

# Involitional lower eyelid entropion: causative factors and therapeutic management

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## Abstract

**Purpose** To summarize proposed causative factors and the outcomes of surgical practices for involitional lower eyelid entropion.

**Methods** We reviewed the literature on proposed causative factors and the outcomes of surgical practices for involitional lower eyelid entropion, searched on PubMed.

**Results** Vertical and horizontal laxities of the lower eyelid, and overriding of the preseptal orbicularis oculi muscle onto the pretarsal orbicularis oculi muscle have been proposed as the major causes of involitional lower eyelid entropion. Treatment procedures have been developed over the years to address one or more of these causative factors.

**Conclusions** Various causative factors and treatment procedures have been advocated to explain and correct involitional lower eyelid entropion. The appropriate procedure is chosen according to the patient's condition, such as the presence of vertical laxity, horizontal laxity, and orbicularis oculi muscle overriding. A combination of these procedures to correct multiple factors further decreases the recurrence rate.

**Keywords** Involitional lower eyelid entropion · Vertical laxity · Horizontal laxity · Overriding of preseptal orbicularis oculi muscle · Procedures

## Introduction

Involitional lower eyelid entropion (involitional entropion) is the most common type of entropion affecting the lower eyelids. The prevalence rate among the elderly population is 2.1%, which increases with age [1], while a higher incidence is seen among East Asians compared to non-East-Asians [2, 3]. Inward turning of the eyelid margin can cause mechanical friction by the eyelashes on the corneal surface and can lead to significant corneal epithelial disruption, resulting in corneal scarring and vision loss [4].

Several causative factors in the development of involitional entropion have been enumerated. The main factors include vertical and horizontal laxities of the lower eyelid, and overriding of the preseptal orbicularis oculi muscle (OOM) onto the pretarsal OOM [3–6]. Various surgical procedures have been developed for decades to address each of these factors. Surgical alterations on the lower eyelid retractor (LER), such as plication, shortening and reinsertion, or placing fornix sutures which also pass from the LER, have been used to correct vertical laxity. Horizontal laxity is corrected by lower eyelid

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shortening procedures such as wedge resection of the tarsus, lateral tarsal strip (LTS), and canthopexy. Transverse blepharotomy (Wies procedure), OOM-strip-advancement, OOM tightening, OOM excision, OOM transposition, and Hotz procedure have been used to prevent overriding of the preseptal OOM. On the other hand, non-surgical procedures had been also advocated.

In this review, we summarize proposed causative factors in the development of involutional entropion and treatment outcomes for the correction of this condition.

## Materials and methods

We reviewed the literature on proposed causative factors and outcomes of surgical practices for involutional lower eyelid entropion, searched on PubMed.

### Causative factors of involutional entropion

#### Vertical laxity of the lower eyelid

Vertical laxity mainly results from attenuation or dehiscence of the LER from the lower tarsus [6]. The LER is comprised of anterior and posterior layers [7, 8]. The posterior layer, which includes dense smooth muscle fibers, mainly regulates the vertical tension of the lower eyelid [7, 8]. On the other hand, the anterior layer, continuing from the Lockwood ligament to the anterior lamellae of the lower eyelid, supports the skin and OOM [7, 8].

Vertical laxity is evaluated by pulling the lower eyelid down to the level of the orbital rim. A lax LER allows the forniceal fat to prolapse [5]. The vertical excursion of the lower eyelid between the extremes of upward and downward gaze significantly decreases in patients with entropic eyelids, which is also thought to reflect an attenuation or dehiscence of the LER [9].

#### Horizontal laxity of the lower eyelid

Loosened tarsus and canthal structures are the major causes of horizontal laxity of the lower eyelid [6, 10]. Significant horizontal eyelid laxity is demonstrated in 79% of patients with primary and recurrent involutional entropion [11], while some patients do not show

this characteristic [12], indicating that horizontal laxity is an important but not indispensable causative factor [13].

