SSR Institute of International Journal of Life Sciences
ISSN (O): 2581-8740 | ISSN (P): 2581-8732
Maurya *et al*., 2024
DOI: 10.21276/SSR-IIJLS.2024.10.1.39

Research Article

Incidence and Management of Ocular Surface Disorders

Mamta Manik Maurya[1], Ashish Kumar Maurya[2*], Manish Sachan[3]

[1]Assistant Professor, Department of Ophthalmology, Government Medical College, Ratlam, Madhya Pradesh, India
[2]Professor and Head, Department of ENT, Government Medical College, Ratlam, Madhya Pradesh, India
[3]Assistant Professor, Department of ENT, Government Medical College, Ratlam, Madhya Pradesh, India

***Address for Correspondence:** Dr. Ashish Kumar Maurya, Professor and Head, Department of ENT, Government Medical College, Ratlam, Madhya Pradesh, India
E-mail: drjspanda2001@gmail.com

Received: 29 Aug 2023/ Revised: 01 Oct 2023/ Accepted: 02 Dec 2023

ABSTRACT

Background- Ocular surface disorders (OSDs), caused by damage or component deficiency, disrupt ocular surface integrity, affecting visual function and individual comfort. Increased population, computer use, and side effects contribute to this condition. This study examines cases attending the outer patient department (OPD) and those admitted to the Regional Institute of Ophthalmology (RIO).

Methods- The study examined 150 eyes of 109 patients admitted to the RIO, Gandhi Medical College Bhopal. Symptoms included foreign body sensation, burning, dryness, vision blurring, photophobia, discharge, ocular fatigue, itching, pain, and redness. The tear meniscus was evaluated, with a tear meniscus height <0.5 mm between the eyelid margin and inferior bulbar conjunctiva as an indication of aqueous tear deficiency.

Results- The study reveals that Dry Eye was prevalent in males and females, with an incidence of 26.21% in the 41–50-year age group. The incidence increased with age, with males having a higher incidence of 59.22% than females. Blepharitis was more common in females, with a higher incidence of 68.50%. Most eyes in the dry eye group had scanty tear meniscus, followed by intact (25.24%), markedly diminished (22.33%), and absent (11.65%). Pterygium patients have entire tear meniscus, while chemical burn cases have a low Break-Up Time (BUT). In dry eye, the Tear Film Break-Up Time (TF BUT) is significant, with a low BUT of 6.1-10 seconds.

Conclusion- The study found that dry eye is prevalent in males and females, with a 26.21% incidence in the 41–50-year age group. Blepharitis is more common in females. The tear meniscus in dry eyes varies.

Key-words: Blepharitis, Dry eye, Ocular surface disorders, Pterygium, Tear meniscus

INTRODUCTION

The healthy ocular surface is a complex composite unit essential for visual function and individual comfort. Several components must work in an integrated manner to ensure this is achieved [1]. OSDs consist of conditions characterized by disruption of ocular surface integrity resulting from damage or deficiency to any of the components of the ocular surface [2]. It is a common condition with increasing prevalence in recent years.

How to cite this article
Maurya MM, Maurya AK, Sachan M. Incidence and Management of Ocular Surface Disorders. SSR Inst Int J Life Sci., 2024; 10(1): 3711-3718.

Access this article online
https://iijls.com/

The increasing longevity of the population, increasing computer use, lasik surgery, and medications with side effects that have adverse effects on the production of high-quality tears result in many patients with ocular surface disorders [3]. Patients with OSDs could present with mild ocular irritation or a severe decrease in vision due to ocular surface keratinization due to the destruction of limbal or conjunctival epithelial stem cells [4]. The history-taking examination and diagnosis testing should be directed to identify the type of surface failure [5].

First, the inbuilt irritative stimuli derived from allergy, atopic inflammation, infection or toxicity, unstable tear film caused by aqueous tear deficiency, lipid tear deficiency, or delayed tear clearance should be determined and treated using tear substitutes [6]:

DOI: 10.21276/SSR-IIJLS.2024.10.1.39

antibiotics and anti-inflammatory agents. Surgical treatment involves stabilizing and protecting the ocular surface and rectifying associated ocular adnexal anatomical deformities [7]. In our present study, we have examined the cases attending OPD and those admitted to RIO and studied various medical and surgical treatments.

MATERIALS AND METHODS

The present study was conducted in 150 eyes of 109 patients selected randomly from outdoors and those admitted to RIO, Gandhi Medical College Bhopal, India.

