

COMPREHENSIVE EVALUATION OF MEIBOMIAN GLAND FUNCTION IN NEW VERSUS LONG TERM USERS OF TOPICAL ANTI-GLAUCOMA MEDICATIONS USING MEIBUM EXPRESSION AND TEAR FILM ANALYSIS

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Abstract

Background: The prolonged use of topical anti-glaucoma medications (AGM) can have negative impacts on the meibomian glands and the stability of tear-film, so it is important to compare meibum expression and tear-film parameters between new and long-term AGM users.

Objective: To comprehensively evaluate and compare meibomian gland function and tear film parameters in new versus long-term users of topical anti-glaucoma medications.

Method: A comparative cross sectional study was conducted in Sighton Optix Eye care centre, Lahore. Participants were sampled using non-probability consecutive sampling and divided into 2 groups based on the length of time they had been using topical anti-glaucoma medication: new users with ≤ 6 month of topical anti-glaucoma medication use and long-term users with ≥ 2 year of topical anti-glaucoma medication use. Tear break-up time (TBUT) was used to assess tear-film stability and the Schirmer I test (without topical anesthesia) was used to assess tear production. The data that were collected were coded for confidentiality and analysed using the IBM SPSS Statistics version 27.0. P value < 0.05 was taken as statistically significant.

Result: Among the 60 participants, the mean age was 60.63 ± 12.06 years, with females comprising 35 (58.3%) and males 25 (41.7%). Most participants had good adherence to treatment (49, 81.7%) and primary open-angle glaucoma was the most common diagnosis (38, 63.3%). The prevalence of MGD was high in both eyes with 44 (73.3%) participants showing MGD in right eye and 48 (80.0%) in left eye. The mean quality of meibum was 1.38 ± 0.42 vs. 0.88 ± 0.31 , upper lid gland loss was $23.93 \pm 3.98\%$ vs. $11.93 \pm 5.84\%$, lower lid gland loss was $26.22 \pm 4.95\%$ vs. $11.85 \pm 4.50\%$, OSDI score was 28.41 ± 8.91 vs. 18.90 ± 8.63 , and TBUT was 7.68 ± 1.34 vs. 10.46 ± 1.24 seconds in long-term versus new users, respectively (all $p < 0.001$). Long-term therapy was also significantly associated with the presence of MGD in both the right eye ($\chi^2 = 21.82$, $p < 0.001$) and left eye ($\chi^2 = 10.42$, $p < 0.001$).

Conclusion: The results showed that the prevalence of MGD was very high among patients treated with topical anti-glaucoma drugs, and that the degree of ocular surface dysfunction was higher among long-term anti-glaucoma users than among new users.

Introduction

Glaucoma is a progressive optic neuropathy and a major cause of irreversible visual impairment. Sustained reduction of intraocular pressure (IOP) remains the cornerstone of glaucoma management, commonly requiring long-term or lifelong use of topical medications such as prostaglandin analogues, beta-blockers, alpha-2 adrenergic agonists, and carbonic anhydrase inhibitors.[1] Meibomian glands produce meibum, a lipid-rich secretion that forms the outermost layer of the tear film. This lipid layer reduces aqueous tear evaporation and contributes to tear-film stability and ocular surface protection. Dysfunction of these glands can therefore result in increased evaporation, tear-film instability, ocular surface inflammation, and symptoms of dry eye disease (DED).[2]

Patients receiving topical anti-glaucoma therapy may be particularly susceptible to ocular surface abnormalities because of prolonged exposure to both active pharmaceutical agents and preservatives, especially benzalkonium chloride (BAK).[3] Chronic exposure to BAK may cause epithelial toxicity, oxidative stress, inflammation, and disruption of ocular surface homeostasis. Ocular discomfort associated with OSD may negatively affect quality of life and adherence to glaucoma treatment.[4]

