Ocular surface and tear film changes after eyelid surgery

Wanlin Fan[1]^, Alexander C. Rokohl[1], Yongwei Guo[2]^, Ludwig M. Heindl[1,3]

[1]Department of Ophthalmology, Faculty of Medicine and University Hospital Cologne, University of Cologne, Cologne, Germany; [2]Eye Center, Second Affiliated Hospital, School of Medicine, Zhejiang University, Hangzhou, China; [3]Center for Intergrated Oncology (CIO), Aachen-Bonn-Cologne-Duesseldorf, Cologne, Germany

Contributions: (I) Conception and design: W Fan, LM Heindl; (II) Administrative support: LM Heindl; (III) Provision of study materials or patients: LM Heindl, AC Rokohl, W Fan; (IV) Collection and assembly of data: AC Rokohl, W Fan, Y Guo; (V) Data analysis and interpretation: LM Heindl, W Fan; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Ludwig M. Heindl, MD. Department of Ophthalmology, Faculty of Medicine and University Hospital Cologne, University of Cologne, Kerpener Strasse 62, 50937 Cologne, Germany. Email: Ludwig.heindl@uk-koeln.de.

Abstract: Eyelid surgery is widely and extensively used in facial plastic and reconstructive surgeries. There are many categories of eyelid surgeries, the most common of which include blepharoplasty, ptosis surgery, and eyelid reconstruction. In many cases, these procedures are combined, and there are many different techniques for each type of operation. Upper eyelid blepharoplasty usually includes the excision of skin, preseptal orbicularis oculi muscle, and orbital fat. Common methods of lower eyelid blepharoplasty are the skin-muscle flap, the skin flap, and the transconjunctival. Ptosis surgery is mainly divided into three types: transcutaneous, transconjunctival, and sling surgery. Surgeons often used the Hughes or Cutler-Beard Bridge Flaps in eyelid reconstruction. Different types and methods of surgery have their own advantages and disadvantages, and postoperative complications may occur. Therefore, postoperative complications of eyelid surgeries, such as dry eye symptoms, should be taken into serious consideration. Relevant literature involving these complaints can be found in PubMed by searching the terms “dry eye”, “eyelid”, “surgery”, and other related keywords. Moreover, various ocular surface and tear film alterations may be detected using the Ocular Surface Disease Index (OSDI), tear film breakup time, Schirmer test, fluorescein staining, and lissamine green staining after various eyelid surgeries. As dry eye disease is prevalent in the general population, it is more urgent to figure out what we can learn from these complaints. Further exploration in this field may help surgeons to choose a better surgical method and give an accurate evaluation of the postoperative effect.

Keywords: Ocular surface; tear film; dry eye syndrome (DES); eyelid surgery

Received: 16 May 2020; Accepted: 12 November 2020; Published: 15 March 2021.
doi: 10.21037/aes-20-98
View this article at: http://dx.doi.org/10.21037/aes-20-98

Introduction

Cosmetic and functional eyelid surgery is one of the most common facial plastic surgeries. The eyelids serve aesthetic and operational purposes. Cosmetically, the eyelid region is essential for facial beauty and aging. Functionally, the primary function of the eyelid is to protect the cornea by distributing tears over the cornea and adjusting the physiological flow of the tears. Successful surgery can preserve the essential functions of the eyelids while maintaining proper symmetry and aesthetic proportions.

Dry eye syndrome (DES) is a recognized sequela of eyelid surgery (1,2). It is one of the most common eye diseases, with a prevalence ranging from 5% to 50% (3). TFOS DEWS II revised the definition of dry eye as “*a multifactorial disease of the ocular surface characterized by a loss of homeostasis of the tear film and accompanied by ocular*

^ ORCID: Wanlin Fan, 0000-0001-7143-6707; Yongwei Guo, 0000-0001-9195-0770.

