Original Research Report

FERNING AND SCHIRMER TEST 1 FOR THE DETECTION OF GRADING SEVERITY OF DRY EYE SYNDROME IN POST PHACOEMULSIFICATION PATIENTS

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ABSTRACT

Dry eye syndrome is a multifactorial disease on the surface of the eyeball characterized by loss of tear film homeostasis, which is associated with eye symptoms, where there is tear instability and hyperosmolarity, inflammation, and damage to the surface of the eye, as well as neurosensory disorders that act as the cause of this syndrome. The aim of this study was to identify relationship between the Ferning pattern and the Schirmer test 1 in post-phacoemulsification patients. The design of this study was an analytical observational study with a cross-sectional data collection method where the Ferning and Schirmer test 1 were examined to determine the severity of dry eye syndrome in post-phacoemulsification patients. The Ferning test was assessed according to Rolando's classification. In this study, it was found that the gender who suffer from dry eye syndrome are women. The most considerable age is age ≥ 60 years (56,7%). The results showed that the majority of patients experienced dry eyes measured with the Ferning test, and these results were following the previous Schirmer Test 1 examination. The Ferning and Schirmer tests were found to be abnormal in most of the subjects. It was found that there was a significant relationship between the Ferning pattern and the Schirmer test with the calculation of the t-value of 7.345 with a p-value of 0.001. There was a statistically significant difference between the results of Ferning and the Schirmer test in post-phacoemulsification patients.

Keywords: *Ferning test; Schirmer test; dry eye syndrome; phacoemulsification; illness*

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Highlights:

1. Females were the most gender who suffer from dry eye syndrome than males.
2. Undergone phacoemulsification patients had frequent dry eye syndrome.
3. Post-phacoemulsification patients were not statistically significant between the Ferning and the Schirmer test.

INTRODUCTION

Based on Tear Film Ocular Surface Dry Eye Workshop II (TFOS DEWS II) in 2017, dry eye syndrome is a multifactorial ocular surface disease characterized by loss of tear film homeostasis and is accompanied by symptoms of tear instability and hyperosmolarity, inflammation, and damage to the ocular surface, and neurosensory abnormalities. Symptoms that often appear are a scratchy or gritty sensation. Other symptoms are itching, secretions of excess mucus, inability to produce tears, burning sensation, photosensitivity, redness, pain, and difficulty moving the eyelids. Dry eye syndrome increases with age and occurs when the tear film is disrupted due to decreased production of excess water and evaporation of tears (Galor et al. 2011, Cantor et al. 2014).

The prevalence of dry eye syndrome varies from 4.3% to 75% in some populations. The prevalence of dry eye syndrome in Asia varies from 21% to 73.5% using a questionnaire (Chia et al. 2003, Schaumberg et al. 2003, Stapleton et al. 2017). The prevalence of dry eye syndrome is higher in the elderly because of inadequate tear production due to lacrimal gland dysfunction, impaired secretory reflexes, or inflammation of the lacrimal gland. Dry eye syndrome can be assessed with several examinations, such as Schirmer and Ferning test.

Schirmer test is a tear volume assessment test. Schirmer test is performed by placing a paper strip in the lateral third of the lower eyelid after drying the inferior fornix and then measuring the length of the moistened portion of the strip after 5 minutes. The Schirmer I test is performed without anesthesia that measures basic and reflex tearing. The Schirmer II test is done following nasal stimulation that measures reflex tearing only. Ferning test is a tear quality assessment test by examining the tear pattern under a microscope. The pattern of the tear depends on the composition of the tear sample. The Ferning test may be a simple test to assess tear quality (Masmali et al. 2014, Alanazi et al. 2019, Tribowo et al. 2021).

Cataracts are the opacity of the lens and the leading cause of blindness worldwide, which is 35.15%.

Cataracts are divided into metabolic cataracts, congenital cataracts, and age-related cataracts. Older people are also at risk of developing lens opacification and cataracts. The prevalence of cataracts at the age of more than 74 years is 38.3% for men and 45.89% for women (Jick 2019). The procedure of cataract extraction is definitive therapy to resolve blindness due to cataracts, where the technique 'phacoemulsification' is a popular cataract extraction surgical technique at this time (Zhang & Li 2010, Jick 2019, Shi et al. 2022)**.**

Phacoemulsification describes the patient who lies on his back on the operating table, with the patient's head flattened and pointed at an overhead microscope. In 1967, Dr. Charles D. Kelman revolutionized cataract surgery with the introduction of phacoemulsification which is now the safest and most preferred technique for cataract surgery to ensure high volume, high quality, and affordable medical care (Hunter 1995), while in 1993, Nagahara introduced a number of modifications to this technique, including the stop-and-chop (Koch & Katzen 1994), drill-chop (Kim & Jang 2012), nucleofractis (Gimbel 1991), pocket-chop (Braga-Mele & Mednick 2016), crater-and-split (Aslan et al. 2012), cross-chop (Kim 2009), crater-and-chop (Vanathi et al. 2001), multilevel chop (Vasavada & Raj 2011), lift and crack (Cakir & Utine 2010), and retrochop techniques (Falabella et al. 2013, Joshi 2022).