Glaucoma represents a substantial global and regional health burden. An estimated 76 million people worldwide had glaucoma in 2020, with this number projected to increase to 111.8 million by 2040.[5] Approximately 60% of global glaucoma cases occur in Asia, where primary angle-closure glaucoma is particularly important. In South Asia, the pooled prevalence of glaucoma has been estimated at 2.1%, although population-based evidence from Pakistan remains limited.[6]

Meibomian glands are holocrine sebaceous glands located within the upper and lower tarsal plates. Their lipid secretion decreases tear evaporation and contributes to tear-film

stability, optical quality, and ocular comfort. MGD involves chronic glandular changes associated with duct obstruction and qualitative or quantitative abnormalities of meibum secretion.[7] Functional assessment of these glands can be performed through meibum expression and evaluation of meibum quality, while tear-film break-up time (TBUT) provides information regarding the functional consequences of meibomian gland impairment. Assessment of both parameters may therefore provide a more comprehensive evaluation than either measure alone.[8]

Despite increasing recognition of treatment-related ocular surface disease, important gaps remain. Previous research has frequently focused on dry-eye symptoms, tear-film abnormalities, ocular surface staining, or meibomian gland morphology, while comparatively fewer studies have directly evaluated the functional characteristics of meibum.[9] Evidence directly comparing newly treated patients with long-term users is also limited, making it difficult to determine whether observed abnormalities are primarily related to pre-existing ocular surface disease or develop progressively with prolonged topical therapy.[10] Furthermore, relatively few studies have combined direct assessment of meibum expressibility and quality with objective evaluation of tear-film stability.[11] Evidence from Pakistan is particularly limited regarding the relationship between duration of topical anti-glaucoma treatment, meibomian gland function, and tear-film stability.[12]

Therefore, a direct comparison of new and long-term users of topical anti-glaucoma medications may provide important insight into the relationship between treatment duration and ocular surface dysfunction. The present study aims to comprehensively evaluate and compare meibomian gland function, including meibum expressibility and quality, together with tear-film parameters in new versus long-term users of topical anti-glaucoma medications. This approach may help identify

treatment-associated changes and support earlier recognition and management of ocular surface complications in patients requiring chronic glaucoma therapy.

Methods

This comparative cross-sectional study was conducted at Sighton Optix Eye Care Centre, Lahore, over a period of six months following approval of the study synopsis. The sample size was calculated using G*Power version 3.1.9.7 for comparison of two independent means using an independent-samples t-test. Assuming a moderate-to-large standardized effect size (Cohen's $d = 0.80$), a two-sided significance level of 0.05, 80% statistical power, and an equal allocation ratio of 1:1, the required sample size was 52 participants (26 per group).[13] Participants were recruited using a non-probability consecutive sampling technique. Eligible participants included diagnosed glaucoma patients aged ≥ 40 years who were either new users of topical anti-glaucoma medication (≤ 6 months) or long-term users (≥ 2 years). Data collection was initiated after obtaining ethical approval from the Institutional Ethical Review Committee of The Superior University and written informed consent from all participants. Demographic characteristics and relevant medical history, including the type and duration of topical anti-glaucoma medication use, were recorded using a structured proforma. A slit-lamp examination was performed to evaluate the anterior segment and eyelid margins. Meibomian gland function was assessed clinically through evaluation of meibum quality and meibum expressibility. Meibum quality was assessed by applying gentle pressure to the central lower eyelid margin and grading the expressed secretion according to its appearance as clear, cloudy, granular, or toothpaste-like. Meibum expressibility was assessed by applying mild pressure to the eyelid and recording the number of glands from which meibum could be expressed. Tear-film stability was assessed using the tear-film break-up time (TBUT) test, while tear production was evaluated using the Schirmer I test without topical anaesthesia. The dependent variable was meibomian gland function, assessed using meibum quality grading and meibum

expressibility scoring based on standardized clinical assessment during slit-lamp examination. The independent variable was the duration of topical anti-glaucoma medication use.

