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ORIGINAL ARTICLE OCULOPLASTIC

# Minimally Invasive Conjoint Fascial Sheath Suspension for Blepharoptosis Correction

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**Abstract**

*Background* Blepharoptosis can not only affect facial appearance but physical and mental health as well. Traditional treatments require long recovery time and leave unpleasant scars. In this study, we explored a simple and effective way to correct mild, moderate blepharoptosis and analyzed the causes and precautions for postoperative complications.

*Methods* From March 2014 to May 2017, patients presenting with mild or moderate bilateral or unilateral blepharoptosis underwent minimally invasive blepharoptosis correction using suspension of the conjoint fascial sheath of the levator and superior rectus. Mild blepharoptosis was corrected by 1 or 2 of loops suspension sutures, whereas moderate blepharoptosis was corrected by 3 or 5 loops. The postoperative evaluation, including the degree of correction or residual ptosis, asymmetry and presence of lagophthalmos, was performed after a minimum follow-up period of 9 months.

*Results* Forty patients (55 eyelids) were included. The mean followed up period was 13.40 ± 4.60 months. Good results were seen in 48 ptosis eyes (87.27%). Double eyelid crease was formed simultaneously without an obvious wound. Two mild ptosis eyelids received a fair result, and 4 moderate ptosis eyelids improved to "mild ptosis." The mean marginal reflex distance 1 significantly increased postoperatively.

*Conclusion* Long-term follow-up indicates that minimally invasive conjoint fascial sheath suspension works well for mild and moderate ptosis. With its short recovery time, simultaneous double eyelid crease formation and long-lasting effect, the surgery is worth popularizing.

*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** Blepharoptosis · Minimally invasive surgery · Conjoint fascial sheath · Correction · Complication

## Introduction

Blepharoptosis is defined as an abnormally low-positioned upper eyelid margin in the primary gaze position, which results in the narrowing of the palpebral fissure and opening [1, 2]. The two main ways to achieve elevation of the upper lid are to shorten the levator palpebrae superioris or Muller's muscle [3] or to carry out a brow/frontalis suspension procedure. For minimal ptosis, there are three viable options: Muller's muscle-conjunctival resection [4, 5], Fasanella–Servat procedure [6], or levator aponeurotic repair. For moderate ptosis, the treatment of choice is levator aponeurotic repair [7, 8]. Severe ptosis requires some type of frontalis suspension [9]. However, some

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traditional techniques are over invasive, leaving an unpleasant scar and requiring long downtime. Therefore, many patients, particularly those with mild or moderate blepharoptosis, are reluctant to undergo ptosis surgery. To overcome these drawbacks, effective non-/minimal-invasive surgery is necessary.

The conjoint fascial sheath (CFS) is attached to the conjunctival fornix. It is located in the intermuscular space between the anterior one-third of the superior rectus and segment of levator which could be used to correct blepharoptosis. Holmstrom and Santanelli [10] first reported eyelid suspension to CFS can be applied to correct various types of ptosis, and since then, the effectiveness of this method has been reported by many scholars [11–13].

Herein, we would like to illustrate our technique of minimally invasive blepharoptosis correction using CFS suspension. The method corrects blepharoptosis and forms double eyelids at the same time. It requires less downtime and leaves no conspicuous scar on the eyelid. It is beneficial for candidates who desire no skin incision but have indications for levator aponeurotic surgery and do not present with excessive upper eyelid laxity. And we further analyze the causes of postoperative complications and suggest precautions to avoid them.

## Patients and Methods

A total of 189 patients were treated from March 2014 to May 2017. The inclusion criteria are as follows: (1) no skin hooding, (2) no CFS suspension was conducted, and (3) minimal follow-up period of 9 months. Before the surgery, the distance between the uppermost point of the cornea and the lower margin of the upper eyelid, levator function and margin reflex distance 1 (MRD1) [14] were measured at the clinics. The corneal diameter was also measured. The mean corneal diameter among Chinese is 11.26 mm [15], and the MRD1 was adjusted based on this mean corneal length. Patients with MRD1 of 3 mm or greater were defined to have mild ptosis, while patients with MRD1 of 1 to 3 mm were defined to have moderate ptosis, and those with MRD1 of 1 mm or less were defined to have severe ptosis. Patients with mild and moderate ptosis are favorable candidates for correction with our suture method. Patients with severe ptosis will require a more extensive procedure to achieve desirable correction.