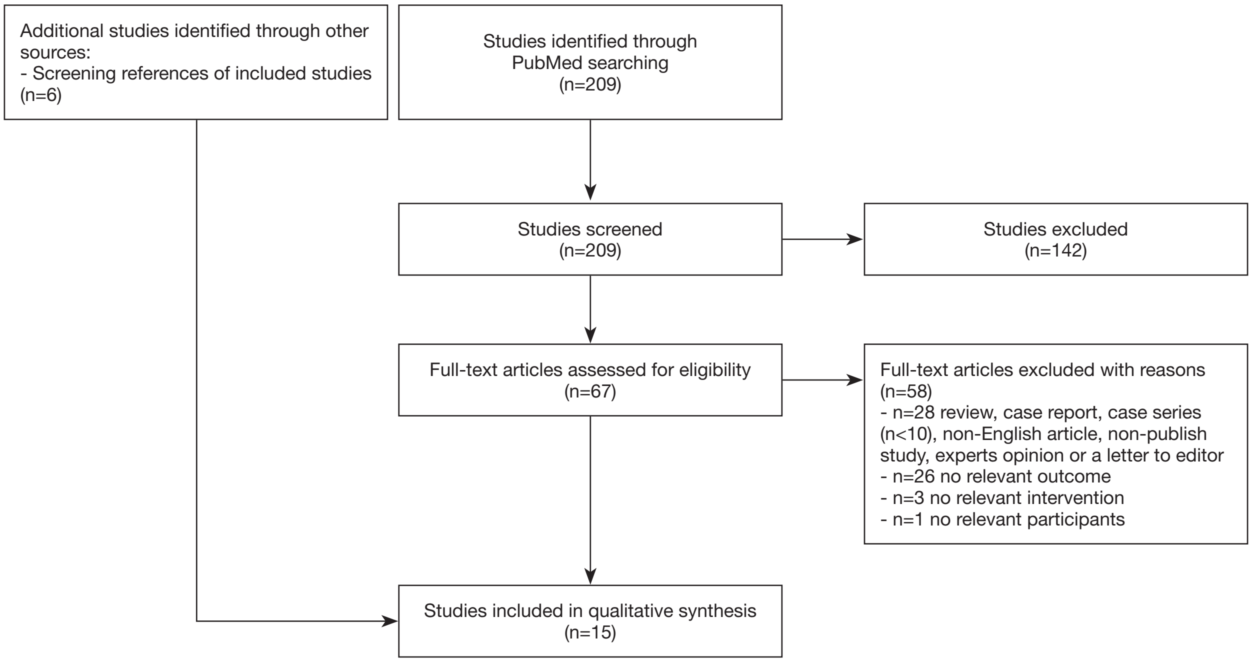

Figure 1 Flow diagram.

symptoms, in which tear film instability and hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities play etiological roles" (4). The unreliability of objective tear production tests suggests that a better understanding of eyelid anatomy and physiology is needed to minimize dry eye after eyelid surgery (5).

Unfortunately, few studies were published to assess DES associated with eyelid surgery. Besides, these studies reported different and sometimes contradictory results. Since these studies included various eyelid surgeries and operation techniques, they seem to be very difficult to compare different outcomes. Finally, the existed randomized controlled studies of eyelid surgery usually focus on aesthetic results rather than functional effects, especially in dry eye diseases. Therefore, to deepen the understanding of this topic, a systematic review was conducted to assess the dry eye symptom following eyelid surgery.

Methods

PubMed database search, including the keywords "dry eye", "eyelid", and "surgery" was performed (for the full list of keywords, see Appendix 1). Besides, we further screened relevant studies missed in the search by checking reference lists of the full-text papers. Studies were eligible for eyelid surgery, and dry eye symptom variables were assessed before and after surgery. The subjects were adult patients (over 18 years of age) with no further age limit and no gender or ethnicity restrictions. The intervention in eligible studies included upper blepharoplasty, lower blepharoplasty, ptosis surgery, eyelid reconstruction, etc. Ocular Surface Evaluation variables were comprised of subjective and objective evaluation. Subjective ocular surface evaluation commonly included the Ocular Surface Disease Index (OSDI), Salisbury Eye Evaluation Questionnaire, and McMonnies dry eye score. The objective evaluation contained tear film breakup time (TBUT), Schirmer test, fluorescein staining, lissamine green (LG) staining, and other parameters. Eligible studies included randomized controlled trials, cohort studies, and case series of ten or more participants, excluding case series of no more than ten participants and case reports and non-English articles. In the study screening process, the titles and abstracts were assessed first, and then the full texts were determined to see when the study met the inclusion criteria. An overview of the study selection is shown in *Figure 1*.

Results

Through the PubMed search, 209 studies were screened, of which 67 full-text articles were assessed for eligibility. In the end, 15 articles were deemed suitable for inclusion in this review (*Table 1*). In these articles reviewed, eyelid surgery