Results

A total of 60 participants were included in the study, comprising 30 new users and 30 long-term users of topical anti-glaucoma medications. The baseline demographic and clinical characteristics of the participants are presented in Table 1. The mean age of participants was 61.83 ± 11.47 years in the new-user group and 59.43 ± 12.70 years in the long-term-user group. There was no statistically significant difference in age between the two groups ($p=0.482$). The mean duration of topical anti-glaucoma medication use was 3.21 ± 1.38 months among new users compared with 62.45 ± 25.11 months among long-term users. The mean number of anti-glaucoma medications was comparable between the two groups, being 1.60 ± 0.72 among new users and 1.53 ± 0.63 among long-term users ($p=0.823$). For the right eye, mean IOP was 15.06 ± 2.17 mmHg in new users and 15.42 ± 2.50 mmHg in long-term users ($p=0.554$). For the left eye, the corresponding values were 15.57 ± 2.70 mmHg and 15.27 ± 2.63 mmHg, respectively ($p=0.661$). Among new users, 17 (56.7%) were female and 13 (43.3%) were male. Among long-term users, 18 (60.0%) were female and 12 (40.0%) were male. A statistically significant difference was observed in the distribution of anti-glaucoma drug classes between new and long-term users ($p=0.042$). Prostaglandin analogues were the most frequently used drug class among new users, accounting for 17 (56.7%) participants, compared with 8 (26.7%) among long-term users. Combination therapy was used by 5 (16.7%) new users and 12 (40.0%) long-term users. Beta-blockers were used by 4 (13.3%) new users and 5 (16.7%) long-term users, whereas carbonic anhydrase inhibitors were used by 4 (13.3%) and 2 (6.7%), respectively. Alpha-agonists were not used among new users but were reported in 3 (10.0%) long-term users. The majority of participants in both groups were using BAK-containing formulations. BAK-containing

medications were reported in 21 (70.0%) new users and 22 (73.3%) long-term users. Other preservative-containing formulations were used by 8 (26.7%) new users and 6 (20.0%) long-term users, while preservative-free preparations were used by 1 (3.3%) and 2 (6.7%), respectively. There was no statistically significant difference in preservative status between the groups ($p=0.725$). Good treatment adherence was reported in 26 (86.7%) new users and 23 (76.7%) long-term users. Moderate adherence was observed in 3 (10.0%) new users and 7 (23.3%) long-term users, whereas poor adherence was reported in 1 (3.3%) new user and none of the long-term users. The difference in adherence between the groups was not statistically significant ($p=0.249$).

The meibomian gland parameters of the two study groups are presented in Table 2. The mean meibomian gland expressibility score was significantly different between new and long-term users in both eyes. In the right eye, the mean expressibility score was 0.47 ± 0.68 among new users compared with 1.70 ± 1.18 among long-term users ($p<0.001$). In the left eye, the corresponding values were 0.97 ± 1.07 and 2.03 ± 1.13 , respectively ($p<0.001$). A significant difference was also observed in meibum quality. The mean meibum quality score in the right eye was 0.71 ± 0.35 among new users and 1.55 ± 0.30 among long-term users ($p<0.001$). In the left eye, the mean scores were 0.88 ± 0.31 and 1.38 ± 0.42 , respectively ($p<0.001$). Meibomian gland loss was substantially greater among long-term users. Upper-lid gland loss in the right eye was $12.25 \pm 5.09\%$ among new users compared with $25.39 \pm 4.30\%$ among long-term users ($p<0.001$). Lower-lid gland loss in the right eye was $14.05 \pm 3.89\%$ and $27.02 \pm 5.99\%$, respectively ($p<0.001$). In the left eye, upper-lid gland loss was $11.93 \pm 5.84\%$ among new users compared with $23.93 \pm 3.98\%$ among long-term users ($p<0.001$). Lower-lid gland loss was $11.85 \pm 4.50\%$ among new users and $26.22 \pm 4.95\%$ among long-term users ($p<0.001$). The prevalence of MGD was also significantly different between the groups. In the right eye,

MGD was present in 14 (46.7%) new users compared with 30 (100.0%) long-term users ($p<0.001$). In the left eye, MGD was present in 19 (63.3%) new users and 29 (96.7%) long-term users ($p=0.004$).

