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ORIGINAL ARTICLE OCULOPLASTIC

A Flexible Suspension Technique of Blepharoplasty: Clinical Application and Comparison with Traditional Technique

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Abstract

Background Double-eyelid blepharoplasty is one of the most popular aesthetic surgeries in China. But the traditional method produces a hidebound double eyelid due to its rigid suturing between the skin and the tarsus. The authors of this article concluded a novel technique of "flexible suspension technique" compared with traditional blepharoplasty which is considered as a "rigid fixation technique."

Methods This is a retrospective study of two groups of 100 Chinese Han females, on whom double-eyelid blepharoplasty was performed, 50 cases by "flexible suspension technique" and the other 50 by "rigid fixation technique." The basic procedure of "flexible suspension technique" is suturing the orbicularis oculi muscle to the septal extension. Thus, the surgical connection between skin and tarsus is flexible. The surgical results were evaluated and compared using the Global Aesthetic Improvement Scale and Visual Analogue Scale/Score.

Results The "very much improved" rate in the "flexible suspension technique" group was higher than that in the "rigid fixation technique" group ($p < 0.05$). Postoperative appearances of the "flexible suspension technique" group were also better than the "rigid fixation technique" group with less edema ($p < 0.05$) and slighter incision scars ($p < 0.05$). However, the incidences of asymmetry and fold loss were higher in the "flexible suspension technique" group ($p < 0.05$).

Conclusion The flexible suspension technique blepharoplasty can obtain a more natural appearance and has less adverse effects and shorter recovery time.

Level of Evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Blepharoplasty · Orbital septum · Orbicularis oculi muscle · Levator aponeurosis · Dynamic

Introduction

Blepharoplasty of the upper eyelid is the most popular aesthetic surgery in China. The ultimate aim of blepharoplasty is to create a natural double-eyelid configuration. The characteristics of "inborn double eyelid (IDE)" include [1]: (1) The upper eyelid skin is smooth without obvious scar or tension; (2) the crease that is movable and not sticking to tarsus emerges and fades dynamically along with blinking [2]; (3) the pre-septal and pre-tarsal skins are flat without a step-like feature; (4) the pre-tarsal skin is movable and moves up a little lag behind the tarsus. The mechanism of blepharoplasty is to connect palpebral skin to the up-lifting power system, so to create a palpebral furrow. The connection in traditional blepharoplasty is achieved by suturing the skin to the tarsus or aponeurosis directly, which is a *rigid fixation technique* (RFT) that usually produces a relatively rigid crease and sagging incision scar. To conquer this shortage, we developed a *flexible suspension technique* (FST) in which the

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connection was created by suturing the orbicularis oculi muscle to the inferior border of the orbital septum, which is a flexible suspension and may achieve a more natural double-eyelid appearance (Fig. 1).

Patients and Operation Methods

Patients

From April 2014 to April 2018, the authors surveyed 100 Chinese Han female patients who underwent double-eyelid blepharoplasty. Among them 50 cases were done by the RFT method, whereas 50 subjects underwent the FST method. The average age was 23.78 ± 4.51 in the FST group and 26.28 ± 5.02 in the RFT group. All surgeries were performed by two of the authors who are senior plastic surgeons using both the RFT and FST. All the subjects were followed up for more than 6 months.

Flexible Suspension Technique (FST) Blepharoplasty

Patients were marked in a sitting position. The level of the crease was located 7.0–7.5 mm from the lid margin, and efforts were made to make the lines symmetric. All surgeries were performed under local anesthesia, and a bipolar coagulator was used for hemostasis. The skin incisions were made by an 11# blade, which were deepened by sharp excision of the orbicularis oculi muscle and the septal extension (superficial to tarsus) [3] until the pre-tarsus fat was exposed (Fig. 2a, b). The herniated orbital fat was excised depending on the patient's age and the eyelid appearance, and attention must be paid to prevent palpebral hollowness. Then, the inferior rim of the septal extension (superficial to aponeurosis), located between the superior tarsal border and the white line, was identified clearly (Fig. 2c). Three to five buried stitches connecting the septal extension rim with the orbicularis oculi muscle were performed using 7-0 prolene sutures (Fig. 2d), by which the skin edge of the inferior incision was suspended to the elevator's upward lifting force (Fig. 2e). At this moment, the palpebral furrow could be observed while the eye opened. If the level and shape of the palpebral furrows on both sides were asymmetric, adjustment should be performed until symmetry is reached. The excision of retro-orbicularis oculus fat (ROOF) was performed only in patients with extremely puffy upper eyelids. The incisions were then closed with 6–8 external stitches using 7-0 prolene in a pattern of skin–muscle–septum–muscle–skin incorporation (Fig. 2f).

