age group of 60-69 years, this distribution is similar with results of Sahay *et al* in which the majority of subjects were in the age group of 61-70 yrs (40.3%). [11]

Gender Distribution

In our study, the proportion of male subjects was higher i.e 43 (61.4%), while female subjects were 27 (38.6%). This was similar with the gender distribution noted both in Sahay *et al* and Rajagopal *et al* where they reported 53% and 51% males respectively. [11, 14]

Post Operative St II Scores

Post-operatively, ST II (Schirmer's Test) values were noted at 2 and 4 week intervals. At the 2 week interval, the mean ST score dropped to 12.81±5.85 mm (p<0.001), this was in accordance with a study done by Andryani *et al* showing a value of 11.93±4.79 mm at 2 weeks. In our study at 4 weeks post op, the ST score slightly improved to 15.46±6.21 mm (p<0.001), showing partial recovery but not returning to baseline levels. In a study done by Rajagopal *et al*, a similar result was seen at 4-week with a ST II score of 16.18±6.26 mm [14, 15].

Post Operative OSDI Scores

The mean OSDI score increased significantly to 22.13±6.11 (p<0.001) at 2 weeks. Increase in OSDI score post-op is consistent with findings of Gadhiya *et al* which showed a mean of 25.97±5.34 (p<0.001) at 2 weeks [16].

In our study, by 4 weeks the OSDI score reduced to 17.71±4.4, consistent with the done by Kasetsuwan *et al*, where the results showed a score of 12.57 (p<0.001) [13]. In a study done by Sidarait *et al* a similar OSDI value of 13.79±10.88 (p<0.001) was seen at 4 weeks post op [17].

These studies also support that maximum ocular discomfort may occur within the first few weeks after surgery after which it leads to a partial recovery but not returning to baseline levels.

SICS vs PHACO

In our study, there were 7 phaco and 63 SICS procedures done. Analysis of postoperative outcomes based on the type of surgery revealed no statistically significant difference in ST II values between the SICS and phacoemulsification groups.

However, differences were seen in the OSDI scores where, at 2 weeks, patients of the SICS group had a higher mean OSDI score of mean OSDI score 22.81±5.98 compared to the phacoemulsification group of 16±3.31 (p<0.001). Nazm *et al* likewise found a larger postoperative rise in OSDI after SICS than phaco [18]. Similarly, at 4 weeks, OSDI scores remained higher in the SICS group 18.21±4.37 (p<0.001) compared to the phaco group 13.28±2.36 (p<0.001), this difference was noted to be statistically significant (p=0.005). A study done by Sahu *et al* reported that a higher fraction of SICS patients had ongoing symptoms during SICS 18.9% and versus 7.8% of patients undergoing phaco (p<0.001), supporting the fact that SICS had a longer recovery time [19].

Incidence of Dry Eyes

The OSDI assessment scores were used to calculate the final dry eye incidence. In our study, the total dry eye incidence at 4 weeks postoperatively was 90% which had 88.89% mild dry eyes, 9.52% moderate and 1.59% severe dry eyes. This trend was also reported in several studies done previously in other parts of the country [20, 21].

Conclusion

Cataract surgery consistently induces acute tear film disruption, peaking at 2 weeks with partial recovery by 4 weeks. SICS causes significantly greater dry eye incidence than phacoemulsification. Although dry eye remains a universal outcome. Proactive management-preoperative screening, patient education, and post op lubricant eye drops -is essential for optimal visual recovery.

Table 1: Repeated Measures of ANOVA comparing different Intervals

	ST II			OSDI		
	Mean	**SD**	**p-value**	**Mean**	**SD**	**p-value**
Pre-op	18.51	6.51	<0.001	9.61	2.01	<0.001
2 Weeks	12.81	5.85	<0.001	22.13	6.11	<0.001
4 Weeks	15.46	6.21	<0.001	17.71	4.45	<0.001

Table 2: Comparison of outcome based on type of surgery

	PHACO		SICS		p-value
	Mean	**SD**	**Mean**	**SD**	
ST					
Pre-op	15.57	3.95	18.84	6.68	0.21
2 Weeks	12.57	2.82	12.84	6.12	0.91
4 Weeks	16.86	1.77	15.3	6.51	0.53
OSDI					
Pre-op	9.71	1.80	9.60	2.04	0.891
2 Weeks	16	3.31	22.81	5.98	0.004*
4 Weeks	13.28	2.36	18.21	4.37	0.005*

*Statistically Significant

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