Horizontal laxity of the lower eyelid is evaluated by the anterior, medial, and lateral eyelid distraction tests, as well as the snap-back test. The anterior eyelid distraction test, also called pinch test, is performed by gently grasping and pulling the lower lid away from the globe; eyelid distraction greater than 8 mm is suggestive of excessive horizontal laxity [1, 3]. The medial distraction test is assumed positive if the lower punctum moved beyond the midpoint of the lacrimal caruncle when the lower eyelid is pulled medially [14]. The lateral distraction test is considered positive if the lower punctum is pulled beyond the midpoint between the plica and medial corneal limbus when the lower eyelid is pulled laterally [14]. Positive results of the medial and lateral distraction tests indicate laxity of the lateral and medial canthal supporting structures, respectively. The snap-back test, also called lid retraction test, is performed by pulling the lower eyelid inferiorly followed by releasing it. The lower eyelid normally springs back to its natural position without blinking. A slow or incomplete return to the original eyelid position indicates decreased tone of the OOM or excessive laxity of the tarsoligamentous sling [15].

#### Overriding of preseptal OOM

The preseptal OOM overrides onto the pretarsal OOM secondary to laxity of the LER [16]. This may increase the backward force for inward rotation of the lower eyelid. Botulinum toxin injection into the preseptal OOM successfully prevents lower eyelid inversion, implying its contribution to the pathogenesis of involutional entropion [17].

On the contrary, previous studies revealed that the backward force by OOM overriding alone is insufficient to invert the lower eyelid [10, 18]. Overriding of the preseptal OOM can still be observed during voluntary maximum forced eyelid closure while holding the upper eyelid away from the lower eyelid [10]. As the lower eyelid does not rotate inward at that time [10], an additional backward force from the upper eyelid, which will be described later, may be necessary to cause inversion of the lower eyelid.

### Positional relationship between the globe and lower eyelid

Enophthalmos, shorter axial globe length, microphthalmos, and anophthalmos occasionally cause entropion [5, 19–21]. In such patients, the lower eyelid margin has a structural backward vector caused by the more posterior location of the corneal surface relative to the inferior orbital rim [21]. In addition, these patients tend to have horizontally elongated lower eyelids, implying increased horizontal laxity [20–22]. However, this factor alone does not produce enough power to invert the lower eyelid [22].

Orbital fat volume may decrease due to involutional changes from aging, resulting in enophthalmos [23]. A recent study demonstrated that patients with involutional entropion had smaller exophthalmometry measurements than those with involutional ectropion [21]. On the contrary, a previous study showed no association between enophthalmos and aging [24], and another study demonstrated no significant difference in exophthalmometry measurements between affected and non-affected sides in patients with involutional entropion [25].

### Involutional changes in the Tarsus

The tarsus is composed of collagen and elastic fibers with meibomian glands [26]. Collagen fibers are sources of tensile strength, while elastic fibers provide matrix resiliency [27]. Degeneration and fragmentation of collagen and elastic fibers with reduction in the number of meibomian glands occur in the tarsus with age, which lead to excessive horizontal laxity of the lower eyelid and atrophic changes (thinning and shortening) in the tarsus [20, 26–29]. The vertical length of the lower tarsus decreases with age by approximately 50% (5.28 mm for those younger than 50 years; 2.3 mm for those older than 60 years on average) [30]. A thinner and shorter tarsus is thought to allow easier inward rotation of the lower eyelid [22, 31].

On the contrary, a recent study demonstrated thickened lower tarsi in patients with involutional entropion, compared to age-matched patients with basal cell carcinoma [6]. This change may be due to chronic inflammation and/or lack of LER stretching forces on the lower tarsus.

### Inward upper eyelid push

Involutional entropion of the lower eyelid does not show inward rotation during eyelid closure when contact is avoided between the upper and lower eyelid margins [10, 18]. The upper eyelid margin overriding on the vertically lax lower eyelid margin during eyelid closure produces high pressure in a backward direction due to contraction of the OOM [32]. When this upper eyelid pressure, as well as contractile power of the OOM on the lower tarsus [16], is beyond the horizontal lower eyelid tension [1], inward rotation of the lower eyelid occurs [18].

### Orbital fat protrusion

Orbital fat protrusion is occasionally seen in the inferior orbit, particularly in the anterosuperior direction across the inferior orbital rim among elderly East Asians [2]. This may also serve as an active force in the inward rotation of the lower eyelid. Such anatomical feature may be a cause of the higher incidence of involutional entropion in the East Asian population [2].

