BMC Ophthalmology

RESEARCH

Open Access

The impact of lacrimal gland characteristics on the clinical presentation of lacrimal gland prolapse in candidates for upper eyelid blepharoplasty

Bahram Eshraghi[1], Nahid Mirzaei[2], Samira Chaibakhsh[3] and Ali Aghajani[2*]

Abstract

Background lacrimal gland prolapse (LGP) is a rare yet significant condition in oculoplastic surgery, characterized by the downward displacement of the lacrimal gland leading to upper eyelid bulging. This study aimed to understand LGP's defining characteristics and clinical implications for accurate diagnosis and tailored treatment planning.

Methods The research, enrolled 496 candidates for upper eyelid blepharoplasty. Initially, all patients underwent an examination in an upright position to identify lateral eyelid bulging, the "supine test" was then performed. Surgical exploration was carried out for those with a positive supine test. Measurements of gland prolapse length and thickness were recorded, with glands classified based on thickness (thin < 2 mm vs. thick ≥ 2.5 mm). Dacryoadenopexy was performed to secure prolapsed glands using non-absorbable sutures, followed by skin closure.

Results The average age of 48.39 years predominantly comprising females. Findings revealed an incidence of LGP around 22%. Patients with LGP were significantly younger than those without, suggesting evolving aesthetic demands. The supine test demonstrated a 90% positive predictive value for LGP. Analysis of the prolapsed lacrimal gland characteristics indicated that the average length in patients with upright prolapse was significantly larger (8.33 ± 3.12 mm) than in those without (6.03 ± 2.91 mm, $p = 0.001$). The odds ratio analysis revealed that each millimeter increase in gland length correlates with a 29% increased likelihood of upright eyelid bulging (OR: 1.29, 95% CI: 1.106–1.509, $p = 0.001$). However, the thickness of the gland and the presence of superotemporal pre-aponeurotic fat did not significantly influence the clinical manifestation of LGP.

Conclusion This study challenges existing assumptions about LGP by revealing a higher incidence, particularly among younger individuals, indicative of evolving aesthetic demands possibly influenced by social media. The supine test proves valuable for LGP assessment. Gland characteristics, especially length, significantly impact clinical manifestation, underscoring the need for tailored approaches. Surgeons should navigate LGP diagnosis and treatment with precision, considering both gland and fat prolapse for comprehensive care and aesthetic results.

Clinical trial number Not applicable.

*Correspondence:
Ali Aghajani
aliaghajani_y@yahoo.com

Full list of author information is available at the end of the article

Keywords Blepharoplasty, Dacryoadenopexy, Lacrimal gland prolapse, Lacrimal gland size, Supine test

Introduction

Prolapsed lacrimal gland, a rare clinical entity, presents unique challenges and diagnostic considerations in the realm of oculoplastic surgery. This condition is characterized by the downward displacement of the lacrimal gland, leading to lateral bulging of the upper eyelid often accompanied by discomfort or aesthetic concerns [1]. As one of the least common lacrimal gland disorders, understanding its defining characteristics, is crucial for accurate diagnosis and successful treatment.

The LGP is usually brought to attention when the patients are seeking cosmetic eyelid surgery. Although most of the individuals are not aware of this condition, some might straightly address their concerns about lateral eyelid bulging especially the patients with underlying eyelid and orbital abnormalities [1–3]. Thus it is important to recognize and respect the patients' problem to achieve most desirable cosmetic results after blepharoplasty. To detect this abnormality, careful and vigilant observation is required. Complementing this, the positive supine test, where the lateral extent of the gland protrudes further when the patient lies down, serves as a telling indicator of this condition's presence [4].

Despite the usefulness a of the current diagnostic examination s for detecting LGP, there is no dedicated study exploring the relationship between prolapsed lacrimal gland characteristics and clinical presentation of LGP, an understanding of these characteristics is crucial for guiding clinical judgment and treatment planning. Furthermore, the lack of specific research in this area highlights an important gap in our current knowledge, emphasizing the need for comprehensive investigation into the role of gland characteristics in the clinical manifestation of LGP. It is within this context that a deeper analysis of these dimensions becomes imperative, not only for diagnostic precision but also for developing tailored treatment approaches, ultimately improving outcomes for individuals affected by this rare yet impactful condition.

Patients and methods

This was a prospective study conducted from August 2023 to December 2024 at t the private office of main author (BE) Isfahan, Iran. All investigations adhered to the tenets of the Declaration of Helsinki. Informed consent was obtained from all participants.