Table 1 Study characteristics

Author (s) and year of publication	No. of participants	Surgical technique	Mean age (years)	Gender	Incidences of DES	DES questionnaire	BUT	Schirmer Test	Fluorescein staining	Lissamine green staining	Other parameters of	Follow-up (months)
Floegel *et al.* (2003)	69	Upper BLE (orbital fat was not removed)	58	79% female	21%	N.S post-op (P>0.01)	N.S post-op (P>0.01)	N.S post-op (P>0.01)	N/A	N/A	N/A	3
Prischmann *et al.* (2013)	892	Lower BLE: skin-muscle flap [694]; transconjunctival [39]; skin pinch [35]	53	86.1% female	26.5%	N/A	N/A	N/A	N/A	N/A	N/A	120
Shao *et al.* (2014)	30	Transcutaneous lower BLE	50.53	76.7% female	16.7% (1-week post-op)	S.I at 1 w post-op (P<0.01)	N.S (P>0.05)	S.D at 1 w post-op (P<0.01)	N/A	N/A	TMA, TMD, TMH: S.I at 1 w, S.D at 1 mo post-op (all P<0.01); CL angle: S.D at 1 w, 1 mo post-op (all P<0.01)	3
Soares *et al.* (2018)	14	Upper BLE	65.1	86% female	0	N/A	N.S post-op (P>0.05)	N/A	N/A	N/A	N/A	1.5
Zloto *et al.* (2020)	BLE group: 23; POT group: 31	BLE group: upper BLE; PTO group: combined BLE and MMCR	BLE group:67.4; PTO group:64	BLE group: 65% female; PTO group: 65% female	N/A	BLE group: N.S post-op (P>0.05); PTO group: S.I post-op (P<0.01)	BLE group: N.S post-op (P>0.05); PTO group: N.S post-op (P>0.05)	BLE group: N.S post-op (P>0.05); PTO group: N.S post-op (P>0.05)	BLE group: N.S post-op (P>0.05); PTO group: S.I post-op (P<0.01)	BLE group: N.S post-op (P>0.05); PTO group: S.I post-op (P<0.01)	N/A	3
Rymer *et al.* (2017)	BLE group: 28; PTO group: 18	BLE group: skin-only excision; PTO group: BLE combined with MMCR	BLE group :60.2; PTO group: 64.7	BLE group: 96.4% female; PTO group: 88.9% female	0	BLE group: N.S post-op (P>0.05); PTO group: S.D at 90 days, post-op (P<0.01)	BLE group: N.S post-op (P>0.05); PTO group: N.S post-op (P>0.05)	BLE group: N.S post-op (P>0.05); PTO group: N.S post-op (P>0.05)	BLE group: S.D at 30 days, post-op (P<0.001); PTO group: N.S post-op (P>0.05)	N/A	RBS: N.S post-op in the two group. (all P>0.05)	3
Bautista *et al.* (2018)	15	PTO surgery: MMCR	62	79% female	0	N/A	N.S Post-op (P>0.05)	N/A	N/A	N/A	LLT: N.S post-op (P>0.05); TO: N.S post-op (P>0.05)	3
Wee *et al.* (2014)	30	PTO surgery: MMCR	55.8	63% female	22%	S.I post-op (P<0.05)	N.S Post-op (P>0.05)	S.D post-op (P<0.01) and 2 mo post-op (P<0.05)	N/A	N/A	N/A	2.6
Ugurbas *et al.* (2014)	16	PTO surgery: MMCR	51.4	69% female	N/A	N.S post-op (P>0.05)	N.S Post-op (P>0.05)	N.S post-op (P>0.05)	N.S post-op (P>0.05)	N/A	RBS, MGD, GCD, SMG: N.S post-op (all P>0.05)	18.5
Watanabe *et al.* (2014)	59	PTO surgery: levator advancement	66.3	61% female	5.6%	N/A	N.S post-op (P>0.05)	N/A	N/A	N/A	TMR: S.D at 1.5 mo post-op (P<0.001)	1.5
Watanabe *et al.* (2014)	PTO group: 43; BLE group: 29	PTO group: transcutaneous levator advancement; BILE group: skin-orbicularis excision	PTO group: 63.8; BLE group: 68.4	PTO group: 56% female; BLE group: 61% female	PTO group: 6.9%; BLE group: 10.3%	N/A	PTO group: N.S post-op (P>0.05); BLE group: N.S post-op (P>0.05)	N/A	N/A	N/A	TMR: PTO group, S.D at 1.5, 3, 6 mo post-op (all P<0.05); BLE group, N.S post-op (P>0.05)	6
Bagheri *et al.* (2015)	83	PTO surgery levator resection (67.5%); frontalis sling (32.5%)	26.2	44.6% female	78.3%	N/A	S.D at 1 and 6 mo post-op (P<0.001)	S.D at 3 and 6 mo post-op (all P<0.001)	N/A	N/A	N/A	6
Gonnermann *et al.* (2012)	17	ER: Hughes flaps (n=16); Cutler-Beard bridge flap (n=1)	69.12	59% female	N/A	N/A	N.S post-op (P>0.05)	N.S post-op (P>0.05)	N/A	N/A	Maximal and minimal OST: N.S post-op (P>0.05)	24.88
Klein-Theyer *et al.* (2014)	18	ER: Hughes flap	72	67% female	N/A	S.I in operated eyes (P=0.071)	N.S in operated eyes (P>0.05)	N.S in operated eyes (P>0.05)	S.I in operated eyes. (P=0.031)	N.S in operated eyes (P>0.05)	MGD, LMA: S.I in operated eyes (all P<0.001)	34
Zaky *et al.* (2016)	11	ER: Hughes flap	67	36% female	N/A	N/A	S.D in operated eyes (P<0.05)	N/A	N/A	N/A	N/A	18

N.S, no significance difference; S.D, significance decrease; S.I, significance increase; Post-op, postoperatively; TMA, tear meniscus area; TMD, tear meniscus depth; TMH, tear meniscus height; TMR, tear meniscus radius; BLE, blepharoplasty; PTO, ptosis; ER, eyelid reconstruction; LLT, lipid layer thickness; TO, tear osmolarity; RBS, rose bengal scores; MGD, meibomian gland disease; GCD, goblet cell densities; SMG, squamous metaplasia grade; OST, ocular surface temperature; LMA, lid margin abnormalities; mo, nonths, w, week.

mainly included blepharoplasty, ptosis surgery, and eyelid reconstruction. Of these, 7 (47%) were associated with blepharoplasty, 8 (53%) with ptosis surgery, and 3 (20%) with eyelid reconstruction. Studies were categorized based on types of eyelid surgery.

Incidence and ocular surface evaluation after blepharoplasty

As we all know, blepharoplasty can cause postoperative dry eye disease or aggravation of preoperative dry eye complaints. The incidence of dry eye disease after blepharoplasty is 0–26.5% (6,7). DES was more commonly reported following concurrent upper and lower blepharoplasty (31.3%) compared with upper blepharoplasty alone (12.9%) and lower blepharoplasty alone (21.4%). Meanwhile, DES was also more often reported following skin-muscle flap blepharoplasty (29.0%) in contrast to the transconjunctival approach (25.6%) and the transconjunctival approach with skin pinch (22.9%) (P<0.01). The authors also reported that patients with a preoperative history of DES, eyelid laxity, scleral show, or hormone therapy had a higher risk of developing dry eye after surgery. Dynamic differences were shown in the examination results of the postoperative dry eye disease patients. Shao *et al.* (8) reported that the OSDI score increased significantly, and the Schirmer test values decreased significantly 1 week postoperatively (P<0.01), but they returned to baseline by 3 months. The tear meniscus height, depth, and cross-section area values increased significantly at 1 week postoperatively, but decreased at 1 month (P<0.01) and returned to baseline at 3 months (P>0.05). Still, no significant differences were shown in perioperative TBUT. However, Rymer *et al.* (9) mentioned that the blepharoplasty did not affect dry eye scores assessed with a questionnaire. The fluorescein staining scores reduced 30 days postoperatively, with no significant differences (compared to baseline) at 90 days after surgery. No notable differences were found between values of preoperative and postoperative Schirmer, TBUT, or rose bengal scores. The remaining three articles (10-12) evaluated subjective and several objective dry eye parameters, but did not report a considerable effect of blepharoplasty on these parameters.

