Original Article

Examining the Role of Cataract Surgery in Causing Dry Eye Syndrome

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Abstract

Purpose: To investigate the effect of cataract surgery on dry eye.
Patients and Methods: In this prospective observational study, patients who were candidates for cataract surgery were enrolled, and three methods for evaluating dry eye, such as the ocular surface disease index (OSDI) questionnaire, Schirmer 1 test, and non-invasive tear film break-up time (NI-BUT) measured using the Sirius device, were utilized before surgery and one month after surgery, and the results were compared.
Results: Eighty eyes of 80 patients, including 34 males and 46 females, were included in the study. The mean age of the patients was 65.2 ± 7.3 years. In the conducted evaluations, the numerical results of the OSDI questionnaire increased from 27.52 ± 12.26 before the surgery to 32.42 ± 13.91 one month after surgery ($P < 0.01$). The tear film break-up time using the Sirius device before surgery was 8.52 ± 5.09 seconds, which decreased to 5.37 ± 3.73 seconds after surgery ($P < 0.001$). In the Schirmer 1 test, the results changed from 7.89 ± 2.25 millimeters before surgery to 7.42 ± 2.38 millimeters after surgery ($P < 0.01$).
Conclusion: This study's results suggest that cataract surgery is a predisposing factor for increased dry eye symptoms and can exacerbate the severity of the disease in patients with a history of dry eye.

Keywords: Dry Eye; Cataract; Schirmer Test; Ocular Surface Disease Index.

Article Notes: Received: Jan. 11, 2022; Received in revised form: Feb. 07, 2022; Accepted: Mar. 01, 2022; Available Online: Jun. 22, 2022.

How to cite this article: Ahmad Hassan H, Oraee Yazdani M. Examining the Role of Cataract Surgery in Causing Dry Eye Syndrome. Journal of Ophthalmic and Optometric Sciences . 2022;6(3):20-27.

Introduction

Cataract surgery is one of the most common ophthalmic surgeries [1]. Cataract surgery, using small incisions, now has excellent clinical outcomes, rapid recovery after surgery, and fewer postoperative complications [2,3].

Although cataract surgery has had a positive impact on the quality of life of millions of people worldwide, there are potential complications that can threaten the post-surgical results 2. In general, complications after cataract surgery can be divided into two categories based on the time of occurrence: short-term complications (within one to three months after surgery) and long-term complications. Short-term complications include infection, corneal edema, intraocular lens dislocation, and toxic anterior segment syndrome [4-6]. Long-term complications of this surgery include retinal detachment, potential macular edema, and posterior capsule opacification [5, 7-9].

Problems with tear secretion and dryness of the ocular surface are one of the most common complications after cataract surgery [9, 10]. Among the potential causes of dry eye during and after cataract surgery mentioned in the previous studies are damage to corneal nerves during incision creation, damage to the ocular surface through toxic substances in used eye drops, phototoxicity, and surgical trauma [11]. While there are many potential factors that can cause DED during and after cataract surgery, the question of to what extent cataract surgery causes post-surgical DED is a subject of debate. Several studies report that patients remain dissatisfied and disturbed due to DED for extended periods after cataract surgery [12], while others consider it a transient manifestation of transient ocular surface damage and believe that its detrimental effects diminish within 1 to 3 months [13,14]. Other studies have shown that the ocular surface improves after cataract surgery, which is believed to be attributed to the use of postoperative eye drops and sufficient reduction in eye friction and blinking [15, 16].

Some of the assessment methods for dry eye include questionnaires such as the ocular surface disease index (OSDI) and 5-item dry eye questionnaire (DEQ-5) [17]. Other methods include corneal staining using fluorescein, measurement of tear film height on the lower eyelid, tear break-up time (TBUT), Schirmer test, measurement of tear osmolarity, assessment of inflammatory factors, and new non-invasive methods such as the non-invasive tear film break-up time (NI-BUT) measured using the Sirius device [17].

Although advancements in surgical techniques for cataract surgery have led to improved vision and reduced post-operative complications in patients, many patients still complain of symptoms such as burning, foreign body sensation, and increased tearing after cataract surgery [18]. In some patients, these symptoms can be severe and significantly impact their quality of life. Therefore, evaluating the symptoms and changes that may occur during and after surgery has always been necessary to identify the underlying causes, provide appropriate treatment, and ultimately improve patients' symptoms and satisfaction with surgery. The aim of the present study was to evaluate the effect of cataract surgery among Iranian patients undergoing cataract surgery using OSDI questionnaire, Schirmer 1 test, and tear film break-up time measured by Sirius device.

Patients and Methods

This study employed a continuous observational design to gather data on patients who underwent cataract surgery.

