Avoiding Pretarsal Denervation in Lower Blepharoplasty Incisions: Refined Pretarsal Motor Nerve Anatomy

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Background: Pretarsal atrophy is not uncommonly found in patients who have undergone a transcutaneous or transconjunctival lower blepharoplasty because of intraoperative denervation of the pretarsal orbicularis oculi. The motor-supplying concept to the lower eyelid was recently updated; however, there have not yet been any guidelines to preserve motor nerves in lower blepharoplasty incisions based on the refined knowledge.
Methods: Forty-six fresh cadaveric hemifaces were examined to find a safe zone for a lower blepharoplasty muscle incision and a danger zone for an infraorbital incision in the transblepharoplasty midface approach. In addition, practical anatomy about the pretarsal motor supply was also investigated in detail.
Results: The medial, lateral, superior, and inferior borders of the safe zone for a lower blepharoplasty muscle incision were 9.4 mm from the medial canthus line, 3 mm from the lateral canthal crease, and 6.0 and 6.5 mm from the eyelid margin, respectively. The danger zone for an infraorbital incision ranged from 9.4 mm medial to the midpupillary line to 9.7 mm lateral to the midpupillary line. The motor nerve in the danger zone abutted the distal roof of the preseptal pocket, making it vulnerable to electrocautery heat. Motor nerve distribution of the lower pretarsal orbicularis oculi was fully identified.
Conclusions: There is a safe zone for the lower blepharoplasty muscle incision which, if adhered to, will preserve the pretarsal motor supply and prevent muscle atrophy. There is an infraorbital danger zone, where surgeons should pay special attention to avoid electrocautery heat injury. *(Plast. Reconstr. Surg.* 154: 81, 2024.)

Preservation of preoperative muscle tone is essential for a successful lower blepharoplasty. When the pretarsal orbicularis oculi muscle is denervated during surgery, it eventually atrophies,[1,2] which leads to eyelid malposition and loss of natural pretarsal convexity.[3,4] Pretarsal atrophy may appear variably from slight scleral show to symptomatic ectropion, according to the affected muscle part.[5]

In a transcutaneous blepharoplasty, the main cause of pretarsal atrophy is logically presumed to be a motor nerve injury while incising or excising the pretarsal orbicularis oculi muscle.[6] For example, pretarsal atrophy cephalic to a muscle incision is not uncommon in patients who have undergone a lower blepharoplasty (Fig. 1, *left*). Nonetheless, numerous authors have focused on conservative excision of excessive skin and muscle,[7,8] and lateral canthal tightening procedures[9–12] to prevent postoperative eyelid malposition. Attention has rarely been paid to proper placement of the muscle incision in consideration of correct motor nerve anatomy.

A transconjunctival blepharoplasty has been favored by many plastic surgeons because it does not touch the orbicularis oculi, and therefore, the

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Fig. 1. Pretarsal muscle atrophy after a transcutaneous and transconjunctival lower blepharoplasty. (*Left*) The left lower eyelid of a 58-year-old woman shows typical subciliary muscle atrophy cephalic to the muscle incision after a transcutaneous lower blepharoplasty with a subciliary skin-muscle incision (*filled arrows*) performed elsewhere. Note the skeletonized subciliary region cephalic to the incision with deprived natural pretarsal fullness because of muscle atrophy. (*Right*) The right lower eyelid of a 28-year-old woman shows flattening in the medial pretarsal fullness (*open arrows*) and a lowered lid margin (*filled arrow*) because of partial muscle atrophy after a transconjunctival lower blepharoplasty with tear trough correction performed by another plastic surgeon. This case is described further in Video 1.

muscle is expected to be intact postoperatively.[13–16] Nevertheless, pretarsal atrophy has sometimes been found following a transconjunctival blepharoplasty (Fig. 1, *right*). (**See Video 1 [online]**, which shows a pretarsal atrophy case resulting from previous transconjunctival lower blepharoplasty.) While releasing the orbicularis retaining ligament or tear trough using an electrocautery in a transconjunctival[16,17] or transcutaneous blepharoplasty,[18–20] surgeons sometimes witness pretarsal muscle twitching, demonstrating the presence of a motor nerve danger zone in the infraorbital region.

Understanding of the motor supply to the pretarsal orbicularis oculi has changed recently. Before 2000, the lower eyelid orbicularis oculi was thought to be mainly innervated from the lateral periorbital region.[21] Then, in early 2000, the lower pretarsal orbicularis oculi was thought to be supplied by 2 nerves: a nerve entering vertically from the inferior malar area (previously thought to be the zygomatic branch of the facial nerve)[22] and the angular nerve[23] (also referred to as the superficial buccal branch),[24] which was thought to enter horizontally from the medial periorbital region. Given this anatomical concept, the transcutaneous blepharoplasty incision inevitably leads to transection of the vertically entering nerve,[25] which has caused many plastic surgeons to avoid this technique. However, in 2017, Choi et al.[26] argued that there is no pretarsal denervation if the muscle incision is properly placed in recognition of correct motor nerve anatomy. Their study revealed that the vertically running nerve is not the zygomatic branch of the facial nerve but the sensory nerve, and that the angular nerve does not, in fact, supply the lower eyelid. Instead, the lower palpebral branch was identified as the main motor nerve of the lower eyelid. According to their studies, the main pretarsal portion of the lower eyelid was supplied by the distal part of the lower palpebral branch (referred to as "the lower medial pretarsal branch").[27] Only the lateral pretarsal portion of the lower eyelid region was supplied by a minor motor fiber (the lower lateral pretarsal branch) entering from the lateral periorbital region.[27]

This study aimed to discover a motor nerve safe zone for the transcutaneous lower blepharoplasty incision and a motor nerve danger zone for the transblepharoplasty midface approach, which are critical to avoid denervation-induced muscle atrophy after a transconjunctival or transcutaneous lower blepharoplasty. In addition, this article includes precise anatomy of the pretarsal motor supply of the lower eyelid and incision guidelines for the lower blepharoplasty.