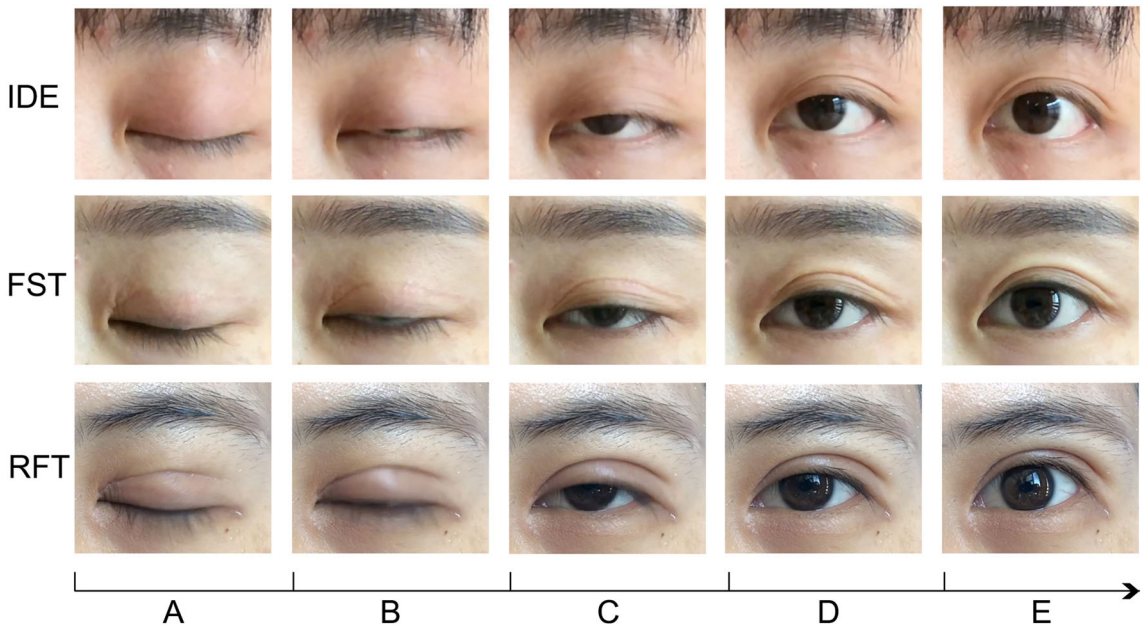

Fig. 1 Comparison of the IDE (inborn double eyelid), FST and RFT double-eyelid configurations with respect to eyelid opening by slow-speed video screen capture images. **a** At the time point before opening. **b** At the very beginning point of eyelid opening (reveal of the bottom of the pupil). **c** At the very point when the palpebral furrows were taking place in the FST and IDE. **d** The point of the crease reached the highest level, and **e** the pre-tarsal width kept decreasing and got a final appearance. Dynamically, a palpebral furrow does not emerge on IDE and the FST palpebrae until time point **c**, but on the contrast, the palpebral sulcus of RFT presents at the beginning. The palpebral show of FST and IDE is so similar that the skin is smooth, flat and scarless. But in the RFT group, there are usually marked scars, an invaginated sulcus, step-like appearance and pre-tarsal fullness on the state of eyes closed