## Treatment procedures

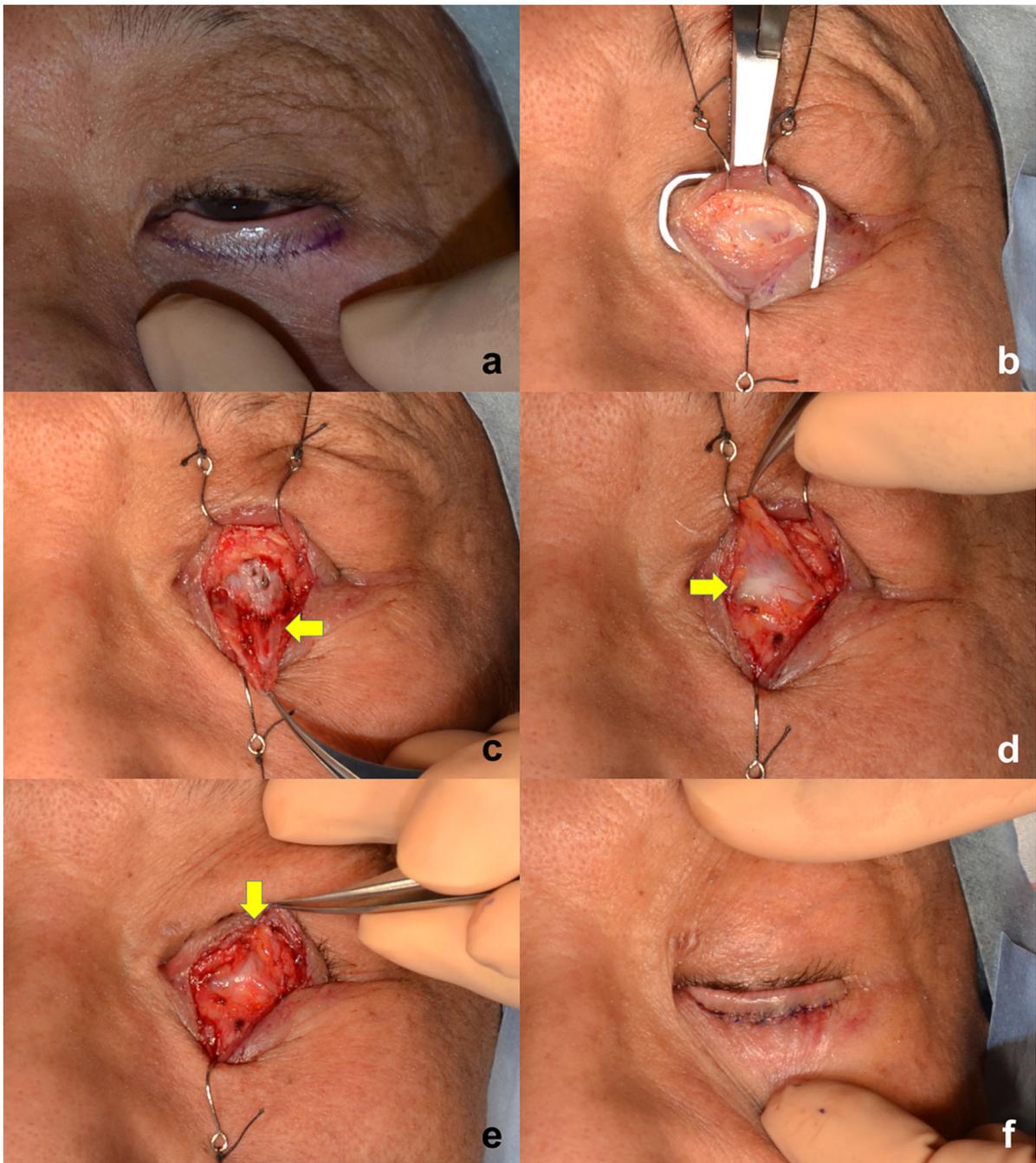
### Correction of vertical laxity

An attenuated or dehiscent LER is the target tissue for correction of vertical eyelid laxity.

#### *Jones procedure*

Vertical tightening of the LER was first described by Jones in 1960 [33], which was a plication procedure of the LER. This technique has a recurrence rate of 5–16.7% [34–36]. Later, reinsertion of a dehiscent LER was reported with a recurrence rate of 3.4–11.5% [37, 38].