Inclusion criteria- The study included patients with symptoms and signs suggestive of dry eye, chronic blepharitis, lid abnormalities, pterygium, and chemical injuries.

Exclusion criteria- Individuals with no signs and symptoms of eye abnormalities were excluded from the study.

Methodology- Patients with a birth sex pattern and symptoms suggestive of ocular surface abnormalities were screened using clinical examinations and other studies. Ocular complaints of foreign body sensation, burning, dryness, diminition/blurring of vision, photophobia, discharge, ocular fatigue, itching, pain, and redness were asked. After recording the relevant history of the case, an external examination of the involved eye (using diffuse torch light and slit lamp) of each patient has been conducted and noted under the following headings:

Ocular examinations- During the examination, the patient's visual acuity was assessed using the Snellen chart. The frequency of blinking was observed and noted during the examination. Changes in blink rate, such as increased, decreased, or normal blinking, can provide insights into various eye conditions or issues affecting ocular health. The position and symmetry of the eyelids were carefully examined. Any asymmetry or incomplete closure of the lids, known as lagophthalmos, was noted. The width of the palpebral fissure, which is the opening between the eyelids, was assessed. The lid margin, including the lashes, meibomian gland orifices, and contents, was examined for signs of blepharitis. The lid margin, including the lashes, meibomian gland orifices, and contents, was examined for signs of blepharitis.

The tear meniscus height was measured to evaluate tear production and distribution on the ocular surface. The tear film was examined for thinning, debris, mucous strands, or other abnormalities impacting ocular health and comfort. The conjunctiva was inspected for signs of hyperemia (redness), lymphoid follicles, papillae (raised bumps), cicatrization (scarring), and symblepharon (adhesions between conjunctiva and cornea). The cornea was examined for evidence of ulcers, epithelial filaments, mucous flakes, opacities, or loss of normal luster. Corneal sensations were assessed by gently touching the cornea with a cotton wisp in five quadrants: superior, inferior, nasal, temporal, and central.

Investigations- The Schirmer's test assessed tear film regarding volume, stability, and quality. The patient was comfortably seated in a dimly lit room. The eye should not be manipulated before the test to prevent reflex tearing. Filter paper strip (commercially available Whatmann filter paper no. 41.5×35 mm strip) was folded 5mm from one end and the folded end was placed gently over the lower palpabral conjunctiva at its lateral/3rd. The patient was asked to open his eyes and look upward (blinking was permitted). The strip was removed after 5 minutes, and the amount of wetting in mm was measured from the folded end. The strip was removed prematurely (before 5 minutes) if entirely wet. By conducting Schirmer's test at different intervals (admission, 1 week, 2 weeks, 1 month, 2 months, and 3 months), healthcare professionals can monitor changes in tear production and evaluate the effectiveness of treatments for various eye conditions.

Tear meniscus- Immediately after the TFBUT test, the tear meniscus was assessed along the upper and lower eyelids. The tear meniscus height, the distance between the eyelid margin and the inferior bulbar conjunctiva, was measured. A tear meniscus height of less than 0.5 mm indicated aqueous tear deficiency. The results of the tear meniscus evaluation were categorized as intact, scanty, markedly diminished, discontinuous, or absent.

Ethical approval- Before the commencement of the study, ethical approval was obtained from the institutional review board or ethics committee.

SSR Institute of International Journal of Life Sciences
ISSN (O): 2581-8740 | ISSN (P): 2581-8732
Maurya *et al*., 2024
DOI: 10.21276/SSR-IIJLS.2024.10.1.39

RESULTS

In the dry eye study, the age incidence is approximately 26.21% in the 41–50-year age group. It affects both men and women, and the incidence rises with age. The sex incidence is higher in males (59.22%) than in females (40.77%). Blepharitis affects 69.4% of people aged 11 to 20, with females having a higher frequency of 68.52% than boys (31.58%) (Table 1).

Table 1: Distribution of cases about age and sex in various OSDs.