The tear-film and ocular-surface findings are summarized in Table 3. Mean tear-film breakup time was significantly lower among long-term users in both eyes. In the right eye, TBUT was 10.38 ± 1.42 seconds among new users compared with 7.68 ± 1.31 seconds among long-term users ($p<0.001$). In the left eye, TBUT was 10.46 ± 1.24 seconds in new users compared with 7.68 ± 1.34 seconds in long-term users ($p<0.001$). The mean OSDI score was also significantly higher among long-term users. New users had a mean OSDI score of 18.90 ± 8.63 , whereas long-term users had a mean score of 28.41 ± 8.91 ($p<0.001$).

The relationship between duration of topical anti-glaucoma therapy and ocular-surface parameters was assessed using Spearman's rank correlation analysis. The results are presented in Table 4. Treatment duration demonstrated a statistically significant positive correlation with meibomian gland expressibility score in both eyes. The correlation coefficient was $\rho=0.543$ for the right eye ($p<0.001$) and $\rho=0.381$ for the left eye ($p=0.003$). A significant positive correlation was also observed between treatment duration and meibum quality score. The correlation was stronger in the right eye ($\rho=0.686$, $p<0.001$) than in the left eye ($\rho=0.464$, $p<0.001$). Treatment duration showed significant positive correlations with upper- and lower-lid gland loss in both eyes. Upper-lid gland loss correlated with treatment duration at $\rho=0.719$ in the right eye and $\rho=0.717$ in the left eye, both with $p<0.001$. Lower-lid gland loss showed correlations of $\rho=0.772$ in the right eye and $\rho=0.675$ in the left eye, also with $p<0.001$. A significant positive correlation was observed between treatment duration and OSDI score ($\rho=0.409$, $p=0.001$). In contrast, TBUT showed significant negative correlations with treatment duration. The correlation coefficient was $\rho=-0.600$ for the right eye and $\rho=-0.727$ for the left eye, with $p<0.001$ for both associations.

Table 1. Baseline Demographic and Clinical Characteristics of Study Participants

Variable	New Users (n=30)	Long-Term Users (n=30)	p-value
Age, years, mean ± SD	61.83 ± 11.47	59.43 ± 12.70	0.482
Topical therapy duration, months, mean ± SD	3.21 ± 1.38	62.45 ± 25.11	<0.001
Number of anti-glaucoma medications, mean ± SD	1.60 ± 0.72	1.53 ± 0.63	0.823
IOP OD, mmHg, mean ± SD	15.06 ± 2.17	15.42 ± 2.50	0.554
IOP OS, mmHg, mean ± SD	15.57 ± 2.70	15.27 ± 2.63	0.661
Sex, n (%)			
Female	17 (56.7)	18 (60.0)	1
Male	13 (43.3)	12 (40.0)	
Anti-glaucoma drug class, n (%)			
Prostaglandin analogue	17 (56.7)	8 (26.7)	0.042
Combination therapy	5 (16.7)	12 (40.0)	
Beta-blocker	4 (13.3)	5 (16.7)	
Carbonic anhydrase inhibitor	4 (13.3)	2 (6.7)	
Alpha-agonist	0 (0.0)	3 (10.0)	
Preservative status, n (%)			
BAK-containing	21 (70.0)	22 (73.3)	0.725
Other preservative	8 (26.7)	6 (20.0)	
Preservative-free	1 (3.3)	2 (6.7)	
Adherence, n (%)			
Good	26 (86.7)	23 (76.7)	0.249
Moderate	3 (10.0)	7 (23.3)	
Poor	1 (3.3)	0 (0.0)	

Abbreviations: BAK, benzalkonium chloride; IOP, intraocular pressure; OD, right eye; OS, left eye; SD, standard deviation. Continuous variables were compared using independent-samples t-test or Mann–Whitney U test according to distribution; categorical variables were compared using χ^2 test. $p < 0.05$ was considered statistically significant.