Full-thickness advancement of the lower eyelid retractor has been proposed by Kakizaki [39] (Fig. 1). In this procedure, the posterior surface of the LER is detached from the tarsus and conjunctiva using an entropion clamp, which facilitates definite advancement of the posterior layer as well as the anterior layer [39]. This procedure alone shows a satisfactory result without recurrence after a 22-month follow-up period



**Fig. 1** Full-thickness advancement of the lower eyelid retractor (LER). **a** A skin incision line is drawn 3 mm below the cilia. **b** The layer under the orbicularis oculi muscle is dissected toward the cilia to expose the lower tarsus. **c** The posterior layer

of the LER (arrow) is detached from the conjunctiva. **d** The orbital septum is incised transversely to expose the sheet-like LER (arrow, anterior layer of the LER). **e** Full-thickness advancement of the LER (arrow). **f** Wound closure

as indicated by negative anterior, medial, or lateral distraction tests [12]. The most common complication of transcutaneous LER plication or advancement is

ectropion (Table 1), but in most cases, it is transient and resolves spontaneously.

**Table 1** Recent studies on lower eyelid retractor (LER) plication or advancement

References	Procedure	Eyelids	Follow-up (months)	Recurrence rate (%)	Complications
Caldato [37]	LER reinsertion (subciliary)	30	28.7	3.4–11.5	Overcorrection
Park [38]		26	7.3		
Boboridis [36]	LER plication (subciliary)	37	31	5	Overcorrection
Chu [4]	LER redirection (subciliary)	67	26.2	3	Ectropion
Nakauchi [92]	LER advancement (subciliary)	9	> 6	33.3	None
Kreis [42]	LER advancement (transconjunctival)	11	7.5	18.2	Chemosis
Kakizaki [39]	Posterior layer advancement (subciliary)	50	> 12	2%	Ectropion
Lee [12]	Posterior layer advancement + OOM excision (in patients with horizontal laxity) (subciliary)	46	26.2	8.7	Ectropion
Lee [12]	Posterior layer advancement + OOM excision (in patients without horizontal laxity) (subciliary)	47	22.2	0	Ectropion
Nakauchi [92]	LER advancement + Hotz procedure	21	> 6	5	Ectropion
Ben Simon [43]	LER plication (subciliary) (+ LTS)	29	6.4	3.4	Eyelid retraction, ectropion, pyogenic granuloma
	LER plication (transconjunctival) (+ LTS)	20	7	15	Pyogenic granuloma
Yip [82]	LER reattachment (subciliary) + LTS	47	13	2.1	Ectropion, wound dehiscence
Athavale [81]	LER advancement onto the anterior surface of the tarsus (skin crease incision) + LTS	67	24	1	Eyelid edema
Lee [12]	Posterior layer advancement (subciliary) + OOM excision + LTS (in patients with horizontal laxity)	47	17	0	None
Ishida [68]	Posterior layer advancement (subciliary) + transcanthal canthopexy (in patients with horizontal laxity)	51	13.9	0	None
Serin [73]	LER tightening (transconjunctival) + everting sutures + LTS	45	22.6	2.2	None
Altieri [53]	LER plication without dissection of orbital septum (subciliary) + OOM excision	9	36	7.1–22.2	None
Altieri [35]		28	48		
Altieri [35]	LER plication + OOM excision (subciliary)	34	48	14.7	None
Cook [40]	LER reattachment (transconjunctival) + OOM excision + LTS (with periosteal flap)	36	31.5	8.3	Trichiasis
Khan [83]	LER plication (transconjunctival) + OOM excision + LTS	114	38.3	1.8	None
Erb [41]	LER reattachment (transconjunctival) + OOM excision + LTS	151	4	3.3	Suture abscess, LTS dehiscence, lateral canthal dystopia, conjunctivochalasis

**Table 1** continued

References	Procedure	Eyelids	Follow-up (months)	Recurrence rate (%)	Complications
Asamura [70]	Posterior layer advancement (subciliary) + Hotz procedure + wheeler procedure	23	16	0	Ectropion

LTS lateral tarsal strip; OOM orbicularis oculi muscle

LER advancement is also performed through the transconjunctival approach [40–42]. This approach, however, shows a higher recurrence rate than the transcutaneous approach. This is likely attributed to less scarring of the anterior lamella and less reliable advancement of the posterior layer [12, 43].

#### Quickert suture

Everting sutures, called Quickert sutures [44], involve mattress sutures through the full thickness of the eyelid. Sutures of 4–0 to 6–0 chromic gut, nylon, silk, and polyglactin are usually used in this procedure [45, 46]. Silk suture is recommended among these owing to lower cost in a setting of limiting resources [47]. These everting sutures incite scarring through fibroblastic activity with collagen formation around the track [45] that may prevent overriding of the preseptal orbicularis and tighten the lower eyelid retractors to some degree, which results in prolonged eyelid eversion for a variable duration after suture removal [3].