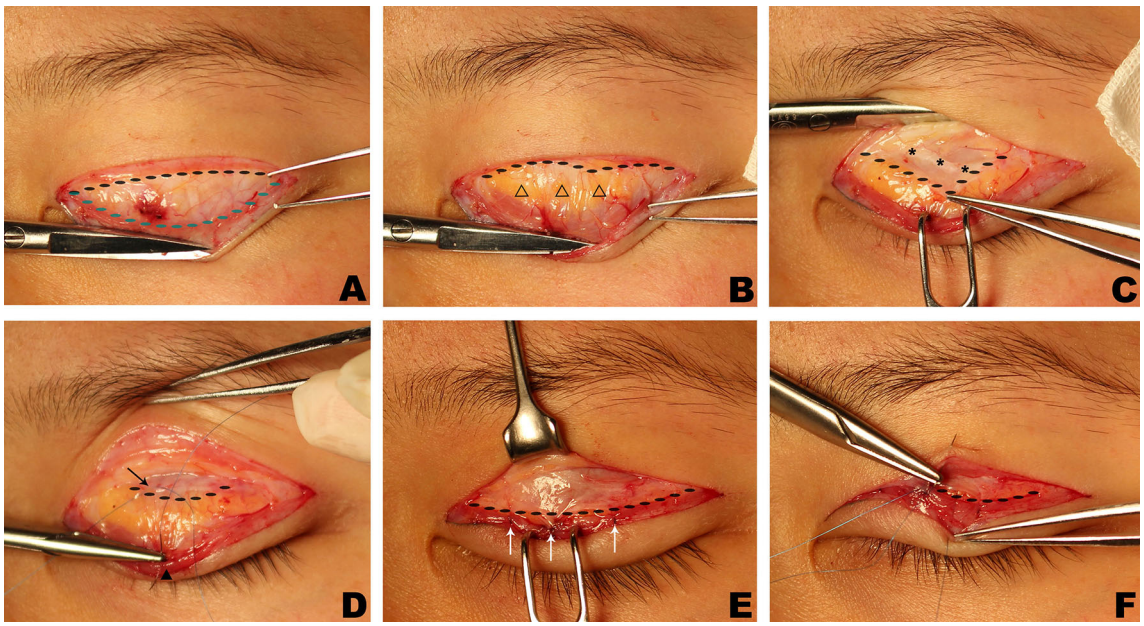

Fig. 2 The main processes of FST blepharoplasty. **a** Exposure of the septal extension. After incision and excision of skin and orbicularis oculi muscle, the septal extension (SE) was revealed as a glistening white fascia superficial to the tarsus (area rounded by black and blue dots). **b** Creation of inferior separated rim of the septal extension. Pre-tarsal SE was excised, and its inferior separated edge (superficial to the aponeurosis) was created, which could be easily recognized (black dotted line). The pre-tarsus fat (white triangle) was exposed as well. **c** The inferior separated rim of septal extension (dotted line) was nipped and pulled down by a clamp, and the white line was observed (asterisk). **d** The first stitch was performed at the pupil midline, which connected the SE (black rightward arrow) with the orbicularis (black triangle). **e** Three stitches (the white upward arrows) were buried to make a secure suspension of the orbicularis to the SE (dotted line). **f** The incision was closed with an incorporated skin–muscle–septum–muscle–skin pattern. The dotted line showed the inferior separated rim of the SE

Rigid Fixation Technique (RFT) Blepharoplasty

The procedures of design, incision, skin removing and fat excision were performed in the same way as the FST method. The orbicularis oculi muscle inferior to the incision and the connective tissues on the tarsus were routinely excised until there are no other tissues between the skin and tarsus. Six to eight external fixation sutures of 7-0 prolene were placed, sequentially incorporating the skin edge of the inferior incision, the tarsus, and the superior skin incision [4]. The main differences in the procedures for the two techniques are shown in Fig. 3.

Postoperative Care

The sutured incisions were smeared with thin ointment and exposed without any bandage dressing. Cold compresses were recommended during the first 48 h postoperation, followed by warm packs in the next 5 days. Stitches were taken off at the 7th day after surgery. It was encouraged to exercise opening and closing of eyes to accelerate recovery.

Postoperative Evaluation

Clinical efficacy assessments were completed by the patients at the 7th day and the 6th month after the operation based on the Global Aesthetic Improvement Scale (GAIS) (Table 1) [5]. Therein the "very much improved" rate (VMIR) (VMIR = very much improved cases/total cases × 100%) of each group was compared and analyzed.

Safety evaluations were conducted by the patients using the Visual Analysis Scale/Score (VAS) that is a line marked from 0 to 10 score. Score 0 means no adverse effect, while score 10 means extremely severe adverse effects. The postoperative adverse effects include the short-term events (such as bruising and edema, assessed on the 7th day after operation) and long-term events (such as scarring, palpebral asymmetry and fold loss, assessed on the 6th month after operation). The VASs were compared between the two groups.

Typical cases of both techniques are shown in Fig. 4.