PATIENTS AND METHODS

This study was conducted using 46 Korean cadaveric hemifaces (all legally donated in

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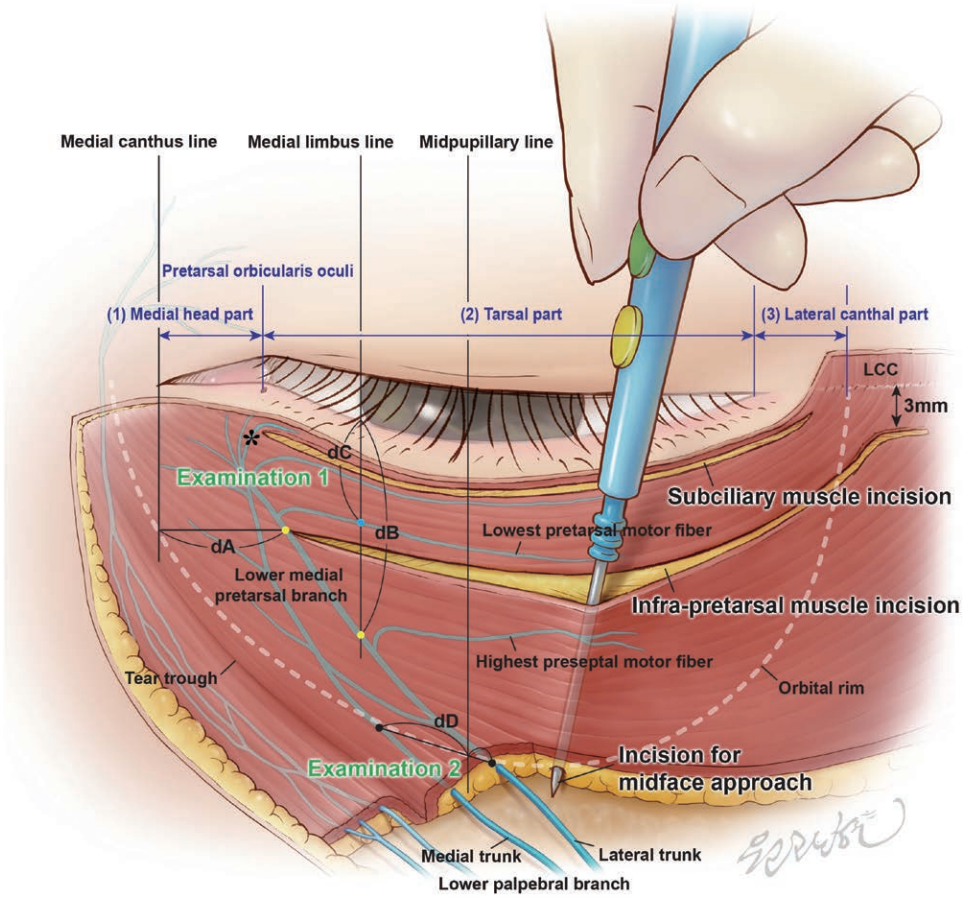


Fig. 2. Diagram for examinations 1 and 2. Examination 1: examining a possible motor safe zone for the infrapretarsal muscle incision by measuring the medial (dA), inferior (dB), and superior (dC) safe limits. *dA*, the horizontal distance between the most lateral motor nerve trunk (at the medial end of the infrapretarsal muscle incision) and the medial canthus line;*dB*, the vertical distance (along the medial limbus line) between the most lateral motor nerve trunk and the eyelid margin; *dC*, the vertical distance (along the medial limbus line) between the lowest pretarsal motor fiber and the eyelid margin. The lateral safe limit was already reported to be 3 mm lateral to the lateral canthal crease (*LCC*) in our previous study (Choi Y, Kim IB. Distribution of the laterally supplying facial nerve to the orbicularis oculi muscle. *Aesthet Surg J*. 2021;41:161–169.). In addition, the distance between the lacrimal punctum line and the main motor nerve fiber (*filled asterisk*) entering the superior part of the pretarsal orbicularis oculi was observed to identify the anatomical relationship between nerve distribution and subciliary denervation after a subciliary skin-muscle incision. Examination 2: examining a possible motor nerve danger zone for a transblepharoplasty infraorbital incision in a midface approach by (1) measuring the distances between the midpupillary line and the points where the lower palpebral branch trunks cross over the orbital rim (*dotted line*), which is indicated with dD; and (2) observing integrity of the lower palpebral branch trunks while using an electrocautery to incise the orbital retaining ligament and the bony origin of the orbicularis oculi.

accordance with national law) and received ethics committee approval from the institutional review board (MC21RISI0024) of College of Medicine, The Catholic University of Korea, Seoul, Republic of Korea. Forty-six cadaveric hemifaces were dissected using a surgical microscope (Carl Zeiss GmbH, Oberkochen, Germany) for examining the following issues, as explained in Figure 2: (1) precise anatomy of the motor supply to the pretarsal orbicularis oculi of the lower eyelid; (2) medial, superior, and inferior safe limits for an infrapretarsal muscle incision in a transcutaneous

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lower blepharoplasty (examination 1 in Fig. 2); and (3) a motor nerve danger zone for a transblepharoplasty infraorbital incision in a midface approach (examination 2 in Fig. 2). The lateral safe limit was measured in only 4 samples in this study because it was revealed to be 3 mm in our previous study.[27] The cadaver dissections were undertaken by a plastic surgeon (Y.C.) who has performed lower blepharoplasties for over 20 years in his private clinic and has also dissected the facial nerve in more than 150 hemifaces for studies about periorbital motor supply over the past 8 years.

Measured values of both sides of each cadaver were analyzed statistically using IBM SPSS Statistics Version 23 (IBM Corp, Armonk, NY) to see symmetry of the nerve distribution. This process was done by another researcher who was not involved in this study to avoid any potential bias.

RESULTS

Forty-six hemifaces (31 male and 15 female hemifaces) from 31 fresh cadavers (mean age, 77.2 years; range, 53 to 99 years) were dissected between August of 2017 and November of 2022.

A. Motor supply of the pretarsal orbicularis oculi in the lower eyelid. (**See Video 2 [online]**, which shows the motor nerve supplying the pretarsal region of the lower eyelid.)
   1. The pretarsal orbicularis oculi was composed of the medial head part, tarsal part, and lateral canthal part (Fig. 3). The medial head part of the pretarsal orbicularis oculi that was medial to the lacrimal punctum had thick muscle layers (superficial and deep muscle heads) and lacked the tarsal plate. The top of the tarsal part of the pretarsal orbicularis oculi was approximately 1.5 mm inferior to the eyelid margin and its inferior border was 1.5 to 2.5 mm inferior to the inferior tarsal border. The inferior border of the tarsal part of the pretarsal orbicularis oculi was 5.0 to 6.5 mm inferior to the eyelid margin.
   2. The medial head part and tarsal part of the pretarsal orbicularis oculi were supplied by the "lower medial pretarsal branch," which is the distal portion of the lower palpebral branch, whereas the lateral canthal part of the pretarsal orbicularis oculi was supplied by 1 or 2 fine motor fibers, which were reported as the lower lateral pretarsal branch.[27]
   3. As summarized in Figure 4, the lower palpebral branch (the mother nerve of the lower medial pretarsal branch) originated from the zygomatic and/or zygomaticobuccal branches in the deep medial cheek fat layer[28] between the zygomaticus major and minor muscles, together with the upper medial palpebral branch (the medial motor of the upper eyelid). The lower palpebral branch ran in an oblique line connecting the inferior malar prominence (the palpable tip of the zygomatic process of the maxilla)[16] and the inferior lacrimal punctum (Fig. 5, *left*). It passed beneath the zygomaticus minor muscle and obliquely crossed the anterior cheek as 2 to 4 dispersed nerve trunks in the suborbicularis oculi fat.[29] Immediately