All patients scheduled for upper eyelid blepharoplasty were included in this study. Every patient underwent a comprehensive ophthalmologic examination, which included an assessment of visual acuity, slit lamp examination, and funduscopy. Patients were excluded if they exhibited any ocular surface abnormalities that may indicate potential dry eye symptoms following blepharoplasty surgery. Additionally, patients with active collagen-vascular disorders, uncontrolled diabetes, bleeding diathesis, or any underlying systemic conditions that could potentially lead to intraoperative or postoperative complications, such as excessive bleeding or impaired wound healing, were also excluded from the study. Those with a history of thyroid-associated orbitopathy or other forms of orbital inflammatory disorders were similarly excluded from participation in this study.

Prior to surgery, each patient was examined in an upright position to evaluate the presence of lateral eyelid bulging, an indication of lacrimal gland prolapse. The upper eyelid's lateral skin was gently lifted to check for any bulging beneath the lateral border of the orbital rim thorough both inspection and palpation of the superolateral aspect of the upper eyelid; If bulging was observed in the superotemporal area during this maneuver, the patient was considered to have a "positive upright test". Subsequently, each patient was asked to lie down for the supine test, following the method previously described by Kashkouli et al. [4] (Fig. 1). In the supine position, the skin of the upper eyelid was gently lifted to evaluate whether the patient exhibited any bulging in the superotemporal aspect of the orbit. The presence of such protrusion was considered a positive supine test. Patients with a positive supine test had a surgical plan aimed at exploring the supero-temporal orbit to confirm and address the lacrimal gland prolapse. During upper eyelid blepharoplasty, performed through a standard skin incision under local anesthesia, the orbicularis muscle was carefully dissected in the temporal region. Following adequate cautery, the orbital septum was incised to expose the prolapsed lacrimal gland and/or displaced pre-aponeurotic fat pad (Fig. 2). If any fat tissue was found to be displaced temporally at this stage, it was either removed or repositioned at the surgeon's discretion. The protruding LG was then measured for both prolapse length and its thickness. The distance between the tip of the gland to the orbital rim and the maximal gland thickness were recorded during surgery. Those LGs with a thickness of less than 2 mm were categorized as thin, while those with a thickness of ≥ 2.5 mm were classified as thick glands. Dacryoadenopexy was performed for all the patients with LGP; permanent fixation was achieved using non-absorbable 5.0 Prolene suture to the periosteum of the internal aspect of the supero-temporal orbit. Finally, the skin was sutured using 6.0 Prolene.

Fig. 1 Photographs of a 53-year-old female patient taken before undergoing blepharoplasty reveal lateral eyelid bulging affecting both upper eyelids (**a**). This bulging diminishes upon elevation of the lateral aspect of the eyebrow (**b**). During the supine test, a distinct superotemporal bulge in the upper eyelid becomes evident, a phenomenon not observable while the patient is in a seated position (**c**). Intraoperatively, it was noted that the patient exhibited a temporally displaced pre-aponeurotic fat, accompanied by a prolapsed lacrimal gland measuring 6 mm in length

The statistical analysis

Data were analyzed using SPSS version 21.0. Quantitative data were presented as Mean ± SD, while qualitative data were shown as frequency (percentage). Data preparation followed the study protocol, and descriptive statistics were used to explore the data. The normality of continuous data was assessed with the Kolmogorov-Smirnov test. The independent sample t-test and chi-square test (or Fisher's exact test) were employed to compare categorical variables. A binary logistic regression model was used to identify factors associated with positive upright prolapse. The odds ratios (OR) and 95% confidence intervals (CI) were estimated for factors associated with positive upright prolapse. The Type I error rate was set at 0.05.

Results

A total of 496 candidates for upper eyelid blepharoplasty were enrolled in the study. The average age of the participants was 48.39 ± 11.54 years. Among the cohort, 447 of the candidates, 90.7%, were female, while the remaining 9.3% (46 individuals) were male.

Upon examination, 22.1% (109 out of 496) of the participants tested positive during the supine test, while 78% (387 out of 496) tested negative. The mean age of those with a positive supine test was 45.23 ± 10.81years, whereas those with a negative test had an average age of 49.20 ± 11.60 years. This difference in mean age between the two groups was statistically significant ($p = 0.006$, Table 1).