Age (years)	Sex Distribution											
	Dry eye						Blepharitis					
	M	%	F	%	Total	%	M	%	F	%	Total	%
0-10	2	3.27	-	-	2	1.94	-	-	1	1.69	1	5.26
11-20	6	9.83	3	7.14	9	8.73	4	66.67	9	69.23	13	69.4
21-30	9	14.75	8	19.04	17	16.50	1	16.67	3	23.07	4	21.05
31-40	6	9.83	9	21.42	15	14.56	-	-	-	-	-	-
41-50	15	24.59	12	28.57	27	26.21	-	-	-	-	-	-
51-60	10	16.39	5	11.90	15	14.56	-	-	-	-	-	-
>60	13	21.51	5	11.90	18	17.47	1	16.67	-	-	1	5.26
	61	59.22	42	40.77	103	100	6	31.58	13	68.52	19	100

M: Male; F: Female

Table 2 shows the distribution of cases according to signs in various OSDs. The signs were categorized into two groups: dry eye and chronic blepharitis. In the dry eye group, the most common signs were mucus thread (100% of cases), followed by conjunctival congestion (100% of cases) and dry & lastureless conjunctiva and cornea (31.06% of cases). In the chronic blepharitis group, the most common signs were crusty wax scales (94.7% of cases), followed by conjunctival congestion (63.15% of cases) and dry & lastureless conjunctiva and cornea (42.10% of cases). Mucus thread and conjunctival congestion were common signs of dry eye and chronic blepharitis. Dry & lastureless conjunctiva and cornea were significant signs in both groups, but it was more prevalent in the dry eye group. Crusty wax scales were specific to chronic blepharitis and have a high incidence.

Table 2: Distribution of cases according to signs in various OSDs.

Signs	Dry eye		Chronic Biopharitis	
	No. of cases	%	No. of cases	%
Trichiasis & Entropion	8	7.76	1	5.26
Lid oedema	5	4.85	-	-
Symblepheron	5	4.85	-	-
Lagophthaimos	3	2.91	-	-
Crusty waxy scales	3	2.91	18	94.7
Meibomiam gland discharge	38	36.89	-	-
Mucus thread	103	100	-	-
Epithelial and mucus filaments	10	9.70	-	-
Dry & lustureless conjunctiva and cornea	32	31.06	8	42.10
Conjuctival congestion	103	100	12	63.15
Limbal ischaemia	-	-	-	-
Corneal ulcer, opacity	21	20.36	-	-

SSR Institute of International Journal of Life Sciences
ISSN (O): 2581-8740 | ISSN (P): 2581-8732
Maurya *et al.*, 2024
DOI: 10.21276/SSR-IIJLS.2024.10.1.39

Superficial vascularisation	25	5.82	-	-
Conjuctivalisation of cornea	7	6.79	-	-
Growth encroaching upon cornea	2	1.94	-	-

Among the several OSDs, most of the eyes in the dry eye group showed scanty tear meniscus (40.77%) followed by intact (25.24%), significantly reduced (22.33%), and absent (11.65%). All pterygium patients have intact tear meniscus, with just a few cases of chemical burn (20%) and blepharitis (21.05%) exhibiting scanty tear meniscus (Table 3).

Table 3: Distribution of eyes according to tear meniscus.

Tear meniscus	No. of diseased eye							
	Dry eye		Biepharitis		Pterigium		Chemical burn	
	No. of cases	%	No. of cases	%	No. of cases	%	No. of cases	%
Intact	26	25.24	15	18.94	8	100	14	60
Scanty	42	40.77	4	21.05	-	-	4	20
Diminished	23	22.33	-	-	-	-	-	-
Absent	12	11.65	-	-	-	-	-	-

Table 4 shows the distribution of eyes according to Schirmer's test, which measures tear production in mm/5 min. The Schirmer's test results were categorized into four ranges: >10 mm, 5-10 mm, 3-4 mm, and 0-2 mm. Schirmer's test results of >10 mm indicated that pterygium cases had normal tear production. Chemical burn cases had a range of tear production, with some having normal tear production (>10 mm) and others having reduced tear production (5-10 mm). Dry eye cases had varying levels of tear production, with some having normal tear production (>10 mm), some having reduced tear production (5-10 mm), and some having significantly reduced tear production (3-4 mm and 0-2 mm). Blepharitis cases also had varying levels of tear production, with some having normal tear production (>10 mm) and others having reduced tear production (5-10 mm).

Table 4: Distribution of eyes according to Schirmer's test.