Table 2. Comparison of Meibomian Gland Function Between New and Long-Term Anti-Glaucoma Medication Users

Meibomian gland parameter	New Users (n=30)	Long-Term Users (n=30)	p-value
Expressibility score OD, mean $\pm$ SD	0.47 $\pm$ 0.68	1.70 $\pm$ 1.18	<0.001
Expressibility score OS, mean $\pm$ SD	0.97 $\pm$ 1.07	2.03 $\pm$ 1.13	<0.001

Mean meibum quality score OD, mean $\pm$ SD	0.71 $\pm$ 0.35	1.55 $\pm$ 0.30	<0.001
Mean meibum quality score OS, mean $\pm$ SD	0.88 $\pm$ 0.31	1.38 $\pm$ 0.42	<0.001
Upper-lid gland loss OD, %, mean $\pm$ SD	12.25 $\pm$ 5.09	25.39 $\pm$ 4.30	<0.001
Lower-lid gland loss OD, %, mean $\pm$ SD	14.05 $\pm$ 3.89	27.02 $\pm$ 5.99	<0.001
Upper-lid gland loss OS, %, mean $\pm$ SD	11.93 $\pm$ 5.84	23.93 $\pm$ 3.98	<0.001
Lower-lid gland loss OS, %, mean $\pm$ SD	11.85 $\pm$ 4.50	26.22 $\pm$ 4.95	<0.001
MGD present OD, n (%)	14 (46.7)	30 (100.0)	<0.001
MGD present OS, n (%)	19 (63.3)	29 (96.7)	0.004

Table 3. Comparison of Tear-Film Parameters and Ocular Surface Symptoms Between Study Groups

Parameter	New Users (n=30)	Long-Term Users (n=30)	p-value
TBUT OD, seconds, mean $\pm$ SD	10.38 $\pm$ 1.42	7.68 $\pm$ 1.31	<0.001
TBUT OS, seconds, mean $\pm$ SD	10.46 $\pm$ 1.24	7.68 $\pm$ 1.34	<0.001
OSDI score, mean $\pm$ SD	18.90 $\pm$ 8.63	28.41 $\pm$ 8.91	<0.001

Table 4. Correlation Between Duration of Topical Anti-Glaucoma Therapy and Meibomian Gland and Tear-Film Parameters

Parameter	Spearman's ρ	p-value
Expressibility score OD	0.543	<0.001
Expressibility score OS	0.381	0.003
Mean meibum quality score OD	0.686	<0.001
Mean meibum quality score OS	0.464	<0.001
Upper-lid gland loss OD	0.719	<0.001
Lower-lid gland loss OD	0.772	<0.001
Upper-lid gland loss OS	0.717	<0.001
Lower-lid gland loss OS	0.675	<0.001
OSDI score	0.409	0.001
TBUT OD	-0.600	<0.001
TBUT OS	-0.727	<0.001

Discussion

This study demonstrated significantly greater meibomian gland dysfunction and ocular surface compromise among long-term users of topical anti-glaucoma medications compared with newly initiated users, with treatment

duration showing strong positive correlations with gland loss and meibum quality deterioration, and a strong negative correlation with tear-film breakup time. The demographic comparability between groups age, sex distribution, IOP, and number of medications

used were statistically similar strengthens the inference that the observed differences in ocular surface and meibomian gland parameters are attributable to cumulative medication exposure rather than to confounding baseline characteristics.[14]