Statistics Analysis

Data of the VAS of each postoperative adverse effect are presented as means and standard deviation (SD) and were compared intragroup by the Mann–Whitney *U* test. As an

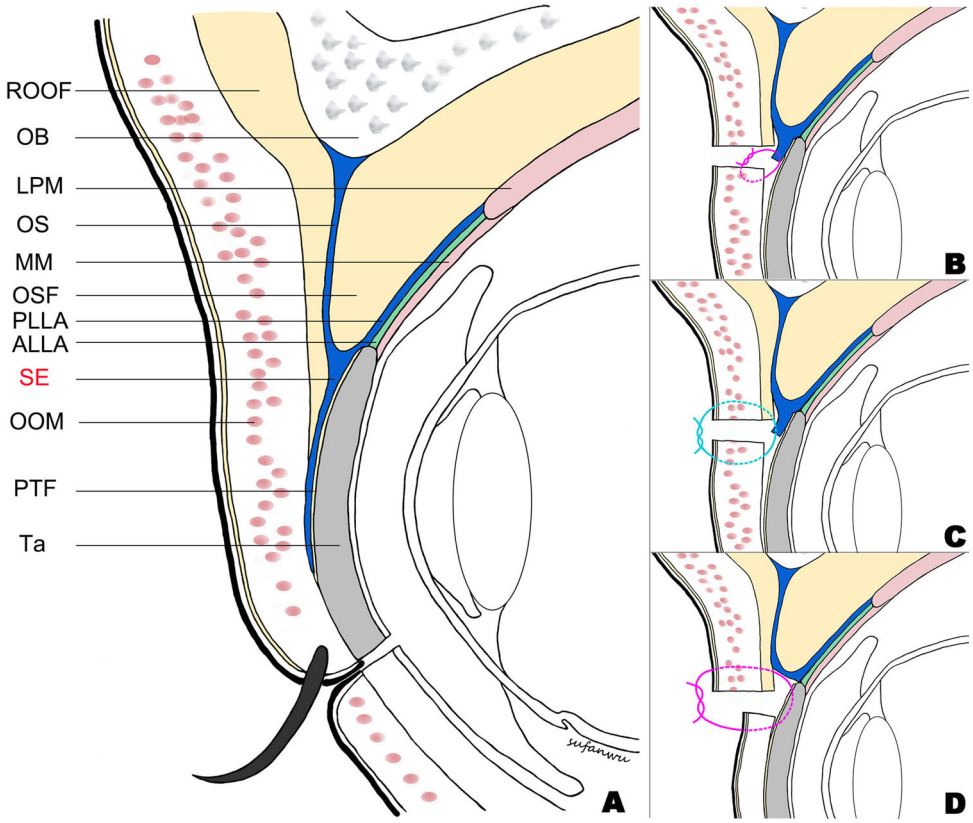

Fig. 3 The upper eyelid anatomy and the schematic diagrams of RFT and FST blepharoplasty. **a** The upper eyelid anatomy of Chinese population. *ROOF* retro-orbicularis oculus fat, *OB* orbital bone, *LPM* levator palpebralis muscle, *OS* orbital septum, *MM* Müller's muscle, *OSF* orbital septal fat, *PLLA* posterior layer of the levator aponeurosis, *ALLA* anterior layer of the levator aponeurosis, *SE* septal extension, *OOM* orbicularis oculi muscle, *PTF* pre-tarsal fat, *Ta* tarsus. **b** In FST blepharoplasty, pre-tarsal OOM is preserved and sutured to the inferior border of the septal extension (superficial to aponeurosis). **c** A second layer suturing of FST (cutaneous suturing) which incorporates the superior edge of the skin, orbicularis, septum, orbicularis and the inferior edge of the skin. **d** In traditional RFT blepharoplasty, all pre-tarsal soft tissues are excised followed by external skin–tarsus–skin sutures to make a rigid fixation, usually resulting in a marked depth of palpebral sulcus

Table 1 Global Aesthetic Improvement Scale

Rating	Description
Very much improved	Optimal cosmetic result in this patient
Much improved	Marked improvement in appearance from the initial condition, but not completely optimal for this patient
Improved	Obvious improvement in appearance from the initial condition, but a small correct surgery is suggested
No change	The appearance is essentially the same as the original condition that means failure of the formation of the double eyelids
Worse	The appearance is worse than the original condition

efficacy indicator, VMIR derived from the GAIS rating was compared between the two groups using the Chi-square test. A probability value of less than 5% was considered statistically significant. All data were analyzed statistically by IBM SPSS Statistics software, version 23.