Of those with a positive supine test, a majority of 94.4% (102 out of 109) were female, while 89.6% of the individuals in the negative supine test group were female. The difference between these two groups in terms of gender distribution was not statistically significant (Table 1).

We should note that among the 109 patients with a positive supine test, 11 were found not to have lacrimal gland prolapse during intraoperative exploration. In these cases, a temporally displaced pre-aponeurotic fat pad was discovered during surgery, which was subsequently addressed by removal or replacement. These 11 patients were classified as experiencing false positive results from the supine test, leading to the conclusion that the test demonstrated a positive predictive value of 90% for detecting LGP. To maintain the integrity of the data, these 11 patients were excluded from further analysis to avoid any potential misinterpretation.

Within the group of patients with a positive supine test, 62.2% (61 out of 98) exhibited a positive upright prolapse,

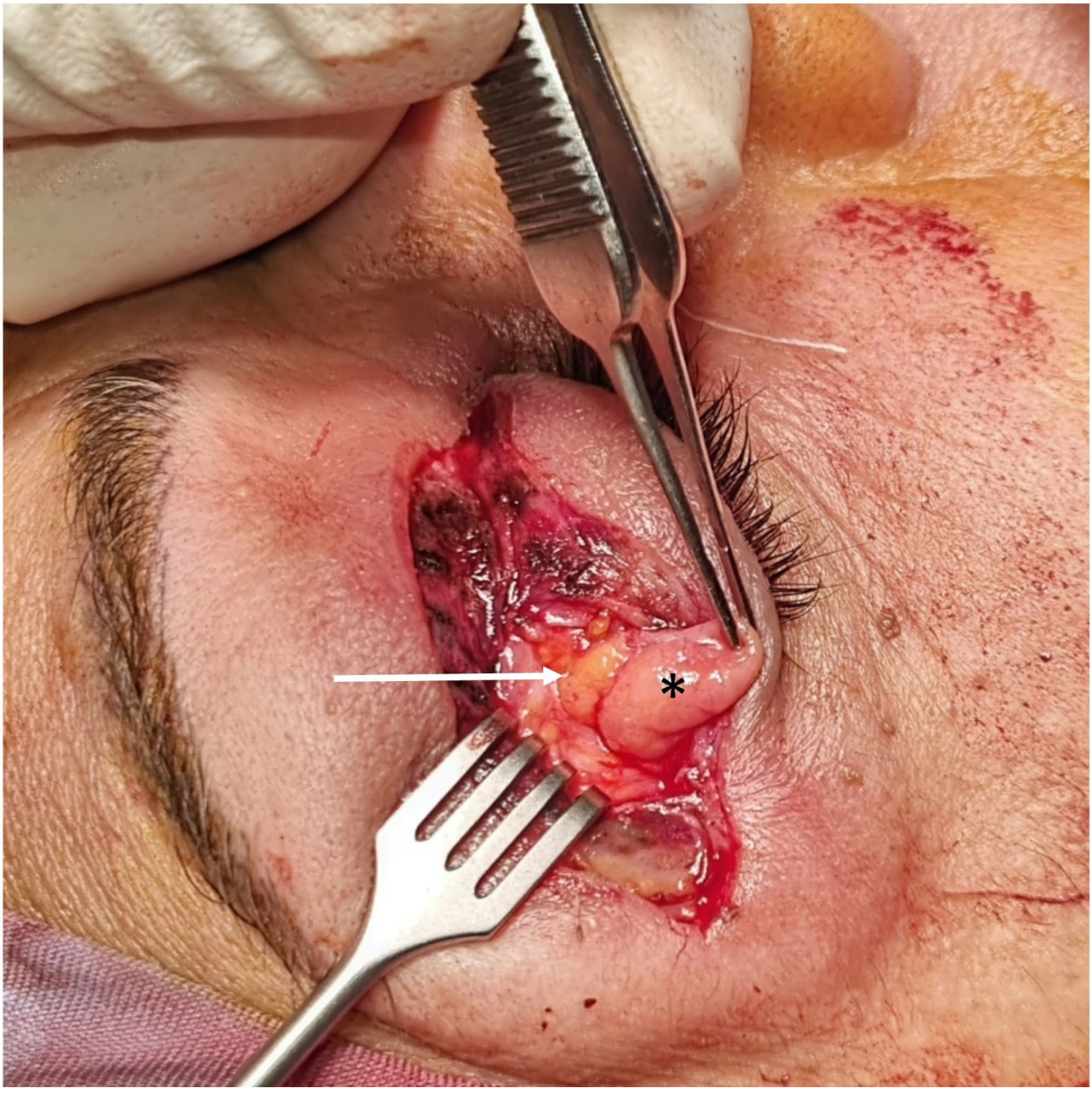

Fig. 2 Intraoperative photograph taken during upper blepharoplasty to explore lacrimal gland prolapse. The white arrow indicates the displaced preaponeurotic fat, while the black asterisk highlights the prolapsed lacrimal gland