An advantage of this procedure is that it only requires a short surgical time; thus, this procedure is regarded as a temporary repeatable method for incapacitated patients. However, it has a high recurrence rate ranging from 7.2% to 33% (Table 2) [46–53]. The risk of recurrence is 3.78 and 2.85 times higher in patients with severe horizontal laxity and of male gender, respectively [51]. The most frequent complications include suture-related granuloma tissue formation and ectropion (Table 2).

#### Correction of horizontal laxity

The lateral canthal supporting structures and tarsus are targeted to correct horizontal laxity of the lower eyelid.

#### Wedge resection

Butler, in 1948, first described a procedure involving excision of a triangular piece of tarsus and conjunctiva at the center of the lower eyelid [54]. Fox modified this technique by the use of a lid splitting approach for triangular excision of the tarsus at the center of the lower eyelid and excising a spindle of skin and orbicularis muscle laterally [55]. Foulds and later Collin and Rathbun, on the other hand, shortened the posterior lamella horizontally through a rectangular excision of the lateral tarsus and lower eyelid margin [22, 56]. Dalglish and Smith, meanwhile, described a full-thickness pentagonal excision of the lower eyelid at its center [57].

Bick described a technique involving full-thickness pentagonal lower eyelid resection at the lateral canthus (Bick's procedure) [58]. Although a previous study showed good surgical outcomes of Bick's procedure alone for entropion [59], this technique has been usually performed as part of a combined procedure [60, 61]. An advantage of this procedure, compared to the LTS which will be discussed next, is a lower risk of secondary inflammation and infection incited by continuous secretion of buried meibomian glands within the deep tissues of the lateral canthus seen in LTS [60, 61].

**Table 2** Recent studies on Quickert sutures

Study	Procedure	Eyelids	Follow-up (months)	Recurrence rate (%)	Complications
Rougraff [50]	Quickert sutures	9	24	7.2–33	Ectropion
Altieri [53]		13	36		
Singh [47]		50			
Jang [51]		69	34.5		
Baek [52]		94	14.9		
Scheepers [46]	Quickert sutures (in patients without severe horizontal laxity)	29	18	11.8–21	Granuloma
Tsang [56]		34	13.2		
Rougraff [50]	Quickert sutures +LTS	125	37	0–12.2	Cellulitis, ectropion, granuloma
Quist [86]		22	33.3		
Ho [84]		41	24		
Barnes [85]		54	18		
Scheepers [46]		26	18		
Baek [52]		44	15.9		

LTS lateral tarsal strip

### LTS

The LTS is a well-recognized surgical technique for correcting horizontal eyelid laxity (Fig. 2). In 1969, Tenzel reported a lateral canthal tendon sling to tighten and elevate the lower crus of the lateral canthal tendon for the treatment of lagophthalmos [62]. Anderson, in 1979, modified this procedure and included stripping of a lateral part of the tarsus and subsequent fixation onto the periosteum of the lateral orbital rim for eyelid shortening [63]. The advantages of this procedure include direct correction of loosened lateral canthal supporting structures, the absence of a marginal suture to prevent eyelid notching, preservation of tear secretion, and prevention of blepharophimosis. On the contrary, this technique may lead to canthal dystopia or the appearance of a “round eye” [64].

This procedure is usually combined with other surgical procedures, as its recurrence rate is as high as 17.4% when performed alone for involutional entropion [65].