Incidence and ocular surface evaluation after ptosis surgery

Ptosis surgery is one of the most popular procedures in oculoplastic surgery. However, the frequency of dry eye after ptosis surgery is still unclear, and the results reported in different literature are inconsistent. Bagheri *et al.* (13) reported that 65 (78.3%) patients complained of eye dryness after ptosis surgery (levator resection and frontalis sling). The TBUT significantly decreased 1 and 6 months after ptosis surgery compared with the preoperative results (P<0.001). The Schirmer test with anesthesia had a significant decrease in 6 months after ptosis surgery in comparison to the preoperative results (P=0.02), and the Schirmer test without anesthesia decreased significantly in 1 and 6 months postoperatively (P<0.001). Wee *et al.* (14) recorded that the incidence of DES was 22%, and the OSDI scores significantly increased postoperatively compared with the preoperative scores (P=0.026). They also found that the results of the Schirmer test were significantly lower after Muller's muscle conjunctival resection (MMCR) surgery (P<0.001) and at 2-month follow-up (P=0.002) than those before surgery. Watanabe *et al.* (15,16) mentioned that the incidence of dry eye was 5.6% and 6.9% after blepharoptosis surgery (transcutaneous levator advancement), and the tear meniscus radius significantly decreased at 1.5, 3 and 6 months postoperatively (P<0.05). Zloto *et al.* (12) examined symptoms changes and dry eye signs after MMCR. They observed a significant increase in fluorescein staining, LG score, and OSDI questionnaire score (P=0.05, P=0.02, and P<0.01, respectively) after surgery. Rymer *et al.* (9) found no changes for the dry eye test (fluorescein staining, Schirmer test, and TBUT) on 18 patients who underwent MMCR, but a significant reduction in "The Salisbury Eye Evaluation Questionnaire" score (P<0.001). Ugurbas *et al.* (17) evaluated 16 patients who underwent unilateral MMCR surgery using a dry eye questionnaire, Schirmer test, TBUT, fluorescein, and rose bengal staining. No noticeable difference in all the measured parameters between the operated eyes and the controlled eyes. Bautista *et al.* (18) observed changes in objective and subjective dry eye tests preoperatively and 3 months postoperatively in 14 patients who underwent MMCR. They revealed no significant difference in the TBUT, lipid layer thickness, and osmolarity. The differences in these results may be attributed to the patient number among studies (18 in Rymer *et al.*; 30 in Wee *et al.*, and 31 in Zloto *et al.*). These studies have also found that MMCR surgery increased the subjective sensation of dry eye and dry eye signs in various clinical tests.

Incidence and ocular surface evaluation after eyelid reconstruction

Eyelid reconstruction is widely used for managing full-

Table 2 Risk factors for dry eye disease after eyelid surgery

Anatomical
Negative vector orbit
Negative lateral canthal tilt
Scleral show
Lower lid laxity
Blepharitis
Ocular surface disease
Periorbital surgery (e.g., blepharoplasty)
Environmental
Wind
Reduced humidity
Air conditioning
Drafts
Heating
Allergens
Medication
Antihistamines
Anticholinergics
Antidepressants
Diuretics
Hormone replacement therapy
Systemic retinoids
Systemic disease
Rheumatoid arthritis
Sjögren's syndrome
Rosacea
Amyloidosis
Aqueous tear deficiency
Stevens-Johnson syndrome
Neuromuscular disorders (Parkinson's disease, Bell's palsy)
Viral infections (HIV, human T-cell lymphotropic virus type 1, hepatitis C, and Epstein-Barr)

thickness eyelid defects. When the defect is more than 50% of the eyelids' horizontal length, the Hughes or Cutler-Beard bridge flaps (19,20) usually suitable for reconstruction of eyelid defects. Wang *et al.* (21) revealed that the McMonnies dry eye score significantly increased in the operated eyes than the fellow eyes. The operated eyes displayed inferior lipid layer quality, non-invasive tear film stability, and tear film evaporation than unoperated fellow eyes (all $P<0.05$). The exposed ocular surface areas, upper and lower eyelid percentages, meibomian gland dropouts, and sodium fluorescein staining scores were higher in operated eyes (all $P<0.01$). Klein *et al.* (22) evaluated ocular surface characteristics and tear film functions in 18 patients following modified Hughes flap for eyelid reconstruction. They reported a significant loss of meibomian glands ($P<0.001$) and more lid margin abnormalities in the upper and lower eyelids ($P<0.001$), as well as increased fluorescein staining of the cornea on the operated sides ($P=0.031$) compared with the unoperated sides. Nevertheless, Schirmer test, OSDI, BUT, tear film osmolarity, LG staining, and the lipid layer interferometry (Tearscope) were compared between both sides, and the differences were not statistically significant. Zaky *et al.* (23) found a significant decrease of BUT in the eyes with a modified Hughes procedure compare to the value in the contralateral eyes, which indicates tear film instability. Gonnermann *et al.* (24) found no significant difference in Schirmer test, break-up time, and ocular surface temperature between 17 patients after full-thickness eyelid reconstruction and a control group.

Discussion

This comprehensive literature review found that the eyelid surgeries associated with dry eye disease mainly involve blepharoplasty, ptosis surgery, and eyelid reconstruction. Given the differences in the current study results, it is not yet clear whether patients who received eyelid surgery have an increased risk of dry eye disease. Dry eye disease is a multifactorial disease, and some risk factors might lead to dry eye disease after eyelid surgery. Hamawy *et al.* (6) divided the risk factors into systemic diseases, drugs, environmental factors, and anatomical factors (*Table 2*). These factors seem not to be an absolute contraindication to eyelid surgery, but early detection will help prevent or reduce dry eye disease incidence.