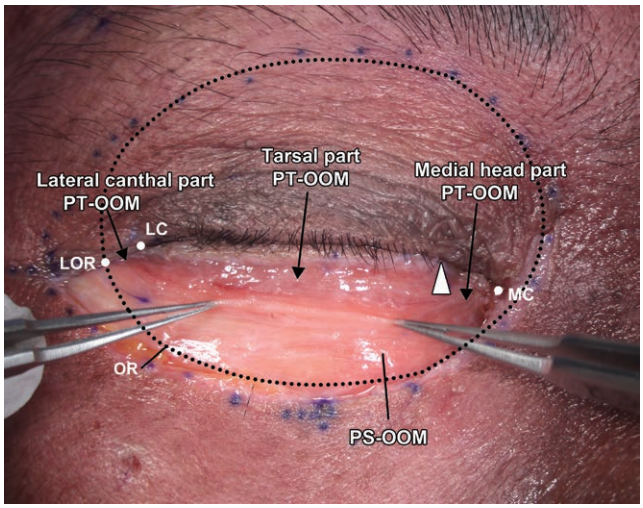


Fig. 3. Three parts of the pretarsal orbicularis oculi (*PT-OOM*) in the right lower eyelid of a 74-year-old male cadaver: the medial head part, tarsal part, and lateral canthal part.The medial head part and tarsal part of the pretarsal orbicularis oculi are divided by the lacrimal punctum (*open arrowhead*), which is located at the medial end of the inferior tarsal plate. The lateral canthal part of the pretarsal orbicularis oculi occupies most of the space between the lateral canthus (*LC*) and the lateral orbital rim point (*LOR*). The pretarsal orbicularis oculi surface has a vertical and horizontal convexity with a darker reddish hue than the preseptal orbicularis oculi (*PS-OOM*). The forceps are pinching the inferior border of the pretarsal orbicularis oculi, which is 5.5 to 6.5 mm inferior to the eyelid margin (1.5 to 2.5 mm inferior to the inferior tarsal border). *MC*, medial canthus; *OR*, orbital rim.

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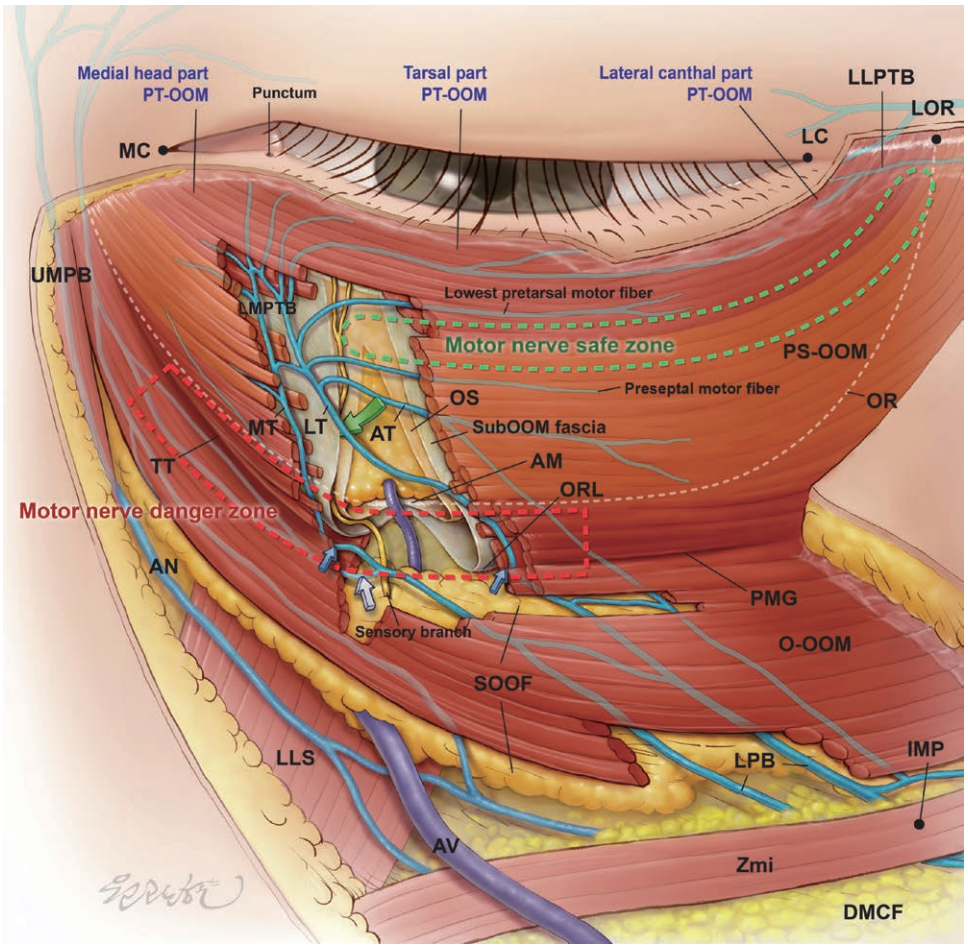


Fig. 4. Summary illustration of pretarsal motor supply with the motor nerve safe zone and danger zone: (1) the pretarsal orbicularis oculi (*PT-OOM*) is composed of the medial head part, tarsal part, and lateral canthal part. The medial head part and tarsal part are supplied by the lower medial pretarsal branch (*LMPTB*), which is the terminal portion of the lower palpebral branch (*LPB*); note that the medial head part is supplied by medially or vertically running, short motor fibers of the lower medial pretarsal branch, whereas the tarsal part is supplied by laterally running, transverse motor fibers of the lower medial pretarsal branch; note also that the lateral canthal part is supplied by the lower lateral pretarsal branch (*LLPTB*); (2) although the lower palpebral branch can be composed of 1 to 3 main trunks in the lower eyelid, this diagram shows the 2-main trunk pattern, which is composed of a medial trunk (*MT*) and lateral trunk (*LT*) and, in this case, an accessory trunk (*AT*) (note that the preseptal motor fibers diverge from the lower palpebral branch in the preseptal region); (3) a possible motor nerve safe zone for the transcutaneous muscle incision (*green dotted area*) is superolateral to the lateral trunk and accessory trunk, inferior to the lowest pretarsal motor fiber, and medial to the lower lateral pretarsal branch; (4) the tissue window shows the preseptal space (*green arrow*) between the orbital septum (*OS*) and suborbicularis (*subOOM*) fascia. The suborbicularis fascia continues inferiorly into the superior lamella of the orbicularis retaining ligament (*ORL*); (5) the *red dotted area* represents a possible motor nerve danger zone in the infraorbital area when an electrocautery is used for a preperiosteal dissection of the midface. Note the deep intramuscular location of the lower palpebral branch trunks in the inferior portion of the preseptal pocket, where the thin suborbicularis fascia and sporadic deep muscle bundles lay beneath the lower palpebral branch trunks, which make the nerve vulnerable to heat injuries by electrocautery use. Note an upper eyelid motor component diverges from the medial trunk of the lower palpebral branch (*open arrowhead*) and travels along the tear trough (*TT*) before joining the upper medial palpebral branch (*UMPB*). *AM*, arcus marginalis; *AN*, angular nerve; *AV*, angular vein; *DMCF*, deep medial cheek fat; *IMP*, inferior malar prominence; *LC*, lateral canthus; *LLS*, levator labii superioris; *LOR*, lateral orbital rim point; *MC*, medial canthus; *O-OOM*, orbital orbicularis oculi muscle; *PMG*, palpebromalar groove; *PS-OOM*, preseptal orbicularis oculi muscle; *SOOF*, suborbicularis oculi fat; *Zmi*, zygomaticus minor.