Results

The outcome was analyzed from both the efficacy and the adverse effects comparison. FST produced a double eyelid as natural as inborn double eyelid (IDE) not only at rest but also in the style of eyelid movement (Fig. 1). The complications of both techniques were similar, such as edema

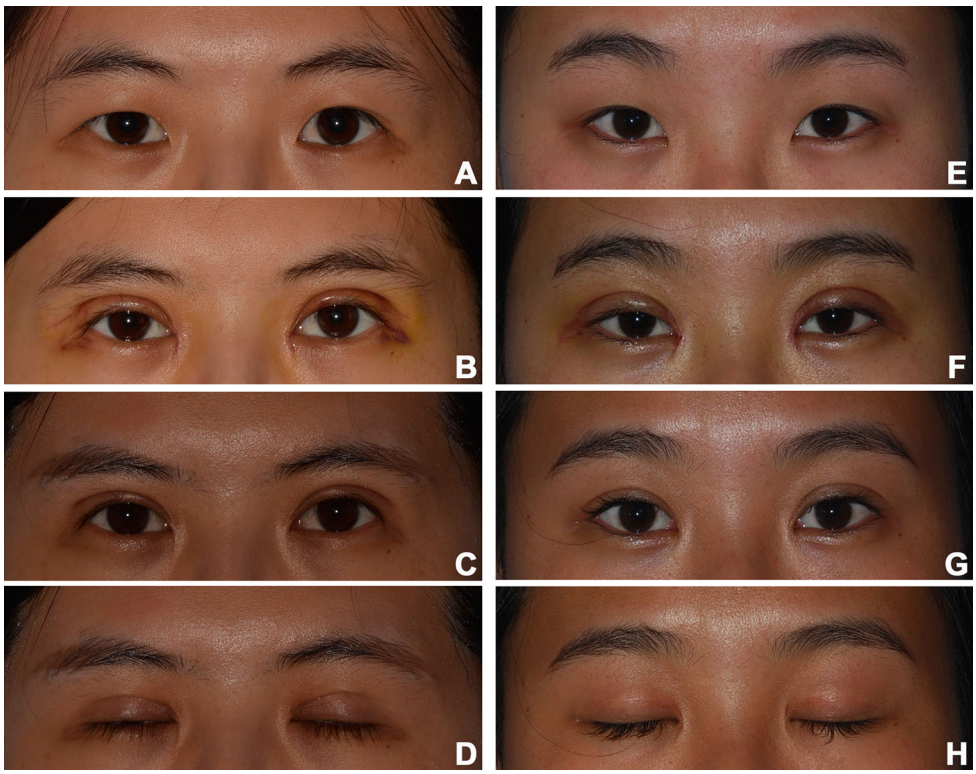

Fig. 4 Two typical cases of RFT and FST. Case 1 (**a**–**d**): a 30-year-old female who underwent an RFT blepharoplasty. **a** Preoperative view; **b** seven day postoperative view. Marked edema and bruising are seen. **c**, **d** Six months after operation, it was still edematous with an obvious incision scar with invaginated sulcus while eyes closed. Case 2 (**e**–**h**): a 24-year-old female who underwent an FST blepharoplasty. **e** Preoperative view; **f** seven day postoperative view. Ordinary edema and bruise were presented. **g**, **h** Six months after operation, recovered palpebrae without edema was presented with invisible scar when eyes closed

Table 2 Comparison of VMIR in the regard of GAIS in RFT and FST groups

	7-days' follow-up		6-months' follow-up	
	RFT	FST	RFT	FST
Very much improved cases	2 (4%)	14 (28%)	5 (10%)	23 (46%)
Other cases	48 (96%)	36 (72%)	45 (28%)	27 (54%)
Pearson's Chi-square	9.00		16.07	
p value	0.003*		0.000*	

and bruising in short time, nothing but the severities were different. For a long-time observation, RFT tended to produce a severer incision scar and sunken deformity (extremely deep palpebral sulcus), which were rarely seen in the FST group. The most common long-term complications of FST were asymmetry and fold loss (decrease in the depth of the palpebral sulcus).

Efficacy Evaluation

The VMIRs in the groups of RFT and FST on the 7th day after operation were 4% and 28%, with a significant difference ($p < 0.05$). After 6 months, VMIRs reached 78% and 86% still with a significant difference between the two groups ($p < 0.05$) (Table 2).