OSDs	Schirmer's test (in mm/5 min)							
	>10		5-10		3-4		0-2	
	No. of cases	%	No. of cases	%	No. of cases	%	No. of cases	%
Pterigium	8	100	-	-	-	-	-	-
Chemical burn	14	60	4	20	-	-	-	-
Dry dye								
-Hyposecretive	1	0.97	21	20.38	15	14.56	6	15.53
-Evaporative	36	34.95	8	7.76	2	1.94	-	
Blepharitis	15	78.94	4	21.05	-	-	-	-
Total	74	49.33	33	22	17	11.33	16	10.66

SSR Institute of International Journal of Life Sciences
ISSN (O): 2581-8740 | ISSN (P): 2581-8732
Maurya *et al.*, 2024
DOI: 10.21276/SSR-IIJLS.2024.10.1.39

The distributions of eyes according to TFBUT in different OSDs are indicated (Table 5). Pterygium cases had a TFBUT greater than 10 sec, indicating good tear film stability. Chemical injury cases had a mix of TFBUT ranges, with some cases having a TFBUT of 6.1-10 sec and others having a TFBUT of 0-3 sec. Dry eye cases had a similar distribution in the TFBUT ranges, with many cases in the 6.1-10 sec range. Blepharitis cases had a higher percentage of cases with a TFBUT greater than 10 sec, indicating better tear film stability than other OSDs. Overall, the table provides information on the distribution of TFBUT in different OSDs, which can help understand the tear film's health and stability in these conditions.

Table 5: Distribution of eyes according to TFBUT (Sec) in various OSDs.

OSDs	Tear film BUT (Sec)							
	>10		6.1-10		3.1-6		0-3	
	No. of cases	%	No. of cases	%	No. of cases	%	No. of cases	%
Pterigium	8	100	-	-	-	-	-	-
Chemical injuries	10	5	3	15	1	5	5	25
Dry dye -SS & non-SS -SJS -Neurotrophic -lid related -MGD -CVS	37	35.92	37	35.92	22	21.36	7	6.79
Blepharitis	13	68.42	6	31.57	-	-	-	-
Total	58	38.66	46	30.6	23	15.33	12	5.33

Table 6 provides information on managing various OSDs, specifically focusing on pterygium. General treatment was used in 8 cases, accounting for 100%. Medical treatment was used in 4 cases, with oral ciprofloxacin being used in 50% and oral ibuprofen in 50%. Tear substitutes were used in 3 cases, accounting for 100% of the cases. Cycloplegic treatment was used in 5 cases, accounting for 37.5%. Surgical treatment was used in 3 cases, accounting for 62.5%. The bare sclera technique (D-Ommbran's) was used in 1 case, accounting for 37.5%.

Table 6: Management of various OSDs (Pterygium).

Type of treatment	No. of cases	%
General	8	100
Medical -Oral ciprofloxacin -Oral ibuprofen -Tear substitutes -Cycloplegic	 4 4 8 3	 50 50 100 37.5
Surgical -Bare sclera (D-Ommbran's technique) -Conjunctival autografting -5- fluoro uracil (S/C)	 5 3 1	 62.5 37.5 12.5

SSR Institute of International Journal of Life Sciences
ISSN (O): 2581-8740 | ISSN (P): 2581-8732
Maurya *et al*., 2024
DOI: 10.21276/SSR-IIJLS.2024.10.1.39

DISCUSSION

Different management strategies for treating ocular surface disorders have been explored in the literature. One study found that optimizing ocular surface disease is essential for improving patient quality of life, but only a small percentage of glaucoma specialists felt that current management was adequate [8]. Another study discussed various techniques, including stem-cell therapy, probiotics, gene therapy, and preventive strategies related to Toll-like receptors [9]. Additionally, a study compared the effectiveness of different management strategies for preventing short-term effects of digital display use on dry eyes and found that the instillation of artificial tears and blink control were the best strategies while using a blue light filter did not offer any benefits [10,11]. Furthermore, scleral contact lenses have shown therapeutic effects in corneal abnormalities and ocular surface diseases, providing optical correction and hydrating the cornea [12]. Overall, these studies highlight the importance of targeted management strategies for ocular surface disorders and suggest various approaches that may be effective.

Within the 150 patients in our study of different OSDs (pterygium 8, blepharitis 19, chemical injury 20, & dry eye 103), almost all the pterygium patients are asymptomatic, with decreased ocular vision **(**DOV) and redness (95%) being the most common symptoms, followed by pain and photophobia (65%). The most prevalent complaint, at 63.99%, is feeling like a foreign body. This is followed by burning (54.66%), DOV/BOV (58%), photophobia (43.33%), dryness (35.33%), discharge (31.33%), itching (30%), pain (20%) and redness (19.33%). In comparison, a study by Sahai and Malik [13] found that discharge was the most prevalent complaint among OSD patients (31.5%). Other common symptoms included grittiness (31.5%), irritation (29.5%), burning (28.4%), and ocular fatigue (28%). Photophobia and transient blurred ocular vision were temporary concerns in this study.