below the orbicularis retaining ligament, the nerve trunks entered the deepest layer of the orbicularis oculi and then traveled the medial half of the preseptal area of the lower eyelid. In this area, the lower palpebral branch

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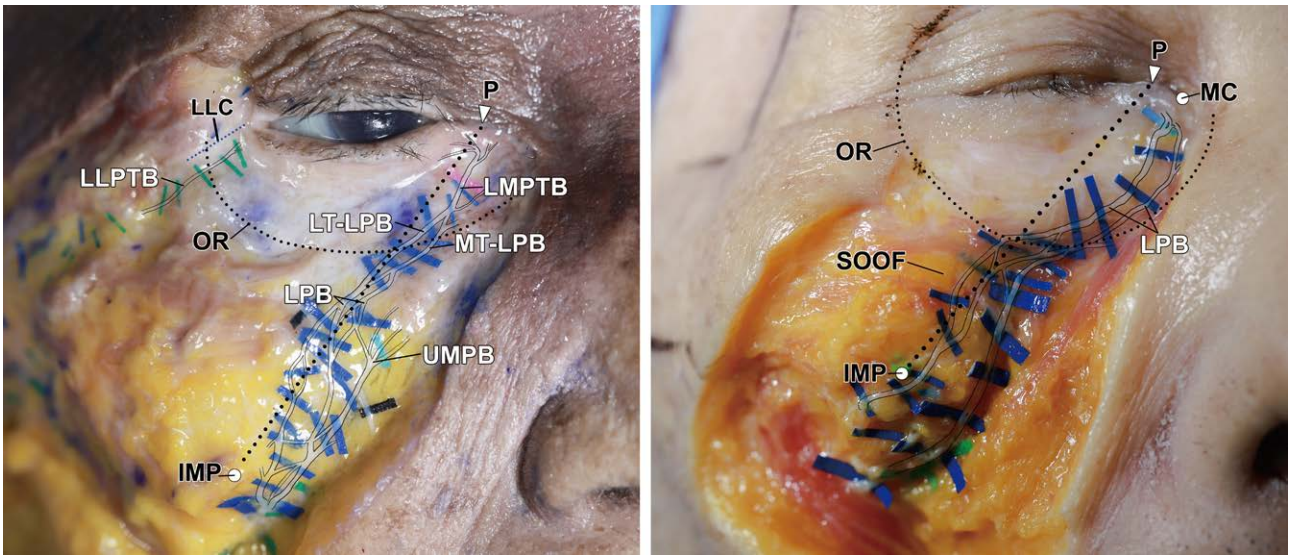


Fig. 5. The course of the lower palpebral branch (*LPB*) (shown in Video 4). Motor nerves are outlined for clear observation of their pathways. (*Left*) In an 85-year-old female cadaver, the lower palpebral branch runs in a typically oblique line (*dotted straight line*) connecting the inferior malar prominence (*IMP*) and the inferior lacrimal punctum (*P*). It obliquely crosses the anterior cheek as 3 dispersed nerve trunks. In the lower eyelid, the lower palpebral branch usually consists of 2 main trunks, the medial trunk (*MT-LPB*) and lateral trunk (*LT-LPB*), which continue onward to become the lower medial pretarsal branch (*LMPTB*). The lower lateral pretarsal branch (*LLPTB*) enters the lateral canthal area immediately below the lateral canthal crease (*LLC*). *OR*, orbital rim; *UMPB*, upper medial palpebral branch. (*Right*) In an 82-year-old male cadaver, because of the fat bulge, the lower palpebral branch in the lower eyelid does not show the typical oblique course, but rather a curved course with the lower medial pretarsal branch taking a nearly vertical course.

was usually composed of 2 main trunks (medial and lateral) and occasionally a few additional accessory trunks.

4. The course of the lower palpebral branch in the lower eyelid usually took a straight oblique course; however, in samples with prominent fat bulge, the nerve course changed into curved shape by the sagging of the preseptal orbicularis oculi and the nerve within it (Fig. 5, *right*). In the area of the prominent fat bulge, the lower palpebral branch trunks ran between the suborbicularis fascia and the muscle proper, which was composed of single-layered muscle bundles.
5. The medial infrapretarsal area (medial to the medial limbus line) was the main motor-entry zone for the pretarsal orbicularis oculi. The lower palpebral branch trunks either united to form a singular trunk of the lower medial pretarsal branch or continued as separate trunks of the lower medial pretarsal branch (Fig. 6). Lots of pretarsal motor fibers radiated medially and laterally toward the pretarsal orbicularis oculi from the lower medial pretarsal branch. The medial group of pretarsal motor fibers had short, oblique courses in the medial head part of the pretarsal orbicularis oculi, whereas the lateral group took relatively horizontal courses in the central pretarsal area.
6. The distance between the most lateral trunk of the lower medial pretarsal branch and the medial canthus line was 2.8 to 9.4 mm (Table 1). The distance between the lacrimal punctum line and the medial canthus was 4.3 to 7.4 mm. In 79.3% of samples, the most lateral trunk was located lateral to the lacrimal punctum line. Meanwhile, 1 or 2 motor fibers supplying the superior part of the pretarsal orbicularis oculi ran vertically and frequently lateral to the lacrimal punctum (Fig. 6, *below*). The most prominent pretarsal motor fiber ran 2.4 to 5.7 mm from the lid margin (Fig. 7).