Safety Evaluation

Short-Time Adverse Effects

On the 7th day assessment, the average edema VAS was 4.42 ± 1.83 in RFT group compared with a 3.34 ± 1.38 VAS in the FST group showing a significant difference ($p < 0.05$). The average VASs of the two groups were not significantly different with regard to bruising, which were 4.02 ± 1.29 and 2.88 ± 0.98, respectively ($p > 0.05$) (Fig. 5).

Long-Term Adverse Effects

After 6 months following up by either clinical consultation or telephone interview, according to the feedbacks from all the subjects, the average VASs of RFT and FST were:

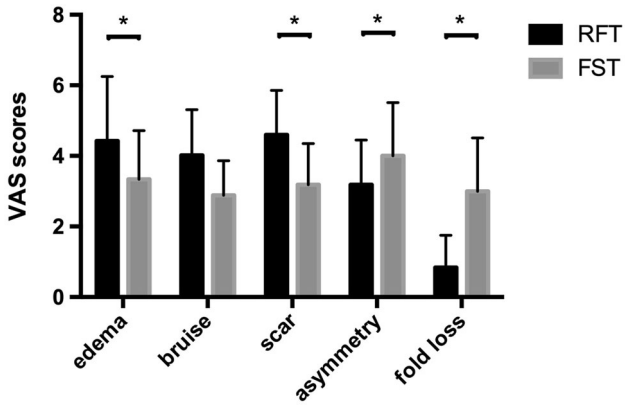

Fig. 5 The comparison of adverse effects VASs of the two groups. The VASs of five adverse effects were compared in the two groups. The former two (edema and bruise) reflect the short-term effects, and the latter three (scar, asymmetry and fold loss) reflect the long-term effects. In the FST group, there was less edema than in the RFT group in the early time after operation ($p < 0.05$), and the incision scars were slighter than the RFT group ($p < 0.05$). However, the incidences of asymmetry and the loss of palpebral furrows were higher in the FST group ($p < 0.05$) (*$p < 0.05$)

4.6 ± 1.26 versus 2.88 ± 1.17 in scarring ($p < 0.05$), 3.18 ± 1.27 versus 4.0 ± 1.51 in asymmetry ($p < 0.05$), 0.84 ± 0.91 versus 3.0 ± 1.51 in shallow fold ($p < 0.05$) (Fig. 5).

Discussion

The mechanism of double-eyelid configuration is that the levator aponeurosis extends more distally onto the subdermis anterior to the tarsus to form the skin crease [6]. However, most Asian people have no upper eyelid crease because of: (1) the absence of the filaments of the levator expansion penetrating the orbicularis muscle, attaching to the overlying dermis [4, 7], (2) thick subcutaneous fat and puffy orbital septum fat retard skin moving and folding. So, the key point of blepharoplasty is to create a sequential connection between the pre-tarsal skin and levator. Only when the pre-tarsal skin can move upward along with the movement of the tarsus pulling by the aponeurosis could a double-eyelid crease emerge.

In traditional blepharoplasty, by excising plump pre-tarsal tissues, creation of an adhesion between the pre-tarsal skin and levator aponeurosis or tarsus produces a reliable adhesion at the point of fixation, thus creating the board-like pre-tarsal unit that invaginates beneath the pre-septal skin on levator contraction. In puffy eyes, several additional anchor stitches are needed to strengthen the fixation between the tarsus and pre-tarsal skin [8]. We call this traditional method the "rigid fixation technique (RFT)," as the connection between the tarsus and pre-tarsal skin is direct and rigid. The traditional RFT has several comings: Firstly, the thickness of the pre-tarsal tissue is thinner than the pre-septal part due to the removal of soft tissues between the skin and tarsus. The incision scar thus becomes more obvious due to its uneven tension distribution on two sides, and the created palpebral sulcus is usually chasmal deep set. Secondly, the pre-tarsal skin is rigidly bound to the tarsus and moves up along with the tarsus simultaneously. In contrast, the pre-tarsal skin in inherent double eyelids is movable and moves up with a little lag behind the tarsus.