Benzalkonium chloride (BAK), the preservative found in the majority of formulations used by both groups in this study, has been implicated in previous work as a driver of meibomian gland epithelial damage and acinar atrophy with chronic exposure. The particularly strong correlations seen for upper- and lower-lid gland loss (p approximately 0.68–0.77) suggest that duration of exposure may be a more consistent determinant of structural gland damage than of functional parameters like OSDI ($p=0.409$), which are more likely to be influenced by additional factors such as environmental exposure, contact lens wear, screen time, and individual symptom-reporting thresholds.[15] This dissociation between structural and symptomatic severity is a recognized feature of MGD more broadly, where meibography-confirmed gland loss does not always correlate proportionally with subjective symptom burden.[16]

The near-universal presence of MGD in the long-term group (100% in the right eye, 96.7% in the left) versus roughly half of new users indicates that meibomian gland pathology in this population may develop relatively early in the treatment course and become almost universal with sustained exposure, which has direct implications for clinical monitoring: patients being counselled at initiation of chronic anti-glaucoma therapy may benefit from baseline and periodic meibomian gland assessment, and preservative-free formulations could be considered preferentially for patients anticipated to need long-term, multi-agent therapy.[17, 18]

Several limitations warrant mention. The cross-sectional design precludes establishing causality or a true temporal sequence of gland damage, and cannot rule out reverse or bidirectional relationships (e.g., patients with pre-existing MGD risk factors ending up on combination therapy after monotherapy failure). Sample size (30 per group) limits the precision of subgroup analyses by drug class.[19]

Confounders such as prior ocular surgery, contact lens history, systemic conditions affecting the ocular surface, and environmental factors were not reported here and may have influenced findings.[20] Finally, since preservative status differed only modestly between groups, this study cannot fully disentangle preservative toxicity from other mechanisms of drug-related glandular injury (e.g., direct pharmacologic effects of beta-blockers or prostaglandin analogues on meibomian gland epithelium), which would require a design stratifying more explicitly by preservative-free versus preserved formulations.

Conclusion

The study concluded that the prevalence of MGD was very high among patients treated with topical anti-glaucoma drugs, and that the degree of ocular surface dysfunction was higher among long-term anti-glaucoma users than among new users.

REFERENCES

- Zhao DX, Quintero M, Mihailovic A, Akpek E, Karakus S, Guo L, Ramulu PY. Utilizing visual symptoms to distinguish dry eye from glaucoma, cataract, and suspect glaucoma patients: a cross-sectional study. *BMC Ophthalmol.* 2024;24(1):16.
- Zhang H, Qi Y, Chen J, Qin G, Xu L, He W, Yu S, Che H, Pazo EE. Management of Glaucoma-Related Dry Eye Disease with Intense Pulsed Light: A Randomized Control Study. *Clin Ophthalmol.* 2024;18:2061-72.
- Wang WX, Chuang YN, Chang CN, Yang MC, Shen EP. Impact of Positive Airway Pressure and Mask Leakage on Dry Eye and Glaucoma Risk in Obstructive Sleep Apnea: A Cross-Sectional Analysis. *Biomedicine.* 2025;13(12).
- Tsai CY, Weng CH, Sheen YJ, Chen JP, Chen HM, Tsai CY, Wang IJ, Chou CC. Association between probiotic prescriptions and the incidence of primary open-angle glaucoma in patients with documented dry eye. *Graefes Arch Clin Exp Ophthalmol.* 2026.