B. Motor nerve safe limits for a lower blepharoplasty muscle incision (Table 1).

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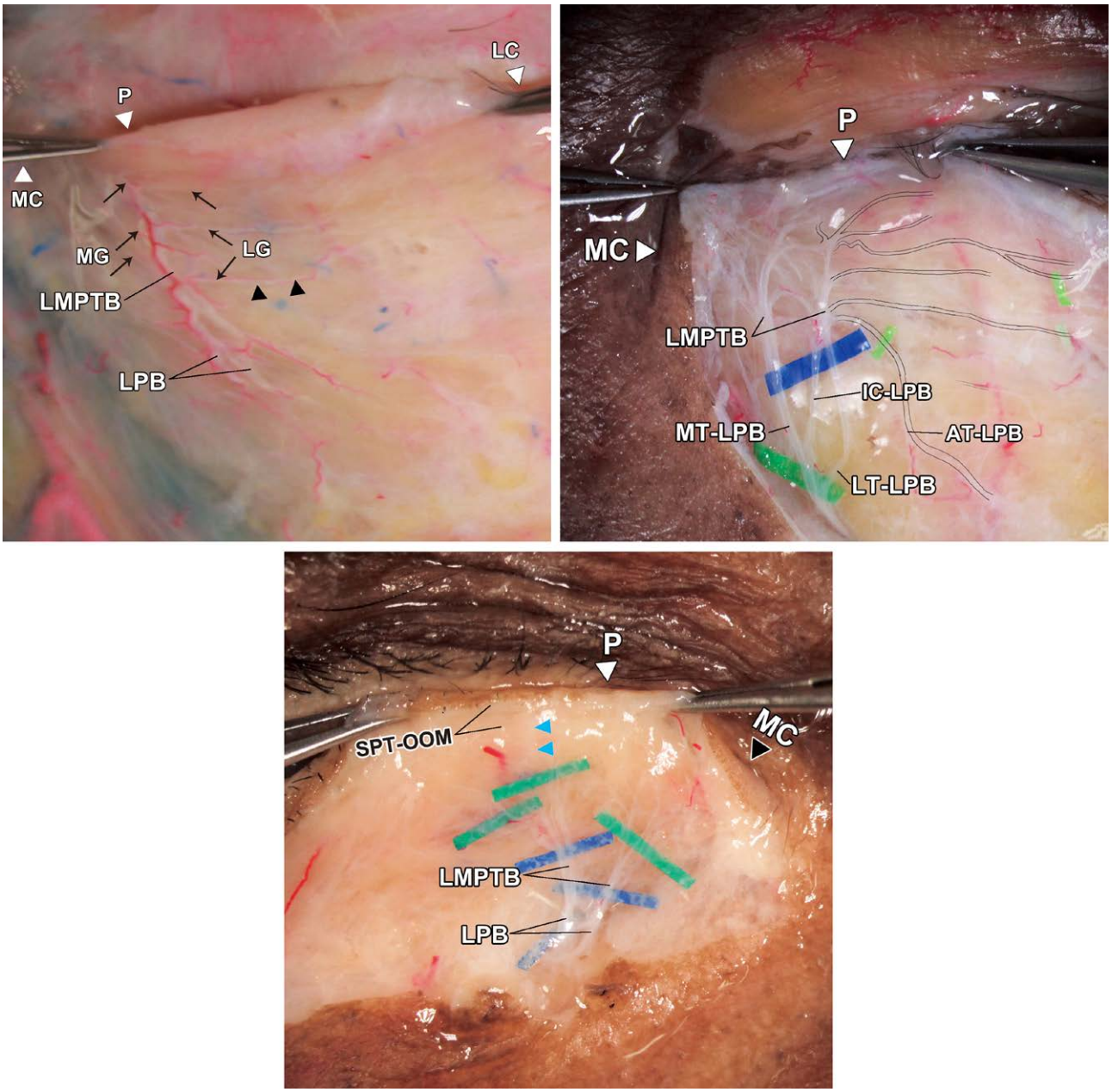


Fig. 6. Pretarsal motor supply patterns of the lower medial pretarsal branch (*LMPTB*) under 6× to 10× magnification (shown in Video 3). (*Above, left*) Single trunk pattern of the lower medial pretarsal branch in the left lower eyelid of a 60-year-old male cadaver, which underwent an emulsifying process of nonnerve soft tissue. The lower palpebral branch (*LPB*) system heads toward the inferior lacrimal punctum (*P*) with the 2 main trunks of the lower palpebral branch uniting to form a singular trunk of the lower medial pretarsal branch. Lots of pretarsal motor fibers radiated medially and laterally toward the pretarsal orbicularis oculi from the lower medial pretarsal branch. The medial group (*MG*) of pretarsal motor fibers have short, oblique courses toward the medial head part of the pretarsal orbicularis oculi, whereas the lateral group (*LG*) takes relatively horizontal courses in the central pretarsal area. The *filled arrowheads* indicate the lowest pretarsal motor fibers, below which the infrapretarsal muscle incision should be located. *MC*, medial canthus; *LC*, lateral canthus. (*Above, right*) A dispersed distribution pattern of the lower palpebral branch and lower medial pretarsal branch in the left lower eyelid of a 77-year-old male cadaver. Note, the lower medial pretarsal branch has 2 main trunks, whereas the lower palpebral branch has 3 main trunks, the medial trunk (*MT-LPB*), lateral trunk (*LT-LPB*), and an interconnecting trunk (*IT-LPB*). This case also has an accessory trunk (*AT-LPB*). (*Below*) Lower medial pretarsal branch with 2 separate trunks in the right lower eyelid of a 65-year-old male cadaver. Note the lateral lower medial pretarsal branch trunk is lateral to the lacrimal punctum (*open arrowhead*), which will be transected if a transcutaneous muscle incision is extended to the lacrimal punctum. Note the motor fiber (*sky blue arrowhe*ads) supplying the superior part of the pretarsal orbicularis oculi muscle (*SPT-OOM*) also runs lateral to the lacrimal punctum (*P*) (*open arrowhead*), which explains subciliary denervation by a subciliary muscle incision, as shown in Figure 1, *left*.

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Table 1. Value Range of Medial, Inferior, and Superior Safe Limits of a Transcutaneous Muscle Incision

	dA (%)[a]			dB (%)[b]			dC (%)[c]
Value range, mm	2.8–7.0	7.1–9.4	Total	6.3–7.9	>8.0	Total	4.8–6.0
Sample no.	23 (50)	23 (50)	46 (100)	11 (23.9)	35 (76.1)	46 (100)	46 (100)
Representative safe limit, mm	9.4			6.3			6.0
Safe range	>9.4 mm lateral from the MCL			<6.3 mm superior from the ELM			>6.0 mm inferior from the ELM

MCL, medial canthus line; ELM, eyelid margin.
[a]Medial safe limit (dA) is 2.8–7.0 mm in 50% of samples (23 of 46) and 7.1–9.4 mm in the remaining 50% of samples (23 of 46) (representative safe limit, 9.4 mm).
[b]Inferior safe limit (dB) is larger than 8.0 mm in 76.1% of samples (35 of 46) and 6.3–7.9 mm in 23.9% of samples (11 of 46) (representative safe limit, 6.3 mm).
[c]Superior safe limit (dC) is 4.8–6.0 mm in all 46 samples (representative safe limit, 6.0 mm).