A standardized form was used to collect demographic information, pre-surgery details, and post-surgical follow-up data throughout the study period. The standardized form facilitates the consistent collection of demographic information, pre-surgery details, and post-surgical follow-up data.

This study adhered to the Helsinki Declaration principles on human research. Written informed consent was obtained from all participants after a detailed explanation of the study. The research protocol received approval from the ethics committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran. Consecutive case recruitment was utilized as the sampling method in this study. Patients were included in the study based on their availability and the sequential order in which they underwent cataract surgery.

The target population for this study consisted of individuals diagnosed with cataracts who underwent cataract surgery at Torfeh Eye Hospital, Tehran, Iran in 2021. All patients participating in the study underwent a comprehensive ophthalmic examination, including a slit lamp examination, to assess their eligibility for cataract surgery and evaluate any existing eye surface disorders. Patients undergoing cataract surgery were included, while those with the following conditions were excluded from the study: allergic conjunctivitis, corneal problems and keratoconus, diabetic retinopathy, complicated cataract surgery, requirement of topical ocular medications for glaucoma or uveitis, requirement of contact lenses, pre-existing subjective symptoms of dry eye, severe meibomian gland dysfunction, history of previous eye surgery, and pterygium.

After initial examinations and ophthalmic evaluations, patients were asked to complete the OSDI questionnaire. Additionally, the Schirmer 1 test was performed by placing a paper strip in the lower outer third of the eyelid for 5 minutes to assess tear production. Also, the NI-BUT test performed using the Sirius device was used to assess dry eye. This involved capturing a video recording of the eye surface during blinking to evaluate tear film integrity. The breakup time was measured, and the resulting corneal surface map indicated the severity of tear breakup, with colors representing different levels of severity (e.g., yellow for mild and minimal breakup, red for more severe breakup).

All surgeries were performed by an ophthalmologist with experience in cataract surgery, using consistent facilities, equipment, and post-operative care. The surgery involved creating a 2.85 mm incision and placing an intraocular lens in the capsule.

One month after surgery, OSDI evaluation, NI-BUT measurement, and Schirmer 1 test were performed again on all patients, and the results were recorded.

To describe the data, measures such as mean, standard deviation, median, range, frequency, and percentage were used. T-test statistical analysis was used to compare pre- and post-treatment results. All analyses were conducted using SPSS version 26 (Armonk, NY: IBM Corp). In these analyses, a significance level of $P < 0.05$ was considered statistically significant. A generalized estimation equation (GEE) model was utilized to account for the correlation between the results of both eyes of an individual.

Results

A total of 80 eyes from 80 patients were enrolled in the study. Of these, 34 (42.5 %) were male and 46 (57.5 %) were female. The mean age of the patients at the time of enrollment was 7.3 ± 65.2 years.

Table 1: Comparison of dry eye test results before and after cataract surgery

Variable	Mean ± SD		Median (Range)		P Value*
	Pre	Post	Pre	Post	
OSDI	27.52 ± 12.26	32.42 ± 13.91	27.08(8.33,72.91)	29.16(8.33,58.33)	< 0.01
NI-BUT	8.52 ± 5.09	5.37 ± 3.73	8.1(1.2,17)	4.4(1.2,17)	< 0.001
Schirmer 1	7.42 ± 2.38	7.89 ± 2.25	7(5,12)	8(5,13)	< 0.01

* Based on pared t test
ODSI: Ocular Surface Disease Index
NI-BUT: Non-Invasive Tear Film Break-Up Time

When evaluating the OSDI questionnaire scores, the mean score before surgery was 27.52 ± 12.26, which increased to 32.42 ± 13.91 after cataract surgery. This increase was statistically significant (P < 0.01), indicating a worsening of dry eye symptoms among patients one month after cataract surgery compared to pre-surgery.

In the NI-BUT evaluation using the Sirius device, it was observed that the mean preoperative tear film stability time was 8.52 ± 5.09 seconds. The mean decreased to 5.37 ± 3.73 seconds after the surgery. This change was also statistically significant (P < 0.001), indicating a worsening of dry eye symptoms among patients one month after cataract surgery compared to pre-surgery.

Another assessment conducted was the Schirmer 1 test before and one month after surgery. This showed a change in the mean reading from 7.89 ± 2.25 mm before the procedure to 7.42 ± 2.38 mm after surgery (P < 0.01).

Discussion

The aim of the present study was to investigate dry eye conditions changes after cataract surgery. As the results indicated, the OSDI questionnaire findings as well as NI-BUT measurements using the Sirius device and Schirmer 1 test results showed a deterioration in tear quality and an increase in dry eye symptoms in patients one month after cataract surgery compared to before surgery.

A study by Liu et al.,[19] reported that dry eye evaluation performed by TBUT and Schirmer test showed worsened results in patients after cataract surgery. This aligns with our study findings.