The postoperative evaluation was performed after a minimum follow-up period of 9 months. During the follow-up, the evaluation criteria are based on (1) the existence of blepharoptosis and severity; (2) symmetry: the difference in MRD1 in 2 eyes is less than 0.5 mm; (3) double eyelid line; (4) satisfaction of doctor and patients. Specifically, surgeries with complete correction of ptosis, symmetric eyes, beautiful and smooth eyelid line and satisfaction by both patients and doctors are considered to have good results. Secondly, the ptosis is improved but not completely corrected, or the double eyelid line becomes shallow or disappears, asymmetric eyes, and one of the doctors or patients is unsatisfied are considered fair results. Lastly, ptosis restored to the preoperative state and surgery results were not satisfactory to both doctors and patients are defined as a poor result. Measurement at the last follow-up visit was used for comparison.

### Surgical Design and Technique

With the patient in an upright position, the degree of ptosis on two eyelids was compared, and the amount of ptosis correction needed was established. Specifically, for patients with unilateral blepharoptosis, by lifting the ptotic eye, we eliminated the effect of increased innervation [16]. Then, we designed the height of the eyelid on the ptotic side according to the contralateral normal eyelid, i.e., the position of ptotic upper eyelid margin was 1 to 2 mm higher than the normal side, which was considered the ideal level. The width of the new double eyelid crease on the ptotic eye was 1 mm shorter than the normal eye because the muscle strength of the ptotic eye was weaker than that of the normal eye and the crease tended to be wider. For patients with bilateral blepharoptosis, the creases were designed at the same height.

### Design for Mild Blepharoptosis Correction

For mild blepharoptosis, 1 or 2 suspension sutures were applied (Fig. 1). In the one-suspension method, one vertical line was drawn from the lash line to the lower border of the eyebrow corresponding to the center of the pupil. The intersection (point A) of the supratarsal crease line and the vertical line was determined as the incisional slit. In the two-suspension method, two vertical lines were drawn from the lash line to the lower border of the eyebrow corresponding to the medial and lateral corneal limbus determining two incisional slits (point B and C).

### Design for Moderate Blepharoptosis Correction

For moderate blepharoptosis, 3 or 5 suspension sutures were applied (Fig. 1). The design of the three-suspension method was the combination of one and two suspension sutures, whereas two vertical lines were drawn 5 mm medially or laterally to point B and C, determining another two incisional slits (point D and E) for the five-suspension method.