The phacoemulsification technique uses ultrasonic technology and a vacuum to emulsify and aspirate the crystalline lens through a very small corneal incision reducing the risk of serious complications associated with wound and vitreous leak**.** This routine technique can be a challenge in medical conditions such as orthopnea, scoliosis, Meniere's disease, kyphosis, and CNS abnormality (Zhang & Li 2010, Jick 2019, Brayan et al. 2022)**.**

MATERIALS AND METHODS

The design of this study was an analytical observation method for cross-section data collection. This test was performed at Chevani Tebing Tinggi General Hospital. The sample of the study consisted of 30 patients who had undergone phacoemulsification at Chevani Tebing Tinggi General Hospital. The sample selection criteria for this study were patients less than a year old who had undergone phacoemulsification and patients aged 18 or older who were willing to become study samples. The exclusion criteria were patients with eye infections, patients with a history of previous eye trauma, patients with a history of previous eye surgery, and patients with systemic diseases, such as diabetes mellitus. Before conducting the research, we gave written informed consent to the research subjects after conducting an explanation beforehand. The stages of sample taking from the Ferning test are (a) the patients are requested to look up, (b) tears are obtained by sweeping Schirmer's paper over the inferior conjunctival fornix and placed on a slide, allowed to dry for a few minutes, and (c) examined under a microscope.

Ferning's pattern is examined with a microscope using 10x and 40x magnification. The classification of tear Ferning patterns consist of 4 types and it relies on assessing the spacing between the branches in the ferns. In Type I, the ferns are closely packed with no spaces between the branches. In Type II, the ferns are smaller and have gaps between the branches. In Type III, the ferns are small and incompletely formed with rare or no branching and the gaps become larger and wider, and in Type IV the Ferning phenomenon is absent.

Stages of sampling in Schirmer I test determination is performed by putting Schirmer paper folded end first in the inferior conjunctival fornix lateral 1/3 for 5 minutes then measuring. The Schirmer I values taken as the study sample were >5 mm and <10 mm. All data are analyzed using the Statistical Product and Service Solution (SPSS version 23 with a 95% confidence level. All categorical data are presented in percentage form. A Chi-square test is performed to determine the relationship between the results of the Ferning test and Schirmer test in dry eye syndrome. The T-test is performed to determine the difference between the results of the Ferning test and the Schirmer test. The p-value <0.05 are considered significant.

RESULTS

Samples of 30 patients who had undergone phacoemulsification have been obtained and have been examined with Schirmer I test and Ferning test on the eyes that had been operated on. As an initial measure, visual acuity was examined in the patient's eyes, then a Schirmer I test was performed, followed by a Ferning test.

In Table 1, the frequency distribution of patients based on age is greatest at the age of 60 years, consisting of 17 patients (56.7%), and at age 50 – 59 years of 13 subjects (43.3%). Most of the patients were female with a total of 17 subjects (56.7%) and male 13 subjects (43.3%). In this study, the frequency distribution of the eye that received phacoemulsification in the right eye and left eye was the same, with 15 subjects each (50.0%). The distribution of the frequency of greatest visual

acuity from the patients was > 6/60 in 26 subjects (86.7%), 1/60 – 6/60 in three subjects (10.0%), and 1/300 in one subject (3.3 %) respectively.

Table 1. Characteristics of research subjects

Characteristics	n	%
Age (years)		
50 – 59	13	43.3
≥ 60	17	56.7
Gender		
Male	13	43.3
Female	17	56.7
Phacoemulsification action		
Right eye	15	50.0
Left eye	15	50.0
Visual acuity		
> 6/60	26	86.7
1/60 - 6/60	3	10.0
1/300	1	3.3
Total	30	100.0

Table 2. Frequency distribution of Ferning test results

Ferning test results	n	%
Type 1	8	26.7
Type 2	4	13.3
Type 3	11	36.7
Type 4	7	23.3
Total	30	100.0

Table 2 shows that most of the groups belonged to type 3, comprising 11 patients (36.7%), type 1 eight patients (26.7%), type 4 seven patients (23.3%), and type 2 four patients (13.3%) respectively.

Table 3. Frequency distribution of Schirmer test results

Schirmer test results	n	%
< 10 mm	23	76.7
> 10 mm	7	23.3
Total	30	100.0

Table 3 shows the results of the Schirmer test. Most of the patients had results <10 mm in 23 patients (76.7%), followed by > 10 mm in seven patients (23.3%).