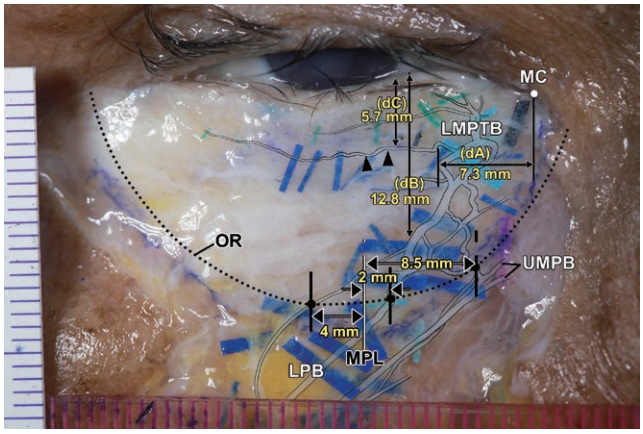


Fig. 7. An example of safe limit measurements for the transcutaneous muscle incision, including distances between nerve crossing points along the infraorbital rim and the midpupillary line (*MPL*), using a 53-year-old male cadaver. The medial (*dA*), inferior (*dB*), and superior (*dC*) safe limits in this case are 7.3, 12.8, and 5.7 mm, respectively. The dA and dB are related to the lateral trunk of the lower medial pretarsal branch (*LMPTB*), and dC is related to the lowest pretarsal motor fiber (*filled arrowheads*). Note that 3 lower palpebral branch (*LPB*) trunks cross the infraorbital rim (*OR*) (*black dotted curve*) at 4 mm lateral to the MPL, and 2 mm and 8.5 mm medial to the MPL. *MC*, medial canthus; *UMPB*, upper medial palpebral branch.

The medial, inferior, and superior safe limits were measured in 46 samples (Fig. 7) and the data are summarized in Table 1. The lateral safe limit was already reported to be 3 mm lateral to the lateral canthal crease in our previous study.[27] Therefore, in this study we only dissected 4 samples, in which we observed the same findings as the previous report. To summarize, the medial and lateral safe limits were 9.4 mm from the medial canthus line and 3 mm from the lateral canthal crease, respectively. The superior and inferior safe limits were 6.0 and 6.3 mm from the eyelid margin, respectively. The measured values of the left-side samples showed statistical difference from those of the right-side samples ($P < 0.5$).

C. Motor nerve danger zone for a transblepharoplasty midface approach (Fig. 8). (**See Video 3 [online]**, which demonstrates pretarsal motor nerve distribution related to a lower blepharoplasty muscle incision.)

When nerve crossing points where the lower palpebral branch trunks crossed the infraorbital rim were measured (Fig. 7), 76% of them (57 of 75) were in a 10-mm infraorbital area around the midpupillary line (from the medial limbus line to the lateral limbus line). All 75 trunks were within a 19.1-mm infraorbital area, from 9.4 mm medial to the midpupillary line to 9.7 mm lateral to the midpupillary line.

Because the lower palpebral branch trunks ran deeply in the intramuscular layer in the caudal part of the preseptal pocket, the nerve trunks abutted the roof of the preseptal pocket. For this reason, the nerve trunks were frequently seen as elevated oblique lines under the roof of the preseptal pocket (Fig. 8), where the lower palpebral branch trunks were vulnerable to damage by electrocautery heat during a transblepharoplasty midface approach. (**See Video 4 [online]**, which shows the infraorbital motor nerve danger zone when releasing the tear trough and orbicularis retaining ligament.)

DISCUSSION

Unexpected eyelid malposition after an open lower blepharoplasty has continued to occur despite surgeons' efforts to prevent it.[18,20,30–32] Conservative excision of excessive skin and muscle,[7,8] and lateral canthal tightening procedures[9–12] have been the main strategies for prevention. Moreover, a mild degree of eyelid malposition is generally accepted and not considered to be a complication,[33] as scleral show is frequently found in the normal population.[34] However, although they may appear similar, denervation-induced scleral show is different from inborn scleral show because it does not have intact neuromuscular function. Motor nerve denervation

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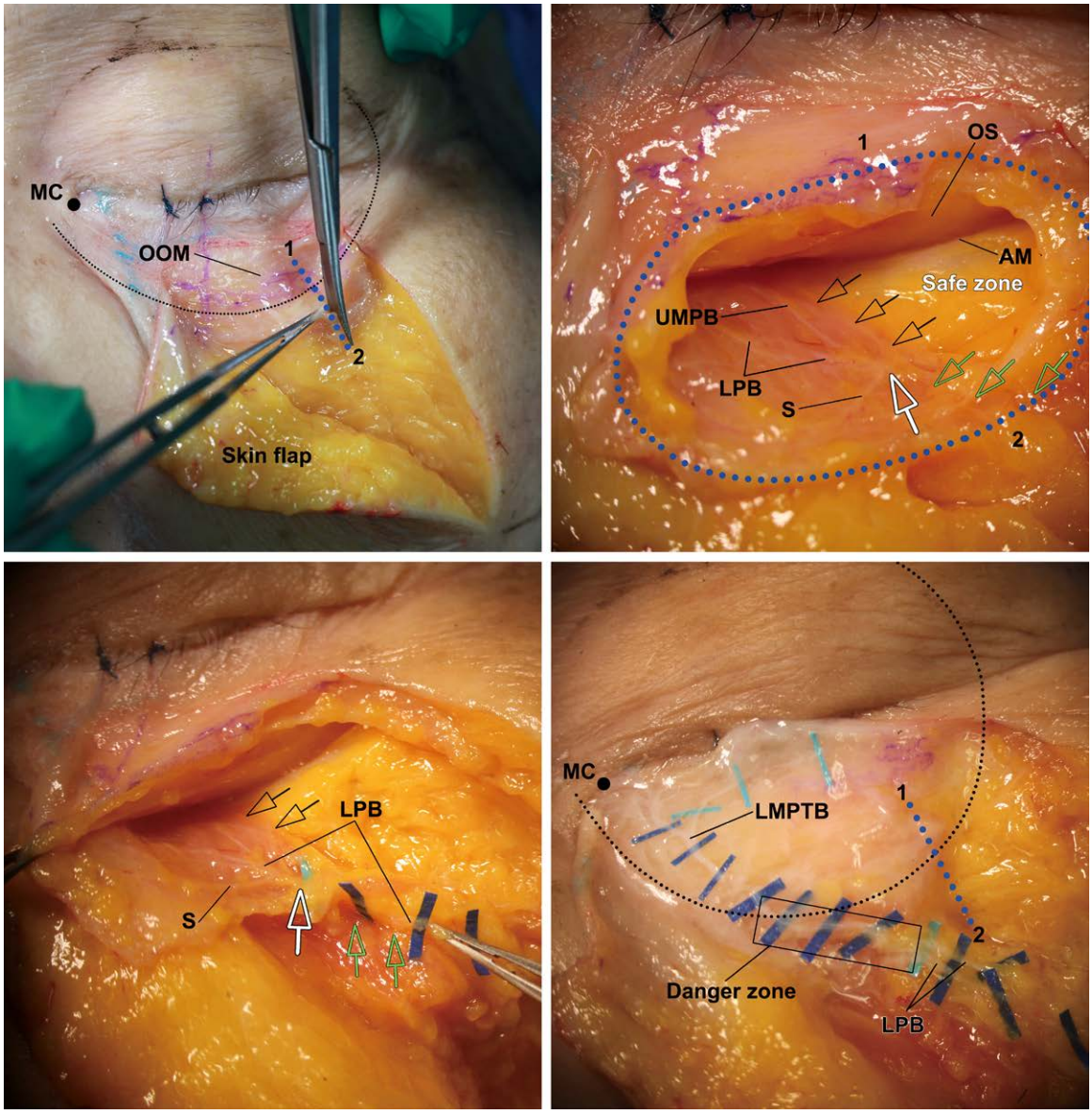