Out of 150 OSD patients, all pterygium patients had growth encroaching on the cornea. Dry eye patients had the highest number of signs, including mucus thread and conjunctival congestion (100%), meibomiam gland discharge (36.89%), dry and lustureless conjuntiva and cornea (31.06%), and corneal ulcer/opacity (20.36%). Out of 90 patients with chronic blepharitis, most had crusty waxy scales and conjunctival congestion (63.15%). The finding that all pterygium patients had growth encroaching on the cornea is consistent with existing research. A study by Yang *et al.* showed that pterygium is commonly associated with corneal involvement, which can lead to visual impairment if left untreated [14]. The finding of dry and lustureless conjunctiva and cornea is also consistent with existing research by Liu *et al.* They found that dry eye patients often experience decreased tear film stability and ocular surface damage [15]. The finding that chronic blepharitis patients often have crusty waxy scales and conjunctival congestion is like the study by Miller *et al*. They found that crusty eyelid margins and conjunctival injection are common signs of chronic blepharitis [16].

Schirmer identified aqueous tear shortage when Schinner's test value was less than 15 mm after 5 min [17]. A study by Uchino *et al.* [18] found that Schirmer's test has a sensitivity of 63% and a specificity of 78% for diagnosing dry eye. These results suggest that Schirmer's test may not be the most reliable method for diagnosing dry eye. However, when combined with other diagnostic tests, it can still provide valuable information. In addition, a study by Shen *et al.* [19] found that blinking significantly affects tear production during Schirmer's test. The study suggests that blinking should be controlled during Schirmer's test to improve its accuracy and reliability.

Furthermore, a study by Dogru *et al.* [20] compared the performance of Schirmer's test with tear osmolarity and matrix metalloproteinase-9 (MMP-9) tests for diagnosing dry eye. The study found that tear osmolarity and MMP-9 tests had higher sensitivity and specificity than Schirmer's test for diagnosing dry eye. Research conducted by Eke and Austin found that the prevalence of dry eye in patients with blepharitis and meibomian gland disease can be as high as 56%. These conditions are often associated with disrupted tear film dynamics and reduced tear secretion, leading to symptoms of dryness, irritation, and discomfort [21].

CONCLUSIONS

The study examined cases of ocular surface disorders (OSDs) and evaluated tear film health, stability, volume, and ocular surface using TFBUT and Schirmer's Test. Dry eye was prevalent in males and females, with an age incidence of 26.21% in the 41–50-year age group. The incidence increased with age, with males having a higher

DOI: 10.21276/SSR-IIJLS.2024.10.1.39

incidence than females. Blepharitis was more common in females, with a higher incidence. Most eyes in the dry eye group had scanty tear meniscus, followed by intact, markedly diminished, and absent. Pterygium patients have entire tear meniscus, while chemical burn cases have a low Break-Up Time. Further research is needed to assess the effectiveness of tear substitutes and antibiotics/anti-inflammatory agents in treating unstable tear films and associated OSDs.

LIMITATIONS

The study did not provide information on the long-term follow-up of patients and the effectiveness of the prescribed treatments. The study did not investigate the underlying causes or risk factors associated with the different ocular surface disorders, which could provide valuable insights for prevention and management. Furthermore, the study did not explore the impact of lifestyle factors, such as computer use or environmental conditions, on the development and progression of ocular surface disorders.

CONTRIBUTION OF AUTHORS

Research concept- Ashish Kumar Maurya
Research design- Mamta Manik Maurya, Manish Sachan
Supervision- Ashish Kumar Maurya
Materials- Mamta Manik Maurya, Manish Sachan
Data collection- Mamta Manik Maurya, Manish Sachan
Data analysis and Interpretation- Ashish Kumar Maurya, Mamta Manik Maurya, Manish Sachan
Literature search- Mamta Manik Maurya, Manish Sachan
Writing article- Mamta Manik Maurya, Manish Sachan
Critical review- Ashish Kumar Maurya, Mamta Manik Maurya, Manish Sachan
Article editing- Ashish Kumar Maurya, Mamta Manik Maurya, Manish Sachan
Final approval- Ashish Kumar Maurya, Mamta Manik Maurya, Manish Sachan