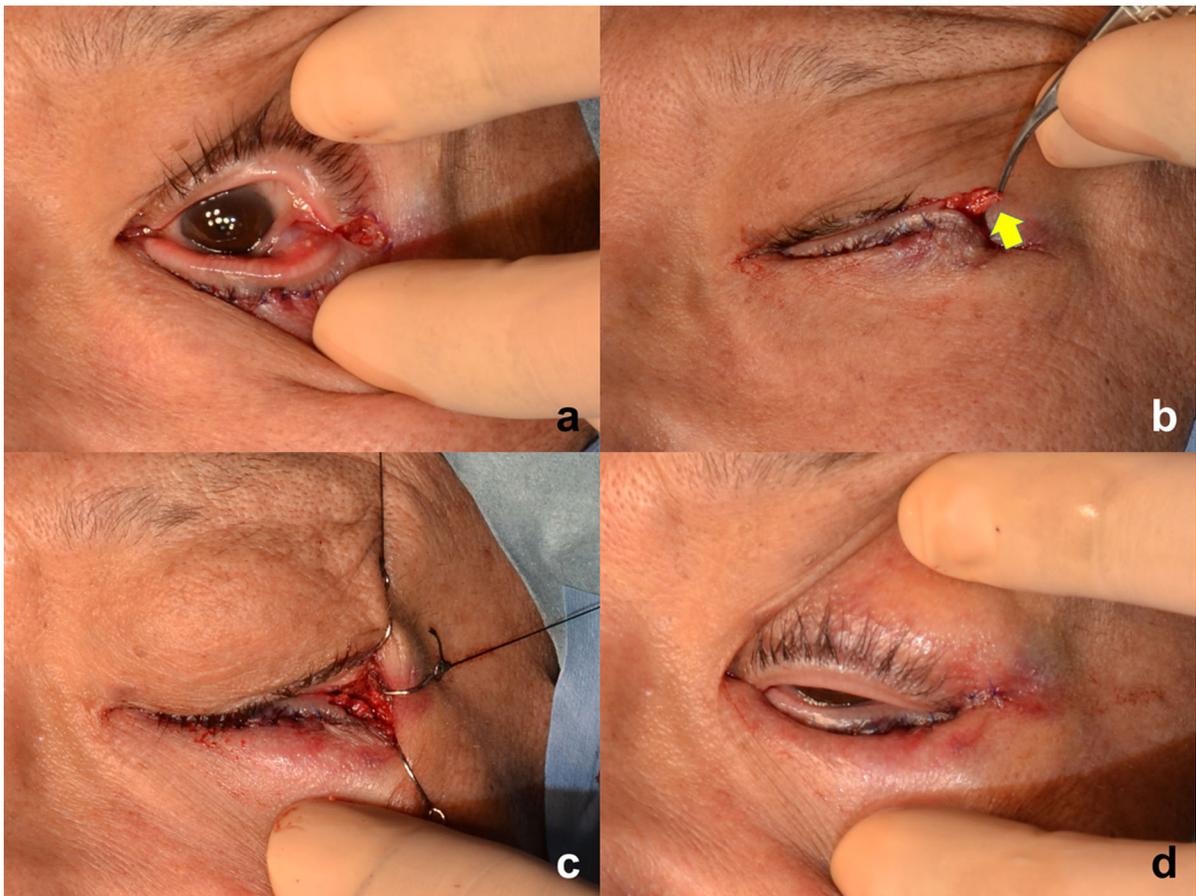
### Transcanthal canthopexy

A canthopexy is a plication procedure of the lateral canthal supporting structures without a lateral canthotomy [66] (Fig. 3). This procedure was first reported by Hamra [67]. This technique is preferred for correcting mild eyelid laxity and has the advantage of preventing a “round eye” [66]. On the contrary, a disadvantage of this procedure is recurrence of horizontal eyelid laxity following a certain period after surgery [68].

### Prevention of OOM overriding

#### Wheeler’s operation

Wheeler described the “orbicularis-strip-advance-ment” technique in 1938 [69]. In this procedure, he elevated a 4-mm strip of the OOM, incised the lateral end of this strip, pulled it temporally, and sutured it to the periosteum of the lateral orbital wall [69]. In the same paper, he also presented an alternative procedure that included a subciliary skin incision, dissection of an OOM strip below the skin incision line, and



**Fig. 2** The lateral tarsal strip procedure. **a** A lateral canthotomy. **b** After a lateral cantholysis, a tarsal strip is fashioned (arrow). **c** The tarsal strip is fixed to the periosteum of the lateral orbital wall. **d** Wound closure

horizontal shortening of the strip [69]. Recently, plication of the OOM strip was reported as a modification of this technique (Modified Wheeler's procedure) [70].

#### *Vertical tightening of OOM*

The preseptal OOM is sutured to the pretarsal OOM for vertical tightening of the OOM. This procedure prevents both overriding of the preseptal OOM and protrusion of fat in the inferior orbit [13].