Mechanism of dry eye after eyelid surgery

The mechanism of normal tear physiology mainly includes: tear production and release from the lacrimal and accessory glands, tear blinking and distribution, and tear pumping into the tear drainage system (25). Blepharoplasty has become the second most common plastic surgery in the United States. It is a surgical procedure that improves the aesthetic appearance of the eyelids. Upper eyelid blepharoplasty is the gold-standard surgery for correcting dermatochalasis. It commonly involves the excision of skin, preseptal orbicularis oculi muscle, and orbital fat. Lower eyelid blepharoplasty's primary surgical approaches include the skin-muscle flap, the skin flap, and the transconjunctival procedure. Blepharoplasty changes the close interaction between the eyelids, the tear film, and the ocular surface, thereby affecting the tear film (26). Operational changes to the anatomy of the eyelid can affect eyelid closure and blink. Standard blepharoplasty involves the removal of both the skin and a portion of the underlying orbicularis oculi muscle. However, the orbicularis oculi muscle excision may lead to a decreased blink rate, incomplete reflex blink, and lagophthalmos. These could eventually result in increased tear evaporation, reduced tear film distribution and tear drainage with impaired debris removal from the ocular surface.

The degree of eyelid droopiness and the preoperative levator function determine which surgical method will be adopted. There are three types of ptosis surgery: transcutaneous (27), transconjunctival (28) and sling surgery (29). In the conjunctival approach, damage to goblet cells and accessory lacrimal glands may affect the quality or quantity of tears (12,14). The transcutaneous approach mechanisms may include bending of the lacrimal canal, particularly which originates from the palpebral lobe, postoperative inflammation, changes of tear flow, widened palpebral fissure, increased tear evaporation, and changed sensitivity of the cornea and conjunctiva (30). Hughes transconjunctival flap procedure involves a meibomian glands loss, which is not only in the lower eyelid due to the tumor excision but also in the upper eyelid transconjunctival flap. Lack of meibomian glands causes insufficient lipid secretion, which leads to instability of the tear film. Moreover, the surgery can also change the eyelids and cornea's relative position, thus mechanically changing the corneoscleral and conjunctival interface, aggravating dry eye disease (24).

Whether the patients underwent blepharoplasty, ptosis surgery, or eyelid reconstruction, they all have the possibility of causing or aggravating dry eye after operation. Therefore, surgeons should pay attention to perioperative evaluation, surgical operation, and postoperative care to effectively reduce dry eye symptoms.

Preoperative evaluation

Before surgery, surgeons should make full communication with patients, such as asking the patient for dry eye symptoms and examining signs of dry eye disease to assess the risk factors for dry eye disease, such as systemic diseases, medications, etc. Ensure the patient did not have an eye surgery recently, if any, it is recommended to postpone the operation for 6–12 months (6). Verify whether patients have a habit of prolonged reading (31), driving, watching electronics, smoking (32), wearing contact lenses (26), and other behaviors that exacerbate dry eye disease. Doctors need to know whether female patients are in their menopause, taking oral contraceptives, or receiving hormone replacement therapy (33,34). Preoperative physical examination should confirm if the patient has morphological risk factors, such as proptosis, lower lid laxity, scleral show, negative vector orbit, and lateral canthal dystopia (35,36).

Furthermore, doctors should record signs of dry eye disease such as epiphora, erythema, eye fatigue, and increased blink rate before surgery. Schirmer test with anesthesia may also be performed before surgery (26). For patients with dry eye disease or dry eye risk factors, surgeons should carefully decide whether to operate according to the degree of symptoms and risks.

Surgical operation

(I) Corneal protection is an essential but often overlooked aspect of the surgery. Trauma or prolonged exposure can lead to corneal bruising or ulcers, one of the leading causes of dry eye disease after surgery. The use of lubricants and corneal protectors is crucial to protect the eyes (37).

(II) Follow the principle of conservative skin excision during the operation. When operating on the upper lid, leave 8–9 mm skin in the pretarsal fold using a caliper, and the upper skin from the lower margin of the brow to the lid margin must be retained at least 20 mm (38). Since postoperative healing and scarring may cause lower lid retraction and ectropion, it is necessary to consider conservative skin excision during lower eyelid surgery. Generally, lagophthalmos do not occur after surgery, even if edema should be less than 2 mm (6).

(III) When upper and lower eyelid surgery is required, performing upper and lower blepharoplasty in stages might reduce the incidence of postoperative dry eye disease (7).

(IV) Avoid aggressive resection of the orbicularis oculi muscle and injury to the innervation, as the operations may result in decreased blink rates and increased loss of tear evaporation (39,40). Kiang et al. (41) found that muscle-sparing upper blepharoplasty produced similar aesthetic outcomes as conventional blepharoplasty, while significantly reducing dry eye disease complications.

(V) Previous studies have found that control of inflammation can reduce postoperative chemosis (42), closely related to dry eye diseases (6). Minimizing dissection, trauma, and denervation can reduce the occurrence of inflammation and chemosis (43). Furthermore, preoperative intravenous injections of dexamethasone can also limit the inflammatory response (44). Other measures taken to preventing chemosis-caused "exposure" include frequent lubrication, temporary tarsorrhaphies, and postoperative Frost-type (traction) sutures.

(VI) Canthopexy can correct the lateral canthal depression and lessen the risk of ectropion. The canthoplasty should correct severe lower eyelid laxity before surgery (6).