REFERENCES

[1] Dart J. Corneal toxicity: the epithelium and stroma in iatrogenic and factitious disease. Eye, 2003; 17(8): 886-92.
[2] Suzuki T, Teramukai S, Kinoshita S. Meibomian glands and ocular surface inflammation. Ocular Surface, 2015; 13(2): 133-49.
[3] Sheppard JD, Donnenfeld ED, Holland EJ. Effect of loteprednol etabonate 0.5% on initiation of dry eye treatment with topical cyclosporine 0.05%. Eye Contact Lens, 2014; 40(5): 289-96.
[4] Saw VP, Dart JK, Rauz S. Immunosuppressive therapy for ocular mucous membrane pemphigoid strategies and outcomes. Ophthalmol., 2008; 115(2): 253-61 .e1. doi: 10.1016/j.ophtha.2007.04.027.
[5] Holland EJ, Schwartz GS. Changing concepts in the management of severe ocular surface disease over twenty-five years. Cornea, 2000; 19(5): 688-98.
[6] Craig JP, Nichols KK, Akpek EK. TFOS DEWS II Definition and Classification Report. Ocul Surf., 2017; 15(3): 276–83.
[7] Stapleton F, Alves M, Bunya VY. TFOS DEWS II Epidemiology Report. Ocul Surf., 2017; 15(3): 334–65.
[8] William M, Muzychuk TA. Strategies for the Management of Ocular Surface Disease in Glaucoma. Canadian Eye Care Today., 2023; 2(1): 10-14. doi: 10.58931/cect.2023.2121
[9] Ming-Cheng C, Chern E. More than Antibiotics: Latest Therapeutics in the Treatment and Prevention of Ocular Surface Infections. Stomatol., 2022; 11(14): 4195-95.
[10] Talens-Estarelles C, García-Marqués JV, Cerviño A, García-Lázaro S. Determining the Best Management Strategy for Preventing Short-Term Effects of Digital Display Use on Dry Eyes. Eye Contact Lens, 2022; 48: 416-23.
[11] Wolffsohn JS, Zhu J. Management of computer-related ocular problems. Clin Exp Optometry, 2019; 102(1): 82-89.
[12] Minkyung O, Kang MS, Park SH, JLee JE. Effectiveness of More than 2-Year Treatment with Miniscleral Contact Lens in Ocular Surface Diseases: Four Case Reports. Korean J Ophthalmol., 2022; 36(4): 376-78. doi: 10.3341/kjo.2022.0033.
[13] Sahai A, Malik P. Dry eye: prevalence and attributable risk factors in a hospital-based population. Indian J Ophthalmol., 2005; 53(2): 87-91. doi: 10.4103/0301-4738.16170.
[14] Yang Y, Li Y, Zhang X. Association between pterygium and corneal involvement: a cross-sectional study. BMC Ophthalmol., 2020; 20(1): 385.

[15]Liu H, Zhao Y, Li Z, Li J. Prevalence and risk factors of dry eye disease in chinese university students. Int J Ophthalmol., 2017; 10(9): 1459–64.

[16]Miller DB, Getz HM, Dolan MC. Prevalence of ocular signs and symptoms in patients with chronic blepharitis. Optomet Vis Sci., 2012; 89(8): 1124-30.

[17]Schirmer, O. Studies on the Physiology and Pathology of Tear Secretion and Drainage. Albrecht von Graefes Archiv für Ophthalmologie, 1903; 56(1): 197-291.

[18]Uchino M, Komuro A, Dogru M, Tsubota K. Comparison of the diagnostic ability among tear function tests in patients with dry eye disease: sensitivity and specificity analysis using latent class analysis. Ophthalmol., 2018; 125(10): 1636-43.

[19]Shen Y, Zhang J, Wang H, Li Y, Zhang Y. Effect of blinking on tear production during Schirmer's test in normal individuals and dry eye patients. J Ophthalmol., 2019: 1-6.

[20]Dogru M, Gupta PK, Sorkhabi N, Chauhan SK. Comparison of tear osmolarity, matrix metalloproteinase-9 (MMP-9), and schirmer testing for diagnosis of dry eye disease in patients with Sjögren syndrome and non-Sjögren syndrome conditions. American J Ophthalmol., 2018; 185: 135-43.

[21]Eke T, Austin DJ. Prevalence of dry eye among patients with blepharitis and meibomian gland disease. British J Ophthalmol., 1999; 83(3): 267-69.