Table 1 Demographic data of the participants of this study in total and different subgroups

Variable		Positive Supine test		*P*-Value	Total		*P*-Value
		Upright Positive 62.2% (61/98)	**Upright Negative 37.8% (37/98)**		**Positive supine test 22.1% (109/496)**	**Negative supine test 78% (387/496)**	
Age (Mean ± SD)		45 ± 9.94	44.8 ± 12.56	0.938	45.23 ± 10.81	49.20 ± 11.60	**0.006**
Gender	Female	59(96.7)	34(91.9)	0.275	102(94.4)	345(89.6)	0.127
	Male	2(3.3)	3(8.1)		6(5.6)	40(10.4)	

Table 2 Characteristics of prolapsed lacrimal gland in each subgroup

Variable		Positive supine test		*P*-Value†	Univariate		Multivariate	
		With Upright prolapse 62.2% (61/98)	Without Upright prolapse 37.8% (37/98)		OR(95%CI)	*P*-value©	OR(95%CI)	*P*-value©
Size of the prolapsed gland (mm, Mean ± SD)		8.33 ± 3.12	6.03 ± 2.913	**0.001***	1.29(1.106,1.509)	**0.001***	1.34(1.127,1.594)	**0.001***
Thickness of the prolapsed gland	Thin	31(50.8)	21(56.8)	0.568	1.27(0.559,2.88)	0.568	0.830(0.328,2.09)	0.694
	Thick	30(49.2)	16(43.2)					
Temporally displaced fat	Positive	27(44.3)	16(43.2)	0.921	0.959(0.421,2.186)	0.921	0.597(0.229,1.55)	0.291
	Negative	34(55.7)	21(56.8)					

OR: Odds Ratio, †: Result from T test and chi square, ©:Result from Logistic Regression

whereas 37.8% (37 out of 98) showed no prolapse in an upright position. The mean age of participants with upright prolapse was 45 ± 9.94 years, while those without upright prolapse had an average age of 44.8 ± 12.56 years. The difference in mean age between these two groups was not found to be statistically significant ($P = 0.938$, Table 1). Furthermore, 96.7% (59 out of 61) of patients with upright prolapse and 91.9% (34 out of 37) without upright prolapse were female. The difference in gender distribution between these two subsets was not deemed statistically significant ($P = 0.275$, Table 1).

Table 2 details the characteristics of the prolapsed lacrimal gland, presenting a comparison between patients with and without upright prolapse. The average length of the prolapsed lacrimal gland was notably larger in patients with upright prolapse in contrast to those without upright prolapse (8.33 ± 3.12 vs. 6.03 ± 2.91, $p = 0.001$, Table 2). Furthermore, the odds ratio (OR) derived from univariate analysis stands at 1.29 (95% CI: 1.106–1.509, $p = 0.001$, Table 2). This odds ratio indicates that for each millimeter increase in the length of the prolapsed lacrimal gland, the likelihood of demonstrating an upright lateral eyelid bulging increases by 29%. Comparable findings were obtained when analyzing the impact of LG thickness and the temporal displacement of pre-aponeurotic fat in a multivariate study. As indicated in Table 2, the presence of thick LG and temporally displaced pre-aponeurotic fat tissue does not seem to influence the clinical manifestation of LGP.