(VII) Depending on the patient's lower eyelid morphology, concurrent midface-lifting, or fat augmentation can prevent the lower eyelids' complications and further reduce the likelihood of dry eye disease (45). Lower eyelid malposition, such as retraction or ectropion, may lead to DES, and thus it is essential to examine the position of the lower eyelid before surgery. It is recommended for patients with both ptosis and lower lid malposition to have lower lid surgery first and then MMCR surgery.

(VIII) In eyelid reconstruction, the flap's shrinkage and contraction may affect the lower eyelid function and lead to eye exposure and irritation. It is recommended to leave a more substantial portion covering 2–3 mm of the lower part of the cornea on the flap division (23).

(IX) Do not damage the lacrimal gland, and avoid mistaking it with fat during the surgery (46,47). Literature (47) reported that about 60% of patients undergoing blepharoplasty had lacrimal gland prolapse, especially those who experienced multiple eyelid surgeries. As the lacrimal gland prolapsed, we advocated resuspending it to the periosteum along the superolateral orbital rim's inner aspect (38).

Postoperative care

Limiting edema, taking lubrication, controlling inflammation, and preventing infection (6,48) are the objectives of postoperative prevention of dry eye. Postoperative edema may be controlled with head elevation and periorbital cold compresses (49). It will take several days for the normal tear membrane to recover due to the damage by surgery. Therefore, it is necessary to administrate artificial tears during the day and eye ointment for lubrication at night. Local antibiotics and steroid drops can be applied to prevent inflammation and conjunctivitis (50).

If dry eye symptoms persist for more than 2 weeks, patients need to evaluate the potential causes. When chemosis is not present, continue to lubricate the eyes and use corticosteroids. For symptoms lasting more than 3 months, consider tear duct occlusion to reduce the flow of tears and maintain eye lubrication (51). If this result from overzealous resection of eyelid skin during surgery, skin grafts may be required (52). When symptoms continue to persist or worsen, consider whether it is related to eyelid malposition. Moreover, if so, it can be corrected by canthoplasty or reduction (50,53). If chemosis persists, it is recommended to using hydration, lubrication, topical or oral steroids, and diuretics. It is also useful to use topical cyclosporin A 0.05% twice per day and temporary eyelid suture (6).

Conclusions

The risk of developing dry eye disease may increase after eyelid surgeries (blepharoplasty, ptosis surgery, and eyelid reconstruction). Only a few studies have reported dry eye disease after limited eyelid surgery. Comparing of the effect of different surgical approaches on the ocular surface and tear film needs further research. Moreover, the ocular surface evaluation methods in the previous studies mainly focused on the Schirmer test, TBUT, and other traditional examinations. We suggested that the latest detection methods should be used to investigate the etiology of postoperative dry eye disease in the future. During the consultation and preoperative evaluation, the surgeon must discuss the patient potential risk factors that may lead to symptomatic dry eye disease. Preoperative assessment of risk factors, intraoperative and postoperative management, and appropriate surgical methods can reduce dry eye disease incidence after eyelid surgery. For this reason, we advised using an algorithm (*Figure 2*) perioperatively, which

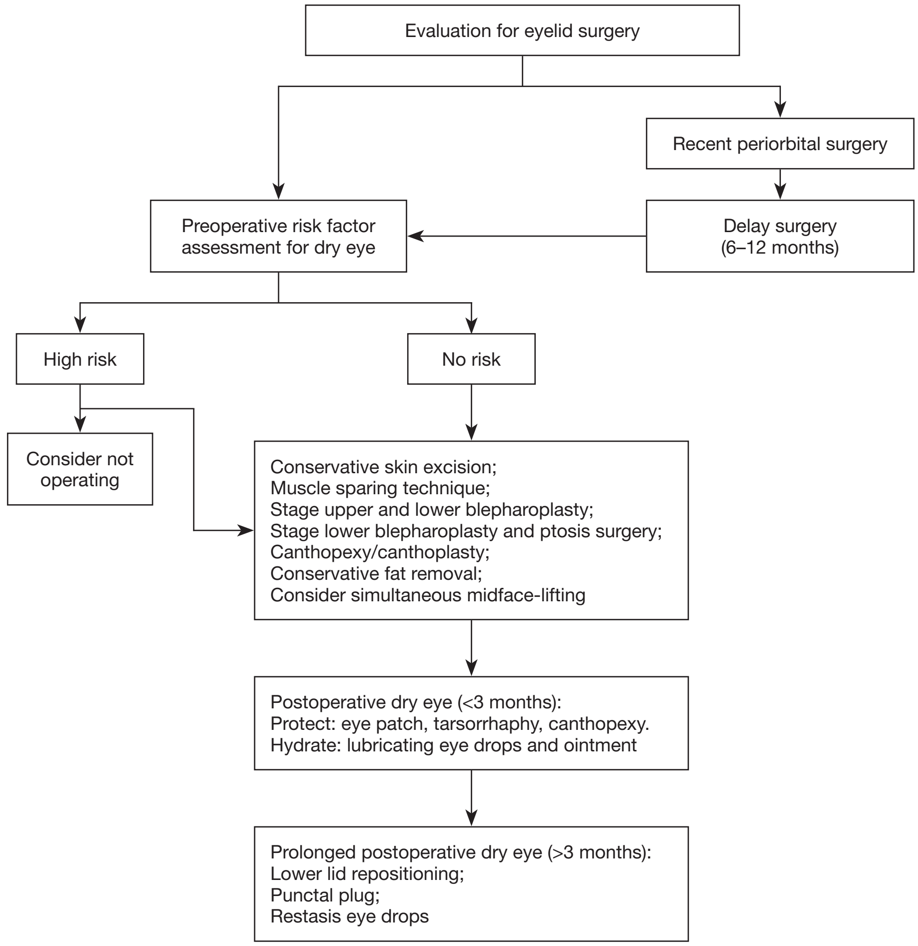

Figure 2 Algorithm for prevention of dry eye disease.

may help to reduce the incidence of chronic DES. The algorithm can improve our overall understanding of DES, select the best surgical method, improve patient compliance, and ultimately improve the prognosis.