Fig. 8. Motor nerve danger zone for a transblepharoplasty midface approach identified both externally and internally in the preseptal pocket of an 80-year-old female cadaver (shown in Video 4). (*Above*, *left*) An orbicularis oculi muscle (*OOM*) incision (*blue dotted line*) is made from point 1 to 2 perpendicular to the infraorbital rim (*filled dotted curve*) at the lateral corneal limbus line to make a window into the preseptal space. *MC*, medial canthus. (*Above*, *right*) A magnified view (10×) of the interior of the preseptal space. This window is made by fully separating the 2 edges of the muscle incision (*blue dotted line* represents the incision margin of the OOM). The *filled arrows* indicate the origin part of the OOM and green arrows represents the nonorigin part in the caudal surface of the preseptal pocket. The lower palpebral branch (*LPB*) is seen as oblique elevated lines in the preseptal pocket, whereas the sensory nerve (*S*) is perpendicular to the arcus marginalis (*AM*). The motor nerve safe zone in the preseptal pocket is the area between the arcus marginalis and inferior orbicularis oculi muscle border that is marked by *filled* and *green arrows*. The *open arrow* indicates the point where the lower palpebral branch changes its anatomical plane from the suborbicularis oculi fat to the intraorbicularis layer. *OS*, orbital septum. (*Below*, *left*) Confirmation of the lower palpebral branch by tracing it in the anterior cheek and pulling it with a forceps to represent its course more prominently in the caudal part of the preseptal pocket. Note, the motor nerve is situated under a very thin interior lining of the preseptal pocket and will be vulnerable to damage by an electrocautery while incising the inferior surface of the preseptal pocket. (*Below*, *right*) The window for the preseptal pocket is closed by repositioning the muscle incision (*blue dotted line*) and the lower palpebral branch and lower medial pretarsal branch (*LMPTB*) are fully identified. Note the motor nerve danger zone for the transblepharoplasty midface approach in the infraorbital area.

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results in a series of degenerative processes including Wallerian degeneration, degenerative fibrosis, and muscle atrophy over a few years.[1,2] Denervation-induced muscle atrophy leads to variable degrees of functional and aesthetic deterioration, such as weakened muscle tone, eyelid descent, dry eye, changes in pretarsal fullness and convexity, and others. Although the eyelid malposition may be overcome by lateral canthal supporting procedures or the symptoms and signs of malposition may be mild enough to be accepted, the weakened muscle tone and changed pretarsal contour will last a lifetime. Therefore, placement of the muscle incision or muscle trimming should be carried out in a motor nerve safe zone to preserve the pretarsal motor supply.

In this study, we investigated pretarsal motor supply related to 2 traditional muscle incisions of the transcutaneous lower blepharoplasty: (1) the subciliary skin-muscle incision[35–37] and (2) the separate muscle incision below the subciliary skin incision.[4,7,8,38,39] In many samples, the superior portion of the pretarsal orbicularis oculi was supplied by 1 or 2 motor fibers immediately lateral to the lacrimal punctum line (Figs. 6 and Video 3). This explains why pretarsal atrophy frequently occurs after a lower blepharoplasty using the classic subciliary skin-muscle incision (Fig. 1, *left* and Video 3).

Vertical placement of this muscle incision was variably reported at 4 mm,[7] 5 mm,[8,38] or 6 to 7 mm[39] below the eyelid margin. In this study, there were 3 to 6 transverse motor fibers spanning the entire vertical width of the pretarsal orbicularis oculi, with the lowest one running within 6.0 mm from the eyelid margin. To preserve postoperative natural pretarsal contour, and muscle tone, none of them should be transected while incising the muscle. To do this, the muscle incision is placed at or below the inferior border of the pretarsal orbicularis oculi, which varied according to sample's vertical scale (from 5.5 to 6.5 mm below the eyelid margin when it was measured along the midpupillary line).

Preservation of motor nerve trunks is of supreme importance and can be achieved by incising the muscle according to the medial safe limit of the nerve trunks. Traditionally, the lacrimal punctum line has been acknowledged as the medial safe limit.[37,40] However, in 22 of 29 samples (79.3%) in this study, at least one main trunk passed 0.4 to 3.5 mm lateral to the lacrimal punctum line. These findings account for why unexpected eyelid malposition (ie, scleral show) sometimes occurs after transcutaneous lower blepharoplasty muscle management, such as incision,[18] thinning,[31] electrocauterizing,[41] resection,[36] and trimming.[42] This suggests that the inferior lacrimal punctum is not a credible reference point for placing the medial end of the muscle incision. For example, the first author (Y.C.) used the lacrimal punctum as a medial safe limit for lower blepharoplasty incisions for 15 years, but then moved it to the medial limbus line after he initially identified the lower palpebral branch and upper medial pretarsal branch in 2016.[26] Since then, he has not experienced any unexpected scleral show or decreased muscle tone in over 200 consecutive open lower blepharoplasty cases (data not included in this article). Although the medial safe limit of the muscle incision in this study was 9.4 mm from the medial canthus line, we recommend a medial safe limit of 10 to 11 mm, which allows for flexible vertical placement of the muscle incision and reflects individual variation of the horizontal eyelid scale. The medial safe limit in this study was measured on the premise that the muscle incision is made along the inferior border of the pretarsal muscle. If the muscle incision is made more inferior than this, the value of the medial safe limit should be increased considering the nerve's oblique course.