Discussion

This study presents several significant findings. Firstly, the prevalence of LGP was observed to be approximately 22%, which is notably higher than in most previous reports. This discrepancy may primarily result from differences in the diagnostic methods used by various authors to detect LGP; not considering reports that identified LGP without conducting a preoperative evaluation (meaning that surgeons opened the orbital septum in every patient to assess for any displaced lacrimal gland). The difference in prevalence compared to other studies such as 10.1% reported by Eshraghi et al. [5] can be partly explained by the supine test used in our study, which has been shown to significantly enhance the ability to detect LGP compared to upright evaluations. Besides, contrary to our expectations, the mean age of patients exhibiting LGP was significantly lower than that of patients without this condition which also contrasts the previous findings reported by Kashkouli et al. [4] who reported an increase in the prevalence of LGP in older patients. It is typically assumed that the incidence of LGP increases with age due to the progressive laxity of the anchoring ligaments of the lacrimal gland [1]. Although we did not directly assess the impact of social media on patients decision to address their concerns about their eyelid appearance the rising influence of social media on aesthetic demands cannot be ignored [6, 7] which appears to be prompting younger individuals to seek surgical intervention for their lateral eyelid bulging. This trend may explain the unexpected findings in our study, leading to a higher incidence of LGP in this study and specifically in younger patients.

Second, while the supine test is commonly utilized by eyelid surgeons for the pre-operative assessment of LGP, our study revealed that not all patients who test positive for LGP exhibit a prolapsed lacrimal gland during surgical exploration. In fact, we determined that the PPV of the supine test was 90%. This finding stands in contrast to the assertion made by Kashkouli et al. [4]. In our study, we found that in at least 10% of cases with positive supine test, surgical exploration revealed only the prolapse of temporally displaced pre-aponeurotic fat, without any accompanying lacrimal gland. Nonetheless supine test is still superior to mere observation of lateral eyelid bulging (with PPV of 30%[4]) in detecting LGP. We also believe that even in situations where no LGP is identifiable during surgical exploration, the presence of prolapsed pre-aponeurotic fat should still be addressed. Removing or replacing this fat is essential for achieving the desired aesthetic outcome, as it can significantly contribute to an improved contour and overall appearance of the upper eyelid.

Third, our study emphasizes that the characteristics of a prolapsed lacrimal gland can have a significant impact on its clinical presentation. Specifically, we found that the length of the prolapsed gland—not its thickness—plays a crucial role in determining the extent of clinical manifestation. Based on the previous reports the mean length of protruded gland is around 5 to 6 mm [4, 5], with less than 15% of patients having greater than 7.5 mm of prolapse [4]. however, these reports have not made a connection between intraoperative findings and clinical manifestation of LGP. As the length of the prolapsed gland increases, there is a corresponding higher likelihood of observing lateral bulging of the upper eyelid when the patient is in a seated position irrespective of presence of PAF. Conversely, patients exhibiting minimal prolapse may not present with clinically significant lateral bulging in the upright position. The latter is to some extent in contrast with the findings of Kashkouli et al. [4]. who reported a negative predictive value of 96% for LGP in patients without lateral eyelid bulging. In fact around 37% of subjects of this study with LGP did not have a lateral eyelid bulging in upright position. This finding emphasizes on the role of pre-operative supine test before upper blepharoplasty. On the other hand this finding raises an important question regarding the necessity of relocating the gland during surgery in such cases. While our general practice has been to reposition the lacrimal gland in all patients with a positive supine test, due to the presumed progressive nature of this condition, the definitive answer to whether this approach is warranted in patients with minimal prolapse requires further investigation. Especially for the surgeons who tend to open up the orbital septum and explore presence of displaced lacrimal gland in all of their patients this should raise the question whether it should be surgically re-fixed if the length of the prolapse is short as the cosmetic effect of the gland repositioning should weigh its possible complications. Future studies should explore the long-term implications of leaving the gland un-repositioned in selected cases, as well as the potential benefits of intervention.

Furthermore, our study revealed that approximately half of the patients with positive supine test and LGP also present with a temporally displaced pre-aponeurotic fat pad. We did not find any relationship between presence of PAF and clinical features of LGP; meaning that it could be found equally in patients with and without presentation of LGP in upright position. Nonetheless it is crucial for surgeons to be aware of this finding during surgical exploration for the prolapsed lacrimal gland. Discovering this fat during surgery does not imply the absence of LGP, nor should it lead to the erroneous conclusion of a false positive in preoperative evaluations. Instead, surgeons should remain committed to their surgical plan and continue their search for the displaced lacrimal gland, even if pre-aponeurotic fat tissue is encountered during the procedure. The presence of PAF should be considered as part of the patients' aesthetic problem and should be addressed accordingly. Alongside the repositioning of the prolapsed lacrimal gland, the PAF should be repositioned or removed depend on the upper eyelid sulcus depth and the preference of the surgeon [1].