Table 4. Incidence of dry eye syndrome

Dry eye syndrome	n	%
Yes	18	60.0
No	12	40.0
Total	30	100.0

As many as 18 patients (60%) of this study sample had dry eye syndrome and 12 patients (40%) did not have dry eye syndrome.

Table 5. Relationship between Ferning test results and dry eye syndroame

Ferning test results	Dry eye syndrome				Total		p value
	Yes		No				
	n	%	n	%	n	%	
Type 1	0	0.0	8	100.0	8	100.0	
Type 2	0	0.0	4	100.0	4	100.0	0.00
Type 3	11	100.0	0	0.0	11	100.0	1
Type 4	7	100.0	0	0.0	7	100.0	
Total	18	60.0	12	40.0	30	100.0	

It is known that all types 1 and 2 did not have dry eye syndrome, and all types 3 and 4 had dry eye syndrome. The p-value was obtained at 0.001 (< 0.05), which means that there was a significant relationship between the results of the Ferning test and dry eye syndrome in post-phacoemulsification patients.

Table 6. Relationship between Schirmer test results and dry eye syndrome

Schirmer test results	Dry eye syndrome				Total		p value
	Yes		No				
	n	%	n	%	n	%	
< 10 mm	11	47.8	12	52.2	23	100.0	
> 10 mm	7	100.0	0	0.0	7	100.0	0.024
Total	18	60.0	12	40.0	30	100.0	

The results of the Schirmer test < 10 mm who had dry eye syndrome were 11 subjects (47.8%). The p-value was obtained at 0.024 (< 0.05), indicating a significant relationship between the results of the Schirmer test and dry eye syndrome in post-phacoemulsification patients.

Table 7. The difference in the results of the Ferning test Schirmer test

Ferning test - Schirmer test	t	Sig.
	7.345	0.001

The calculated t-value was 7.345 with a p-value of 0.001, which could be concluded that statistically there was a significant difference between the results of the Ferning test and the Schirmer's test in post-phacoemulsification patients.

DISCUSSION

In this study, females were more likely than males to experience dry eye syndrome. This was in line with result obtained by Noor et al. (2020) at the Jakarta Eye Center. Meanwhile, the highest age was found to be

61.3 years (50-70 years). This was in accordance with a study conducted by Bobrow (2011), where the incidence of cataracts increased to about 50% in individuals aged 65-74 years and 70% in individuals aged over 75 years.

This study found that the frequency distribution of the Ferning test results was greatest in type 3, which consisted of 11 subjects (36.7%), and the frequency distribution of the Schirmer test results <10 mm in 23 subjects (76.7%). There was a significant difference between the results of the Ferning test and the Schirmer test, where the t-value was 7.345, and the p-value was 0.001. Besides, the Schirmer test technique is easier to apply than the Ferning test in detecting dry eye syndrome.

The Ferning test is an examination carried out to assess the mucus layer of the conjunctiva. Sampling is done by collecting tear fluid through a micropipette from the inferior meniscus and dripping it on the slide and allowed to dry through the evaporation process. To determine the diagnostic results of this examination, the picture of a microscope is classified into 4 types according to the classification of Rolando with type 1 and 2 are normal pictures, and type 3 and 4 as a picture of patients who had dry eye syndrome (Tsubota 2017).

This study found a significant relationship between the results of the Ferning test and dry eye syndrome in post-phacoemulsification patients. This indicates tear film disruption due to tear deficiency or excessive tear evaporation which causes damage to the interpalpebral surface of the eye and is associated with symptoms of eye discomfort. In conventional cataract surgery, a large incision is made at the limbus, denervating nearly half of the superior cornea. As a result, corneal desensitization occurs with various symptoms coupled with the presence of multiple sutures to close the wound, the need for longer antibiotics and steroids is required, exacerbating dry eye symptoms. In the current phacoemulsification operation, when many procedures are performed, the incision in the cornea is much smaller, resulting in less corneal denervation, thereby minimizing tear film disruption. In addition, the shorter duration of phacoemulsification surgery makes the ultrasound device exposure shorter and the visual rehabilitation faster making the tapering of topical drugs faster. However, both with conventional cataract surgery and phacoemulsification, there are still dry eye symptoms after surgery. Previous studies reported that both conventional cataract surgery and phacoemulsification caused or exacerbated dry eye and affected dry eye test scores up to three months postoperatively (Sinha et al. 2018).

The incidence of dry eye in postoperative phacoemulsification patients is associated with corneal denervation, which results from an incision in the clear cornea. The cornea is innervated by the long ciliary nerve which is a branch of the ophthalmic nerve (nervus V1). This nerve reaches the cornea via the limbus and travels radially forward in the stroma before branching off. Loss of innervation or denervation of the cornea results in reduced blink reflex and decreased tear production, leading to increased epithelial permeability, decreased metabolic activity of the epithelium, and inhibited wound healing. Other factors that influence the incidence of post phacoemulsification dry eye include topical anesthetics and eye drops containing preservatives such as benzalkonium chloride (BAC) which are known to affect the corneal epithelium.