Acknowledgments

Funding: This study was supported by the State Scholarship Fund from China Scholarship Council, China (No. 202008080258).

Footnote

Provenance and Peer Review: This article was commissioned by the editorial office, *Annals of Eye Science* for the series "Eyelid Surgery". The article has undergone external peer review.

Peer Review File: Available at http://dx.doi.org/10.21037/aes-20-98

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/aes-20-98). The series "Eyelid Surgery" was commissioned by the editorial office without any funding or sponsorship. LMH served as the unpaid Guest Editor of the series and serves as an unpaid editorial board member of *Annals of Eye Science* from Dec 2019 to Nov 2021. The other authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Morax S, Touitou V. Complications of blepharoplasty. Orbit 2006;25:303-18.
2. Swartz RM, Schultz RC, Seaton JR. "Dry eye" following blepharoplasty. Cause or coincidence? Plast Reconstr Surg 1974;54:644-7.
3. Stapleton F, Alves M, Bunya VY, et al. TFOS DEWS II Epidemiology Report. Ocul Surf 2017;15:334-65.
4. Craig JP, Nichols KK, Akpek EK, et al. TFOS DEWS II Definition and Classification Report. Ocul Surf 2017;15:276-83.
5. Espinoza GM, Israel H, Holds JB. Survey of oculoplastic surgeons regarding clinical use of tear production tests. Ophthalmic Plast Reconstr Surg 2009;25:197-200.
6. Hamawy AH, Farkas JP, Fagien S, et al. Preventing and managing dry eyes after periorbital surgery: a retrospective review. Plast Reconstr Surg 2009;123:353-9.
7. Prischmann J, Sufyan A, Ting JY, et al. Dry eye symptoms and chemosis following blepharoplasty: a 10-year retrospective review of 892 cases in a single-surgeon series. JAMA Facial Plast Surg 2013;15:39-46.
8. Shao C, Fu Y, Lu L, et al. Dynamic changes of tear fluid after cosmetic transcutaneous lower blepharoplasty measured by optical coherence tomography. Am J Ophthalmol 2014;158:55-63.e1.
9. Rymer BL, Marinho DR, Cagliari C, et al. Effects of Muller's muscle-conjunctival resection for ptosis on ocular surface scores and dry eye symptoms. Orbit 2017;36:1-5.
10. Floegel I, Horwath-Winter J, Muellner K, et al. A conservative blepharoplasty may be a means of alleviating dry eye symptoms. Acta Ophthalmol Scand 2003;81:230-2.
11. Soares A, Faria-Correia F, Franqueira N, et al. Effect of superior blepharoplasty on tear film: objective evaluation with the Keratograph 5M - a pilot study. Arq Bras Oftalmol 2018;81:471-4.
12. Zloto O, Matani A, Prat D, et al. The Effect of a Ptosis Procedure Compared to an Upper Blepharoplasty on Dry Eye Syndrome. Am J Ophthalmol 2020;212:1-6.
13. Bagheri A, Najmi H, Salim RE, et al. Tear condition following unilateral ptosis surgery. Orbit 2015;34:66-71.
14. Wee SW, Lee JK. Clinical outcomes of conjunctiva-Muller muscle resection: association with phenylephrine test-negative blepharoptosis and dry eye syndrome. J Craniofac Surg 2014;25:898-901.
15. Watanabe A, Selva D, Kakizaki H, et al. Long-term tear volume changes after blepharoptosis surgery and blepharoplasty. Invest Ophthalmol Vis Sci 2014;56:54-8.
16. Watanabe A, Kakizaki H, Selva D, et al. Short-term changes in tear volume after blepharoptosis repair. Cornea 2014;33:14-7.
17. Ugurbas SH, Alpay A, Bahadir B, et al. Tear function and ocular surface after Muller muscle-conjunctival resection. Indian J Ophthalmol 2014;62:654-5.
18. Bautista SA, Wladis EJ, Schultze RL. Quantitative Assessment of Dry Eye Parameters After Muller's Muscle-Conjunctival Resection. Ophthalmic Plast Reconstr Surg 2018;34:562-4.
19. Herde J, Krause A, Bau V. Results of the Hughes operation. Ophthalmologe 2001;98:472-6.
20. Bertelmann E, Rieck P. Relapses after surgical treatment of ocular adnexal basal cell carcinomas: 5-year follow-up at the same university centre. Acta Ophthalmol 2012;90:127-31.
21. Wang MT, Kersey TL, Sloan BH, et al. Evaporative dry eye following modified Hughes flap reconstruction. Clin Exp Ophthalmol 2018;46:700-2.
22. Klein-Theyer A, Horwath-Winter J, Dieter FR, et al. Evaluation of ocular surface and tear film function following modified Hughes tarsoconjunctival flap procedure. Acta Ophthalmol 2014;92:286-90.
23. Zaky AG, Elmazar HM, Abd Elaziz MS. Longevity results of modified Hughes procedure in reconstructing large lower eyelid defects. Clin Ophthalmol 2016;10:1825-8.
24. Gonnermann J, Klein JP, Klamann MK, et al. Dry eye symptoms in patients after eyelid reconstruction with full-thickness eyelid defects: using the Tomey TG-1000 thermographer. Ophthalmic Res 2012;48:192-8.
25. Mack WP. Blepharoplasty complications. Facial Plast Surg 2012;28:273-87.
26. Belmonte C, Nichols JJ, Cox SM, et al. TFOS DEWS II pain and sensation report. Ocul Surf 2017;15:404-37.
27. Anderson RL, Dixon RS. Aponeurotic ptosis surgery. Arch Ophthalmol 1979;97:1123-8.
28. Putterman AM, Urist MJ. Muller's muscle-conjunctival resection ptosis procedure. Ophthalmic Surg 1978;9:27-32.