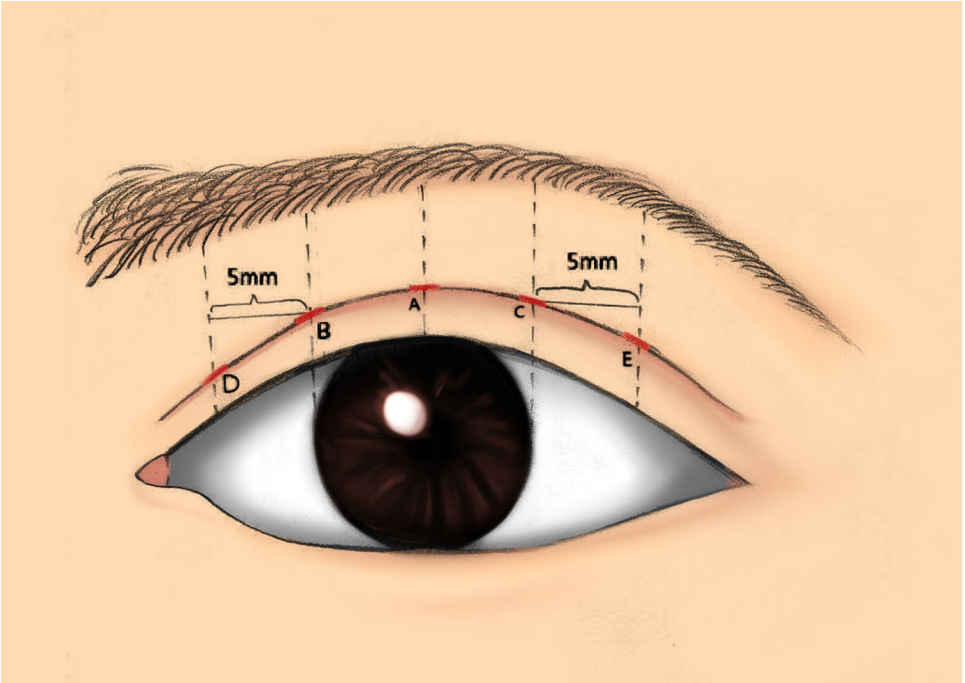


**Fig. 1** Schematic diagram of the minimally invasive conjoint fascial sheath suspension for blepharoptosis correction. Five vertical lines are drawn from the lash line to the lower border of the eyebrow. Specifically, the first vertical line is drawn corresponding to the center of the pupil, then two vertical lines are drawn according to the medial and lateral corneal limbus, and another two vertical lines are drawn 5 mm medially or laterally to the medial and lateral corneal limbus. The intersections of the supratarsal crease line and vertical lines are determined as the incisional slits, point A–E

## Surgical Technique

After confirming the markings, 1% lidocaine with 0.005% epinephrine was infiltrated in and around the surgical site. The skin at the marked points on the eyelid was penetrated with no. 11 blade to make minor slits less than 1 mm in length in which the suspension sutures were enfolded at the end of the operation.

Turning the upper eyelid inside out, a 5/0 nylon suture was applied at the upper margin of the central part of the tarsus and suspended in the anterior superior direction. This suspension provided exposure of the fornix of the superior conjunctiva, making subsequent procedures easy to perform.

Patients were asked to downgaze, and the superior conjunctival fornix (SCF) was identified. No. 6-0 nylon suture (with needles attached to both ends) was inserted into the CFS at point a and passed through the soft tissue 1–2 mm, then exits at point b (Fig. 2). The suture was again introduced into the CFS at point b and routed toward point c at the depth between the levator aponeurosis and the Müller's muscle (Fig. 3). Likewise, the needle at the other end was inserted into CFS at point a and routed toward point c. Strained both ends of the suture, and a dimple appeared on the conjunctiva, indicating the success of suspension (Fig. 4).

Then, the two needles were inserted at point c of the conjunctiva. After piercing through the tarsus, the needles exited from the minor slit previously made. Then, the thread was tied into a slipknot. After finishing other suspension sutures, patients were asked to sit up to evaluate the position. Then, the thread was tightened until the tarsus

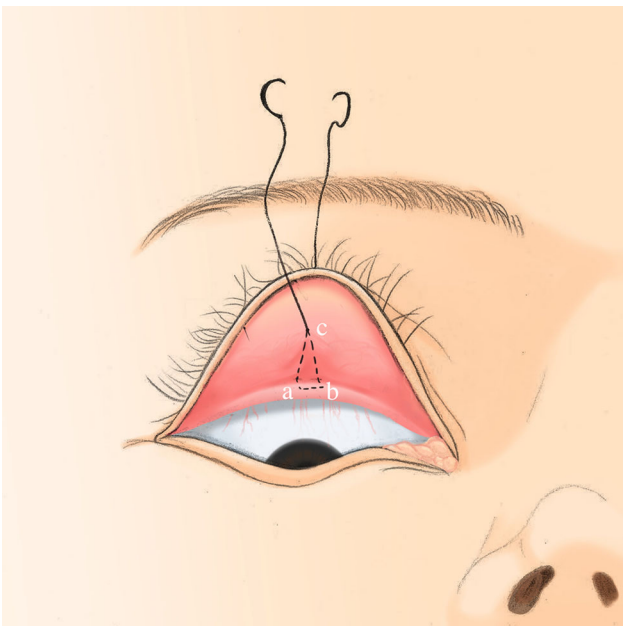


**Fig. 2** A drawing demonstrating the operative procedure of the blepharoptosis correction with the buried suture method. No. 6-0 nylon suture (with needles attached to both ends) is inserted into the CFS at point a and passes through the soft tissue 1–2 mm, then exits at point b. The suture is again introduced into the CFS at point b and routes toward point c at the depth between the levator aponeurosis and Müller's muscle. Likewise, the needle at the other end is inserted into CFS at point a and routes toward point c. Then, the two needles are inserted at point c of the conjunctiva. After piercing through the tarsus, the needles exit from the minor slit previously made