To overcome the short comings of the traditional RFT technique, the authors modified the operations to the FST technique as follows: (1) keeping pre-tarsal orbicularis as much as possible and (2) incorporating the orbicularis and the septal extension with a buried suture. There is an inherent connection between the pre-tarsal orbicularis and pre-tarsal skin [9], whereas the connection between the septal extension and pre-tarsal orbicularis has been created by the FST surgery. The septal extension is contiguous with the posterior layer of the septum [10] and can move upward with the aponeurosis as a composite unit. Thus, in this method, the lifting force of the levator has been sequentially transmitted to the pre-tarsal skin through the cascade as: the levator aponeurosis to the septal extension to the orbicularis oculi muscle and finally to the pre-tarsal skin. Because the pre-tarsal orbicularis is kept intact in the modified method, the tissue thicknesses are identical on both sides of the incision and the incision scar has been not noticeable. Compared to the RFT, the incorporation of the septal extension and orbicularis is more flexible and adjustable; we thus call it the "flexible suspension technique (FST)," which is much closer to the dynamic process in an inborn double eyelid. The reliable results of the FST depend on two layers of suturing: the buried subcutaneous suturing (septal extension to orbicularis) that bears the major strength from the levator and aponeurosis, and the external cutaneous suturing (skin to muscle to septum to muscle to skin) that decreases the incision tension while the eyes open.

The septal extension (SE), extending from the orbital septum and covering the tarsus across the levator–tarsal junction, is the key structure involved in the FST operation, which is a distinct fibrous anatomical layer connecting the tarsus and aponeurosis [4]. Due to the lack of unified nomenclature, the septal extension has also been called the "distal end of the anterior layer of the levator aponeurosis (DEALLA)" [11], "septoaponeurotic vehicle" [12], "septoaponeurotic union" [13], "septoaponeurosis junctional thickening (SAJT)" [1, 14], "conjoined fascia" [15], etc. The orbital septum arises from the periorbita and separates into two layers distally: The anterior layer extends to the eyelid margin and covers the tarsus, whereas the posterior

layer reflects and attaches to the anterior layer of the levator aponeurosis [10]. The aponeurosis is also composed of two layers: the anterior layer that is contiguous with the orbital septum [3] and the posterior layer that attaches to the tarsus [16]. The fusion line of the septum and aponeurosis is defined as the "white line."

Park's method of "orbicularis oculi and aponeurosis fixation" was well known previously, but was different from the method in this article. According to the presentation in his article [17], the aponeurosis was folded with full thickness (layers undefined) and attached to the subdermal orbicularis, and the connection was much deeper than that with the SE. The latter is much freer and more flexible.

The possible reason for less hydropic and a shorter swelling in the FST was that the microcirculation was preserved due to the reservation of the pre-tarsal muscles. The incidence of bruising is mainly related to operative skills and intraoperation bleeding, which usually occur during orbicularis excision. Although it is not significantly different in the bruising VAS between the two groups, in the author's impression, there is less bruising in FST in that the orbicularis is usually kept intact. There are some factors leading to marked bruising, such as non-use of epinephrine, prolonged bleeding, rough handling in the excision and hemostasis, most of which have little relationship with fixation techniques.

Nonetheless, relatively more training time is needed to master the FST operation. It is harder to keep symmetric the palpebral furrows, and especially for new surgeons, partial loss of the palpebral fold or a decrease in the depth of the palpebral sulcus can occur because the fixation points of the orbicularis and the septal extension are more variable and flexible. Asymmetry and fold loss may occur in the following conditions: (1) Septal extension could not be accurately identified anatomically, or the bilateral inferior margins of the septal extension are not equal in height; (2) the connection between the skin and orbicularis begins to loosen unexpectedly, which makes it difficult for the pre-tarsal skin to invaginate the following muscle movement when the eyes open, especially in puffy cases. It is necessary to remove enough orbital fat, and, if necessary, the ROOF to ease the burden of the buried suture points to prevent postoperative fold loss. But how to modulate the fixation points to make bilateral palpebral symmetric and to balance the excision and reservation of soft tissue, are the key points for surgeons to master FST blepharoplasty.

Conclusion

The "flexible suspension technique (FST)" is a reliable blepharoplasty, which could obtain natural and vivid appearances with a high degree of satisfaction in the long term and has less adverse effects and shorter recovery time.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflicts of interest to disclose.

Human and Animal Rights This article does not contain any studies with human participants or animals performed by any of the authors.

Informed Consent For this type of study informed consent is not required.

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