Topical antibiotics containing preservatives are associated with inflammation of the ocular surface characterized by increased proinflammatory cytokines. Preservatives such as BAC have detergent-like properties that can damage the LAM fat layer, resulting in a decrease in surface tension with a consequent decrease in break-up time. This causes evaporation from the aqueous layer and in the long term facilitates superficial punctate epithelial erosion. In addition, preservatives can also damage the microvilli and tight junctions on the surface layer of the corneal epithelium, making it easier for epithelial erosion and increasing the risk of corneal ulcers. In the conjunctiva, besides damaging the conjunctival epithelium, BAC can also reduce goblet cells so that mucin production is also reduced which in turn causes the stability of LAM to be disturbed, causing dry eye symptoms. Thus the decrease in the number of tears in post-cataract surgery patients can be influenced by the use of topical drugs (Kaur et al. 2009, Chao & Lim-Bon-Siong 2017).

A previous study examining the degree of dry eye after phacoemulsification in cataract patients showed results on day 7 to day 30. There were 7 patients (14%) experiencing worsening dry eye symptoms 1 week after surgery which was marked by an increase in the degree of dry eye of the patient. A total of 16 (32%) patients had no change 1 week after phacoemulsification surgery. This previous study also found that the relationship between pre-phacoemulsification dry eye and dry eye 1 month after phacoemulsification had a p-value of 0.000, and indicated a significant relationship (Tarigan 2020). The 24th European Society of Cataract and refractive surgeons (ESCRS) congress also gave the same explanation regarding the pathogenesis of dry eye symptoms post phacoemulsification. Modern cataract surgery with the phacoemulsification technique involves an incision in the cornea, which cuts the corneal sensory nerves. This has the potential to

interfere with the sensory feedback mechanisms required for tear film stability and tear basal production. Disruption of this mechanism is thought to cause dry eye symptoms, and may even contribute to more complex conditions such as neurotrophic keratitis (Korb 2018).

However, a prospective study of the impact of surgery on phacoemulsification of dry eye symptoms performed at Harold Wood Hospital, Romford, Essex, UK, reported that there was no significant change in tear production six to eight weeks after cataract surgery in 50 eyes examined. However, a number of patients reported an increase in dry eye symptoms after surgery but this increase was not statistically significant (Naderi et al. 2020).

Exposure to light from operating lamps is also thought to be associated with postoperative dry eye. In addition, the use of ultrasound in cataract surgery can damage corneal structures, such as the epithelium, stroma, keratocytes, endothelium, and nerve plexuses. However, when compared with conventional cataract surgery, ocular surface complications are less common in phacoemulsification surgery (Ernawati et al. 2020).

Another study evaluated 23 patients with dry eye who underwent phacoemulsification. Although all patients reported sensations of discomfort and irritation that were more severe than before surgery even persisting 3-4 weeks after surgery, as well as minimal changes in Schirmer's test and TBUT, it was concluded that phacoemulsification was safe and there were only minimal complications in dry eye patients related to surgery. with age, with or without systemic disease**.** Changes in corneal sensitivity and tear film physiology in postoperative phacoemulsification patients. There was a decrease in corneal sensitivity and tear film immediately after phacoemulsification surgery. Although there is a trend toward full recovery, corneal sensitivity does not return to its preoperative state until 3 months postoperatively. However, tear film function improved within 1 month postoperatively (Eah et al. 2021).

A study had previously stated that dry eye can develop or worsen dramatically after cataract surgery if not treated promptly (Sahu et al. 2015), and this can occur one week after surgery and peak in about one month. In addition, misuse of eye drops is one of the main pathogenic factors that cause dry eye after cataract surgery (Zaidi 2013). However, the role of eye drops in the postoperative dry eye has not been confirmed in other studies.

Strength and limitation

This study can contribute to existing studies by providing more experiments utilizing Ferning and Schirmer tests. It strengthens the evidence for the validity of both tests in assessing dry eye syndrome among post-phacoemulsification patients. However, the limitation of this study was that it only had a small study population.

CONCLUSION

It was found that there was a significant relationship between the Ferning pattern and the Schirmer test with the calculation of the t-value of 7.345 with a p-value of 0.001. This study concluded that in post-phacoemulsification patients, there was a statistically significant difference between the outcomes of the Ferning and the Schirmer test.

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Conflict of interest

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Author contribution

TSH and RRL contributed in the conceptualization, design of the research, data analysis, and interpretation of the obtained results and collected the specimens and wrote the manuscript. TSH and LP were final check the manuscript.

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