29. Crawford JS. Repair of ptosis using frontalis muscle and fascia lata: a 20-year review. Ophthalmic Surg 1977;8:31-40.
30. Dailey RA, Saulny SM, Sullivan SA. Muller muscle-conjunctival resection: effect on tear production. Ophthalmic Plast Reconstr Surg 2002;18:421-5.
31. Karakus S, Agrawal D, Hindman HB, et al. Effects of Prolonged Reading on Dry Eye. Ophthalmology 2018;125:1500-5.
32. Altinors DD, Akca S, Akova YA, et al. Smoking associated with damage to the lipid layer of the ocular surface. Am J Ophthalmol 2006;141:1016-21.
33. Schaumberg DA, Buring JE, Sullivan DA, et al. Hormone replacement therapy and dry eye syndrome. JAMA 2001;286:2114-9.
34. Uncu G, Avci R, Uncu Y, et al. The effects of different hormone replacement therapy regimens on tear function, intraocular pressure and lens opacity. Gynecol Endocrinol 2006;22:501-5.
35. McKinney P, Byun M. The value of tear film breakup and Schirmer's tests in preoperative blepharoplasty evaluation. Plast Reconstr Surg 1999;104:566-9; discussion 570-3.
36. Jelks GW, Jelks EB. The influence of orbital and eyelid anatomy on the palpebral aperture. Clin Plast Surg 1991;18:183-95.
37. Parikh M, Kwon YH. Vision loss after inadvertent corneal perforation during lid anesthesia. Ophthalmic Plast Reconstr Surg 2011;27:e141-2.
38. Yang P, Ko AC, Kikkawa DO, et al. Upper Eyelid Blepharoplasty: Evaluation, Treatment, and Complication Minimization. Semin Plast Surg 2017;31:51-7.
39. Saadat D, Dresner SC. Safety of blepharoplasty in patients with preoperative dry eyes. Arch Facial Plast Surg 2004;6:101-4.
40. Abell KM, Cowen DE, Baker RS, et al. Eyelid kinematics following blepharoplasty. Ophthalmic Plast Reconstr Surg 1999;15:236-42.
41. Kiang L, Deptula P, Mazhar M, et al. Muscle-sparing blepharoplasty: a prospective left-right comparative study. Arch Plast Surg 2014;41:576-83.
42. McCord CD, Kreymerman P, Nahai F, et al. Management of postblepharoplasty chemosis. Aesthet Surg J 2013;33:654-61.
43. Enzer YR, Shorr N. Medical and surgical management of chemosis after blepharoplasty. Ophthalmic Plast Reconstr Surg 1994;10:57-63.
44. Flood TR, McManners J, el-Attar A, et al. Randomized prospective study of the influence of steroids on postoperative eye-opening after exploration of the orbital floor. Br J Oral Maxillofac Surg 1999;37:312-5.
45. Terella AM, Wang TD, Kim MM. Complications in periorbital surgery. Facial Plast Surg 2013;29:64-70.
46. Whipple KM, Korn BS, Kikkawa DO. Recognizing and managing complications in blepharoplasty. Facial Plast Surg Clin North Am 2013;21:625-37.
47. Massry GG. Prevalence of lacrimal gland prolapse in the functional blepharoplasty population. Ophthalmic Plast Reconstr Surg 2011;27:410-3.
48. Tseng SC. A practical treatment algorithm for managing ocular surface and tear disorders. Cornea 2011;30 Suppl 1:S8-S14.
49. Fujishima H, Yagi Y, Toda I, et al. Increased comfort and decreased inflammation of the eye by cooling after cataract surgery. Am J Ophthalmol 1995;119:301-6.
50. Gomes JAP, Azar DT, Baudouin C, et al. TFOS DEWS II iatrogenic report. Ocul Surf 2017;15:511-38.
51. Lelli GJ, Jr., Lisman RD. Blepharoplasty complications. Plast Reconstr Surg 2010;125:1007-17.
52. Leatherbarrow B, Saha K. Complications of blepharoplasty. Facial Plast Surg 2013;29:281-8.
53. Li M, Gong L, Sun X, et al. Anxiety and depression in patients with dry eye syndrome. Curr Eye Res 2011;36:1-7.

doi: 10.21037/aes-20-98
Cite this article as: Fan W, Rokohl AC, Guo Y, Heindl LM. Ocular surface and tear film changes after eyelid surgery. Ann Eye Sci 2021;6:9.

Appendix 1

PubMed: ((((((((((((Dry Eye Syndrome[Title/Abstract]) OR Dry Eye Disease[Title/Abstract]) OR Dry Eye Diseases[Title/Abstract]) OR Dry Eye[Title/Abstract]) OR Dry Eyes[Title/Abstract]) OR Evaporative Dry Eye Disease[Title/Abstract]) OR Evaporative Dry Eye Syndrome[Title/Abstract]) OR Evaporative Dry Eye[Title/Abstract]) OR Dry Eye, Evaporative[Title/Abstract]) OR Evaporative Dry Eyes[Title/Abstract]) OR "Dry Eye Syndromes"[Mesh])) AND (((((Surgery, General[Title/Abstract]) OR Surgery[Title/Abstract]) OR "General Surgery"[Mesh])) AND ((Eyelid[Title/Abstract]) OR "Eyelids"[Mesh])))