A major limitation of this study is the absence of data regarding orbital depth and globe position in relation to the presentation and severity of LGP or fat prolapse. Although our clinical experience suggests that LGP tends to be more prominent in patients with negative vector orbits or specific types of orbital anatomy (such as those with less prominent frontal bossing), we were unable to document these observations thoroughly enough to provide general recommendations on the impact of orbital shape on the clinical presentation of LGP.

In conclusion, this study provides valuable insights into the incidence and characteristics of LGP and challenges some established assumptions regarding its presentation. The unexpectedly high prevalence of LGP, especially among younger patients, highlights the evolving demands for aesthetic interventions. This trend may be due to increased patient awareness regarding the aesthetic criteria of their eyelids. As a result, eyelid surgeons should become well-versed in the diagnosis and management of LGP to achieve the most desirable outcomes. Furthermore, while the supine test is utilized to differentiate the presence of the lacrimal gland from pre-aponeurotic fat prolapse, it is not infallible. In approximately 10% of patients with a positive test, only fat is observed during surgical exploration. However, this should not deter surgeons from searching for a displaced lacrimal gland when encountering fat prolapse during surgery, as this condition is commonly found in about half of the patients with LGP. Moreover, the study highlights that the characteristics of the prolapsed lacrimal gland—specifically its length—play a crucial role in its clinical manifestation. As the length of the prolapsed gland increases, so does the likelihood of discernible lateral bulging in the upright position. As our standard practice has involved repositioning the gland for all patients with a positive supine test, further investigation is warranted to determine the long-term outcomes of potentially leaving the gland unrepositioned in select cases.

Author contributions

B.A. conceptualized and administered the research, B.A. and A.A. wrote the main manuscript text and N.M. gathered the data and S.C. analyzed the data. All authors reviewed the manuscript.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sector.

Data availability
Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Declarations

Ethics approval and consent to participate
All investigations adhered to the tenets of the Declaration of Helsinki. Informed consent was obtained from all participants. The study was approved by the ethic committee of Isfahan University of medical sciences (IR.ARI.MUI.REC.1403.240).

Competing interests
The authors declare no competing interests.

Author details
[1]Department of Ophthalmology, University of Texas Health at San Antonio, San Antonio, TX, US
[2]Isfahan eye research center, Department of Ophthalmology, Isfahan University of medical sciences, Isfahan, Iran
[3]Rajaie Cardiovascular Medical and Research Institute, Iran University of Medical Sciences, Tehran, Iran

Received: 16 January 2025 / Accepted: 20 March 2025
Published online: 28 March 2025

References

1. Eshraghi B, Najafi M, Babaei L, Moradi M, Aghajani A. Diagnosis and treatment of lacrimal gland prolapse: A narrative review. Aesthetic Plast Surg Aug. 2024;48(15):2786–92. https://doi.org/10.1007/s00266-024-04017-x
2. Zhou J, Ding J, Li D. Blepharochalasis: clinical and epidemiological characteristics, surgical strategy and prognosis– a retrospective cohort study with 93 cases. BMC Ophthalmol Aug. 2021;28(1):313. https://doi.org/10.1186/s12886-021-02049-4
3. Gao Y, Chang Q, Li Y, et al. Correlation between extent of lacrimal gland prolapse and clinical features of thyroid-associated ophthalmopathy: a retrospective observational study. BMC Ophthalmol Feb. 2022;10(1):66. https://doi.org/10.1186/s12886-022-02270-9
4. Kashkouli MB, Tabrizi A, Ghazizadeh M, Khademi B, Karimi N, Supine Test. A new test for detecting lacrimal gland prolapse before upper blepharoplasty. Ophthalmic plastic and reconstructive surgery. Nov/Dec. 2019;35(6):581–5. https://doi.org/10.1097/iop.0000000000001397
5. Eshraghi B, Ghadimi H. Lacrimal gland prolapse in upper blepharoplasty. Orbit (Amsterdam Netherlands) Jun. 2020;39(3):165–70. https://doi.org/10.1080/01676830.2019.1649434
6. Seetan K, Yassin RY, Khamees A, et al. The effect of social media on the decision to have aesthetics or cosmetic procedure: A Case-Control study. Aesthetic Plast Surg Oct. 2024;28. https://doi.org/10.1007/s00266-024-04470-8
7. Sonmez M, Esiyok E. The importance of media on decision to undergo cosmetic surgery operation. Aesthetic Plast Surg Dec. 2022;46(6):3101–7. https://doi.org/10.1007/s00266-022-03139-4

Publisher's note