In a recent study conducted by Sidaraite et al., [20] the authors examined changes in the ocular surface after cataract surgery in 48 patients. They performed TBUT, Schirmer test, Cochet-Bonnet corneal sensitivity measurement, confocal scanning, and filled in the OSDI questionnaire for patients before surgery and one month after cataract surgery. They observed that TBUT, Schirmer test values, and corneal nerve density were significantly lower at the end of one month than before surgery [20]. The OSDI score also showed a significant increase [20]. This study's results are consistent with the present study and provide confirmation of postoperative changes in tear quality and ocular surface after cataract surgery.

In a study conducted by Oh et al., [21] in 2012, the authors investigated changes in tear film

and ocular surface after cataract surgery. In their study, they observed 48 eyes that underwent cataract surgery and found that corneal sensitivity decreased in the central and temporal areas on the first day after the operation but returned to normal by the end of the first month [21]. The Schirmer test showed no significant difference before and after surgery, but the tear breakup time (TBUT) had a significant decrease on the first day after surgery, which returned to the preoperative level by the end of the first month [21]. The authors also evaluated the mean goblet cell count through cytology and observed a decrease in cell density at all postoperative time points [21]. They concluded that this decrease in cellular density is the main cause of postoperative symptoms in patients due to trauma and toxic substances in the eye drops [21]. Contrary to this study, in our study, the TBUT measured by the Sirius device still showed a decrease at the end of the first month. It seems that the reason for this difference in TBUT between the two studies is due to the superior capabilities of the Sirius device compared to traditional methods of measuring TBUT.

There are various factors involved in cataract surgery that contribute to pathophysiology of postoperative dry eye. Corneal sensory nerve disruption, as the cornea has the highest density of sensory nerves in the body, is one of the factors that might contribute to postoperative dry eye [22]. Severing these nerves can lead to impaired wound healing, increased epithelial permeability, decreased epithelial metabolic activity, and loss of cytoskeletal structures [22]. Clinically, we can observe a decrease in corneal sensitivity along with reduced tear secretion, leading to dry eye [23-25]. Although corneal sensitivity returns to its preoperative state over time, the time of recovery is correlated with the size of the created wound, where larger incisions take longer for corneal sensitivity to return to its previous state [21, 25]. While it does not appear that the location of the incision effects dry eye, previous data suggest that its shape can be influential, as multiplanar incisions compared to single-plane incisions in patients without preoperative symptoms can induce dry eye signs [26].

One of the other influential factors in increasing inflammatory mediatores is the stimulation of the ocular surface during cataract surgery [27]. This stimulation can induce an inflammatory response and the accumulation of neutrophils and macrophages, leading to the production of chemical factors such as free radicals, proteolytic enzymes, and cyclooxygenases [28,29]. These factors can damage ocular surface structures and cause tear film changes. In addition, local anesthetics and preservative-containing eye drops before and after surgery have been suggested as factors that contribute to inflammatory reactions [30,31]. The reduction in goblet cell production can jeopardize tear film integrity and lead to evaporative dry eye. Studies have shown a decrease in goblet cell density after cataract surgery [32]. The mechanism behind this phenomenon is still debated, with some attributing it to improper eye drops use, while many others believe inflammation is the most likely culprit [21,32,33]. Dysfunction of the meibomian glands is another known factor for post-cataract surgery dry eye. The secreted lipids from these glands effectively prevent tear evaporation during blinking, and it seems that cataract surgery can impact the secretion of these glands [22]. The exact mechanism of meibomian gland dysfunction after surgery is not yet fully understood, however inflammation, bacterial colonization, and topical medications containing preservatives play a role in this condition [32,34,35].

In a study conducted by Park et al.,[36] in

2016, the effects of cataract surgery on the ocular surface were examined in 48 eyes. Patients' symptoms worsened in the follow-ups at one and two months after surgery, but tear breakup time (TBUT), corneal staining score, and sensation gradually improved in the first and second months [36]. Additionally, factors such as IL-1β, IL-6, IL-8, MCP-1, TNF-α, and IFN-γ decreased at the end of the first and second months [36]. The quality of meibomian gland secretion was also reduced after surgery [36]. They concluded that although the changes associated with unstable tears are significant after surgery, they return to the preoperative state over time, while the quality of meibomian gland secretions does not, and it remains a factor in long-term symptoms among patients [36].

This study had some limitations including a short follow-up duration and lack of quantitative evaluation of meibomian gland function.

Conclusion

This study results suggest that cataract surgery is a predisposing factor for increased dry eye symptoms and can exacerbate the severity of the disease in patients with a history of dry eye.

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Footnotes and Financial Disclosures

Conflict of interest:

The authors have no conflict of interest with the subject matter of this manuscript.