- Zahid A, Zainab HR, Shaukat T, Jamil MH, Ahmed I. The Correlation of Axial Length with Choroidal Thickness in Myopic Patients. *Ophthalmology Pakistan*. 2026;26(2):66-72.
- Bulat N, Cusnir VV, Procopciuc V, Cusnir V, Cusnir NV. Diagnosing the Dry Eye Syndrome in modern society and among patients with glaucoma: a prospective study. *Rom J Ophthalmol*. 2020;64(1):35-42.
- Coco G, Iannetta D, Febbraro I, Elmo E, Manni G. Efficacy of Nonpreserved Sodium Hyaluronate Artificial Tears in Dry Eye Disease Patients Treated with Prostaglandin Analogs for Primary Open-Angle Glaucoma: A Prospective, Nonrandomized, Open-Label Pilot Study. *J Ophthalmol*. 2022;2022:1320996.
- Shaukat T, Riaz R, Jamil MH, Rafique K, Ali HZ. B-Scan Evaluation of Medial and Lateral Rectus Muscle Thickness in Horizontal Strabismus. *Pakistan Journal of Ophthalmology*. 2026;42(2).
- Coco G, Piccotti G, Rossi L, Fucci P, Manni G. Assessment of dry eye questionnaires in patients with and without glaucoma. *Br J Ophthalmol*. 2026;110(6):615-20.
- Eraslan N, Bahar A. Evaluation of corneal epithelial thickness by anterior segment optical coherence tomography in glaucoma patients receiving topical prostaglandin and dry eye treatment. *Int Ophthalmol*. 2025;45(1):481.
- Gan EH, Woo WW, Seng KF, Singh P, Lee MY, Kong VY, Khoo SP, Lee MW, Liang LK. Ocular Surface Disease and Dry Eye Severity in Glaucoma Patients at Urban Private Eye Care Centres in Malaysia. *Clin Ophthalmol*. 2024;18:3249-62.
- Tahir S, Abdul Basit I, Arslan A, Irfana A, Rashida R. Knowledge and Awareness Regarding Keratoplasty and Eye Donation in High Risk Occupations. *Ophthalmology Pakistan*. 2024;14(1):24-8.
- Kamdougha H, Taminiau B, Fall PA, Ben Amor S, Trigui A, Daube G, Mnif B. Alterations of ocular surface microbiome in glaucoma and its association with dry eye. *J Med Microbiol*. 2025;74(5).
- Nijm LM, Schweitzer J, Gould Blackmore J. Glaucoma and Dry Eye Disease: Opportunity to Assess and Treat. *Clin Ophthalmol*. 2023;17:3063-76.
- Ocansey S, Antiri EO, Abraham CH, Abu EK. Dry eye symptom questionnaires show adequate measurement precision and psychometric validity for clinical assessment of vision-related quality of life in glaucoma patients. *PLoS One*. 2023;18(3):e0283597.
- Kolko M. Rethinking Dry Eye and Ocular Surface Disease in Glaucoma: Pathophysiology, Diagnosis, and Management. *J Glaucoma*. 2026;35(7):455-63.
- Chaudhary¹ A, Shafiq U, Shaukat T. EFFECT OF SYSTEMIC STEROIDS ON TEAR FILM STABILITY. 2025.
- Pan SY, Sheen YJ, Weng CH, Chen JP, Lin HJ, Wang IJ, Chou CC. Relationship Between Omega-3 Fatty Acids and Glaucoma Risk in Patients With Dry Eye Disease: A Multinational Retrospective Cohort Study. *Transl Vis Sci Technol*. 2026;15(6):2.
- Kountouras J, Zavos C, Polyzos SA, Vardaka E, Kazakos E, Chatzopoulou-Tzitaridou M, Chatzopoulos D, Tzivras D, Papanikolaou IS, Liatsos C, Gavalas E. Potential Influence of Helicobacter Pylori on Glaucoma-Related Alterations of Ocular Surface Microbiota and Dry Eye Disease Pathophysiology. *Invest Ophthalmol Vis Sci*. 2025;66(15):72.
- Maeng KJ, Lee K, Kim S, Park CK, Kim EW, Lee SY, Bae HW, Seong GJ, Kim CY. Effects of Glaucoma Medication on Dry Eye Syndrome and Quality of Life in Patients with Glaucoma. *Korean J Ophthalmol*. 2021;35(6):467-75.