#### *Wies procedure*

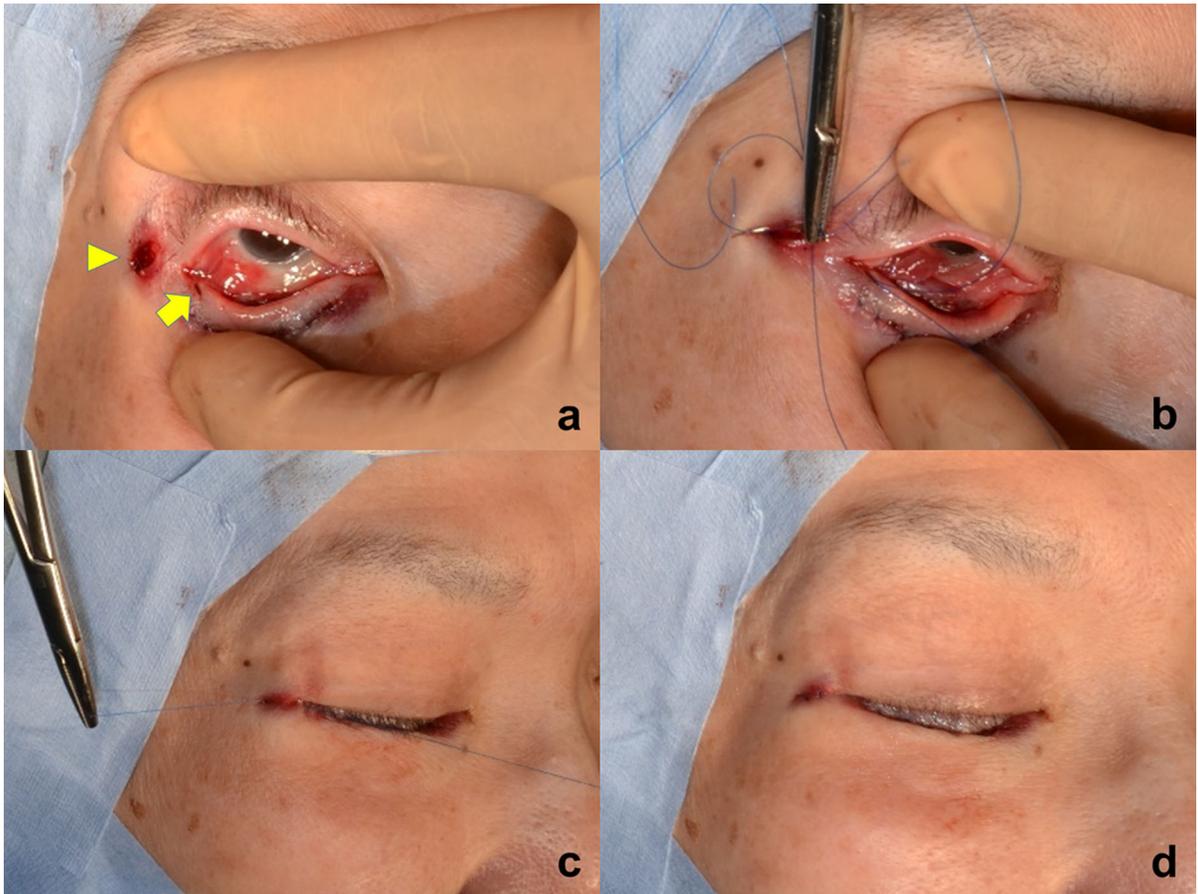
Wies described the creation of a full-thickness lower eyelid scar by the use of a transverse eyelid split in 1954 [71]. This technique includes everting sutures [71–73]. This procedure mainly aims at preventing

preseptal OOM overriding by scar formation, whereas the everting sutures act to provide vertical tightening. However, the recurrence rate remains high (10.6–26%) if performed alone [36, 72–74]. Ectropion is a well-recognized complication of this procedure, which occurs in 10–31% of cases [36, 71].

#### *Removal of OOM*

A strip of the preseptal OOM is often excised during any combination of procedures, although a previous study showed good surgical outcomes even after preseptal and pretarsal OOM excision alone [75].

Nowinski reported an OOM extirpation procedure, in which the preseptal OOM is removed from the incision line down to the orbital rim [76]. This procedure is also usually combined with other techniques of vertical tightening or horizontal shortening



**Fig. 3** Transcanthal canthopexy. **a** A 10-mm skin incision is made along the lateral canthal rhytids, just anterior to the lateral orbital rim (arrow head). A stab incision is made at the lower eyelid margin just medial to the commissure (arrow). **b** Needles

are inserted into the stab incision, passed through the periosteum of the lateral orbital rim, and pulled out from the skin incision area. **c** A firm ligation of this suture. **d** Wound closure

[76]. The complications of this procedure include excess tearing and overcorrection [76].