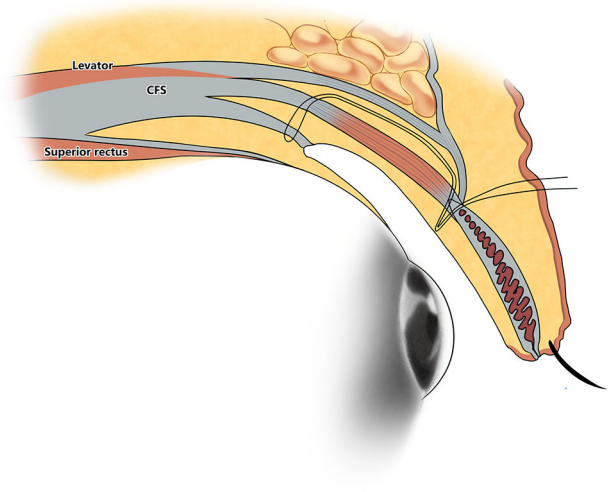


**Fig. 3** Sagittal section of the upper eyelid showing the suspension sutures on the conjoint fascial sheath and going between the levator aponeurosis and the Müller muscle as the appropriate plane for CFS suspension

was elevated to the ideal level: in bilateral surgery, lid margins are placed at or 1 mm below the superior limbus. In unilateral surgery, the margin of the ptotic lid is placed 1–2 mm higher than that of the contralateral lid. Then, the thread was knotted and buried inside the minor slit of the upper eyelid. The 5-0 nylon suture is removed. No suture needs to be applied to close the slit.

### Statistical Analysis

Study data are presented as means ± standard deviations. IBM SPSS Version 21.0 software (IBM Corp, Armonk, NY) was used for statistical analysis. A paired-sample *t* test and a Chi-square test were used to determine the statistical significance.

## Results

Forty patients met the inclusion criteria, and the basic information is summarized in Table 1. Thirteen males and eighteen females received the operation. Patient ages ranged from 13 to 35 years (23.75 ± 5.44). Of these, 24 patients did not receive any surgery before, whereas 16 patients had undergone a surgical correction and required further treatment due to poor correction or recurrence. Eyelid ptosis was bilateral in 15 patients and unilateral in 25. Thus, a total of 55 eyelids were corrected. Preoperatively, 28 eyes were diagnosed as mild ptosis, whereas 27 eyes were diagnosed as moderate ptosis. The mean follow-up period was 13.40 ± 4.60 months.

Twenty-six (92.86%) of the twenty-eight eyelids with mild ptosis returned to "normal," whereas two eyelids received a fair result. Of the 27 eyelids with moderate ptosis, 22 eyelids (81.49%) improved to "normal," while 4 eyelids improved to "mild ptosis" (Figs. 5, 6, 7). One eyelid with moderate ptosis which had 3 suspension sutures observed overcorrection 5 days postoperatively. We removed one suspension suture and a 1-year follow-up showed a satisfying outcome. The poor result was observed in one moderate ptosis eyelid, whose double eyelid fold shallowed and underwent levator aponeurosis resection 2 months after the primary surgery. No significant difference was shown between mild and moderate ptosis in terms of