The lateral safe limit of the muscle incision should not be ignored for complete preservation of the pretarsal muscle tone. In the lateral canthal area, the muscle incision should be made more than 3 mm medial from the lateral canthal crease.[27] Table 2 includes guidelines for the muscle incision to preserve pretarsal motor supply. It should be noted that it is possible for incisions placed outside of our guidelines not to cause any motor denervation, as the safe limits suggested in this study reflect the data of outliers (data that are more than 2 SD from the mean) to pursue complete preservation of pretarsal motor supply across all cases. We believe that reflecting the data outliers also covers racial, sex, or facial size differences. Regarding racial differences in facial nerve distribution, in our own 10-year facial nerve study, we found that the temporal branch and marginal mandibular branches in our Asian samples showed the same patterns as were described in many published articles based on White samples. Furthermore, when we traced the lower palpebral branch system in 2 of our own White samples, they, too, showed the same distribution patterns as our Asian samples.

Decrease or flattening in pretarsal fullness, descent of the lower eyelid margin, or lagophthalmos may occur after the transconjunctival lower blepharoplasty (Fig. 1, *right*).[43] Wong and Mendelson explained that those postoperative pretarsal changes are derived from a detachment of the masseteric origin of the orbicularis oculi during correction of the tear trough.[43] However,

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Table 2. Safe Zone for a Transcutaneous Muscle Incision and Guidelines for an Infraorbital Incision

Safe zone for a transcutaneous muscle incision
10–11 mm lateral to the medial canthus line or lateral to the medial limbus line
3 mm medial to the lateral canthal crease
5.5–6.5 mm from the lower eyelid margin according to the vertical width of the lower eyelid
Choi's guidelines for the infraorbital incision
An electrocautery pencil should be held at over 30 degrees to the bony surface with keeping the tip directed toward the bony surface
An electrocautery incision should be used only for a superficial incision before blunt dissection of the midface
The incision follows the inferior border of the orbicularis oculi in the origin portion and continues to follow the arcus marginalis maintaining 3–4 mm distance from it

this study suggests the possibility of motor nerve damage of both the upper and lower eyelids while making a transblepharoplasty infraorbital incision (Video 4), which was also demonstrated in our recent study.[44]

An electrocautery, which has been used for incising the inferior surface of the preseptal pocket, may decrease nerve axons by heat injury (rather than nerve transection). Two common mistakes that endanger the lower palpebral branch trunk occur when (1) the angle of the electrocautery pencil is parallel to the skin surface (in which the electrocautery tip is directed toward the motor nerve) and (2) the incision is made along the caudal muscle border in a preseptal pocket (Fig. 9). As summarized in Table 2, an electrocautery pencil should be held at over 30 degrees to the bony surface, keeping the tip directed toward the bony surface. In the orbicularis oculi origin, the incision should be placed along the caudal border of the orbicularis oculi origin. Then, in the nonorigin area, the incision should be maintained 3 to 4 mm from the arcus marginalis. Electrocautery incisions should be used only for a superficial incision before a blunt dissection of the midface.

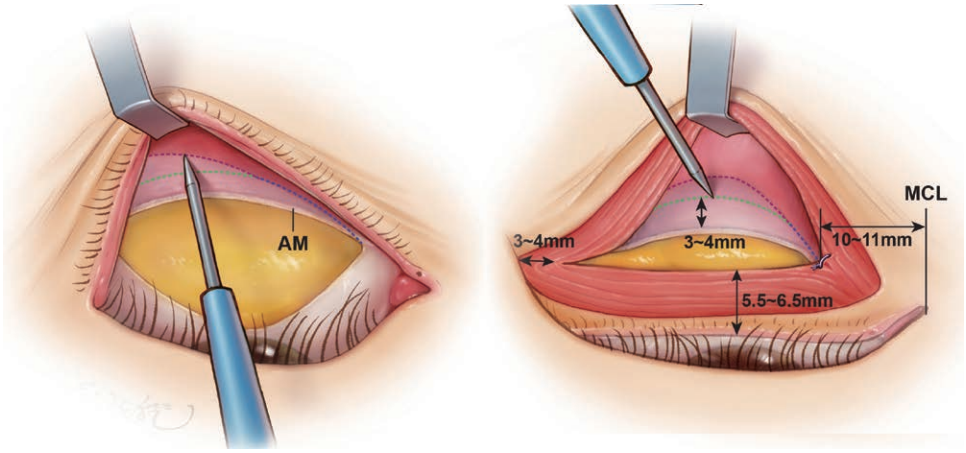


Fig. 9. Dangerous versus safe "transblepharoplasty infraorbital incisions" in the transconjunctival and transcutaneous approaches of a lower blepharoplasty. (*Left*) This figure shows an incorrect infraorbital incision: (1) the incision is made along a dangerous line (*red dotted line*) and (2) the electrocautery handle is parallel to the skin surface with its tip directed toward the motor nerve. The darker colored area above the *red* and *blue dotted lines* illustrates the undersurface of the orbicularis oculi muscle. The *blue dotted line* represents the origin portion of the orbicularis oculi muscle, and the *red dotted line* indicates the nonorigin portion. The safe line for the infraorbital incision follows the *blue dotted line* in the medial infraorbital area without damaging the muscle proper and laterally continues along the *green dotted line* by maintaining a 3- to 4-mm distance from the arcus marginalis (*AM*) in the middle infraorbital area. The *red dotted line* (the caudal border of the nonorigin portion of the orbicularis oculi muscle) indicates a dangerous line for denervation. (*Right*) The safe limits for the infrapretarsal muscle incision in a transcutaneous lower blepharoplasty are shown: (1) lateral to the medial limbus line (or more than 10 to 11 mm lateral to the medial canthus line), (2) 5.5 to 6.5 mm inferior to the lid margin, and (3) more than 3 to 4 mm medial to the lateral canthal crease, according to a patient's eyelid scale. Note the temporary suture at the medial end of the muscle incision, which prevents additional muscle separation while pulling the muscle flap superiorly with a retractor during the dissection process. Also note the correct use of an electrocautery; the electrocautery handle is kept at over 30 degrees to the bony surface to prevent a heat injury to the motor nerve.

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This article also provides videos (Videos 2 through 4) for practical understanding about pretarsal motor supply across the palpebromalar area while performing a lower blepharoplasty. One limitation of this study is the lack of sufficient clinical data, which we hope to provide in future studies.

CONCLUSIONS

There is a safe zone for the lower blepharoplasty muscle incision that if adhered to will preserve the pretarsal motor supply and prevent muscle atrophy. There is also a danger zone for the transblepharoplasty midface approach in the infraorbital area where surgeons should pay special attention not to damage motor nerve trunks, particularly when using an electrocautery.

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