#### *OOM transposition*

A bundle of pretarsal OOM is sutured to the lower surface of the orbital septum in this procedure. This technique allows a low recurrence rate of 5% when done alone [77], although no comparative study has been performed so far.

#### *Non-surgical injection procedures*

Botulinum toxin injection into the preseptal OOM is a non-surgical procedure for temporary correction of involutional entropion [17]. The preseptal OOM can

be injected with 12.5–35 units of botulinum toxin [17, 78, 79]. A previous study recommended to avoid injection in the medial portion of the lower eyelid to maintain lacrimal drainage function [78]. Relief of the symptoms last for at least 3 months in most cases [17, 78, 79].

Filler injection is a possible non-surgical procedure for correction of involutional entropion. A previous study involving dogs and cats reported on subdermal filler injections performed 1–2 mm from the eyelid margin in the affected area, with 36 of 40 (90%) animals obtaining resolution of entropion-related symptoms during the mean follow-up of 152.5 days [80]. Fillers injected near the eyelid margin may stabilize the eyelid position and prevent OOM

overriding. However, there had been no reports on filler injections for involitional entropion in humans.

### Combined procedures

#### *Vertical tightening and horizontal shortening*

*Lower eyelid retractor advancement (or plication) with horizontal shortening* Plication, reattachment, or advancement of the LER shows a recurrence rate of 0–8.3% when combined with LTS (Table 1) [12, 40, 41, 73, 81–83]. Transcutaneous advancement of the posterior layer of the LER combined with LTS or transcanthal canthopexy achieved excellent surgical outcomes without recurrence for 13.9 and 17.0 months [12, 68]. Transconjunctival advancement of the lower eyelid retractor is also combined with LTS, although the reported success rate (1.8–8.3%) was lower than the transcutaneous approach [40, 41, 73, 83].

*Everting sutures with horizontal tightening* Quickert sutures with LTS have a lower recurrence rate compared to everting sutures alone, although the recurrence rate stated in the literature is variable (0–12.2%) (Table 2) [46, 50, 52, 84–86]. The variations in recurrence rates are likely attributed to differences in patient population, surgical technique, and follow-up period [46].

#### *Horizontal shortening and prevention of OOM overriding*

*Wies procedure with LTS* Wies procedure combined with LTS showed no recurrence in 29 cases after a minimum 6-month follow-up period [72].

*OOM excision with Wedge resection (Bick' procedure)* Leibovitch reported removal of a thin strip of skin and OOM via a subciliary incision after full-thickness wedge resection (Bick's procedure), which showed a recurrence rate of 1.7% [61]. Beigi also presented a similar technique of OOM stripping with wedge resection, with a recurrence rate of 8.1% [87].

*OOM excision with LTS* Dunbar et al. reported excision of a skin-OOM flap with LTS. Only 1 out of 80 patients showed recurrence with mild entropion [88].

*Other combinations* Rabinovich et al. combined the technique of suture fixation of the pretarsal OOM to the anterior tarsal surface with LTS [89]. No recurrence was reported in this study [89]. Spinelli et al. presented lateral OOM suspension following LTS, also without recurrence [90]. Olali et al. showed a combined procedure of Wheeler's procedure and horizontal shortening of the tarsus, with a recurrence rate of 1.9% [91].

#### *Vertical tightening and prevention of OOM overriding*

The Hotz procedure is combined with LER advancement in the technique proposed by Nakauchi, which is thought to prevent OOM overriding to some extent [92]. The modified Wheeler's procedure showed a complete success rate in combination with advancement of the posterior layer of the LER [70].

## Conclusions

Many causative factors and treatment procedures have been advocated to explain and correct involitional lower eyelid entropion. These are chosen according to the patient's condition, such as the presence of vertical laxity, horizontal laxity, and OOM overriding. A combination of these procedures to correct multiple factors further decreases the recurrence rate. Due to the lack of comparative studies, the best surgical technique remains controversial.

### Compliance with ethical standards

**Conflict of interest** All authors declare that they have no conflict of interest.

**Informed consent** Written informed consent for the use of the face photos was obtained from the patients.

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