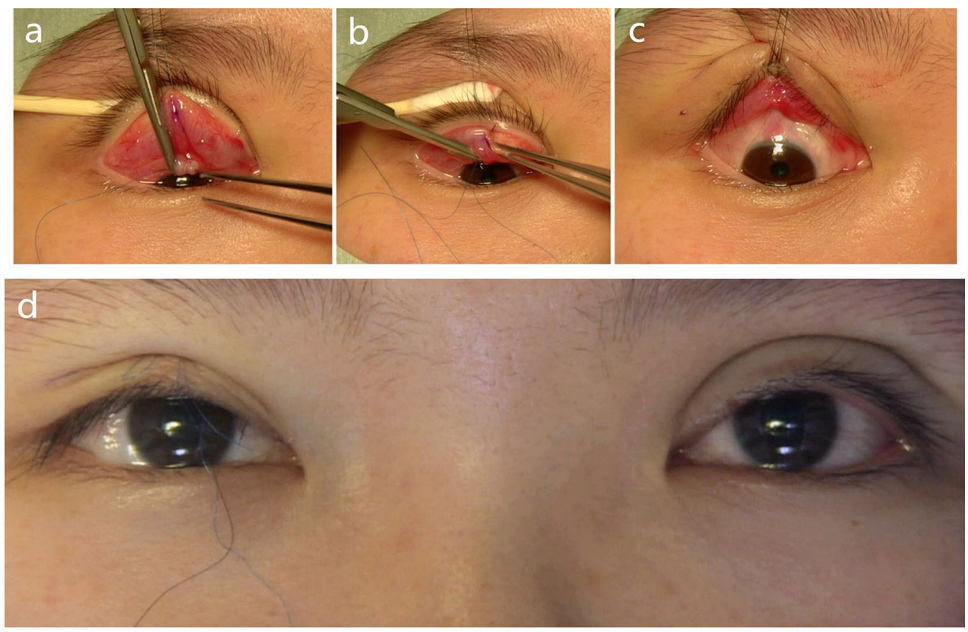


**Fig. 4** **a** Suture is inserted into the CFS and passed through the soft tissue 1–2 mm. **b** The suture was again introduced into the CFS and routed toward point c at the depth between the levator aponeurosis and Müller's muscle. **c** Strained both ends of the suture, and a dimple appeared on the conjunctiva, indicating the success of suspension. **d** Tightening for tarsus elevation at its ideal level

**Table 1** Case summary

| Patients characteristics | *n* (*N* = 40) |
|---|---|
| Sex | |
| Male | 16 |
| Female | 24 |
| Age, years | |
| 10–20 | 11 |
| 21–30 | 22 |
| 30 | 7 |
| Ptosis eye | |
| Unilateral | 25 |
| Bilateral | 15 |
| Follow-up duration, months | |
| 9–12 | 19 |
| > 12 | 21 |
| Degree of ptosis | *n* (*N* = 55) |
| Mild | 28 |
| Moderate | 27 |

operation outcome, indicating comparable effectiveness of this method in treating mild and moderate ptosis (Table 2). The mean MRD1 increased from 2.64 ± 0.85 mm preoperatively to 3.79 ± 0.80 mm postoperatively, which was statistically significant ($P < 0.001$) (Table 3).

## Discussion

CFS, a thin transparent fascia wrapping the posterior half of the levator, is gradually thickened backward and fused with the upper portion of the aponeurosis sheath surrounding the superior rectus. Because of its tough and compact structure, it could be a dynamic scaffold to which the drooping tarsus may be suspended. When opening the eye, under oculomotor nerve innervation, the levator with insufficient but partial strength contracted at a high position; meanwhile, the superior rectus caused the CFS to shift upward when the globe turned upward [11, 17]. By suspending the tarsus to the CFS, both of these forces are transmitted to the tarsal plate through the CFS.

Previously, many surgeons used CFS to correct blepharoptosis in open methods. Although the ptosis was corrected, it required prolonged recovery time and left behind a conspicuous scar [13, 18]. So it is suitable for severe blepharoptosis. For mild-to-moderate ptosis or postoperative ptosis (corrected by other methods) that requires minor adjustment, minimally invasive surgical procedures may be more acceptable [19].

The minimally invasive surgery suspends the upper eyelid to the CFS. In the early stage, the suture effect of pulling and fixing is the main force. Once the scar forms a stable adhesion in the later stage, the effect of correction is long lasting. Since between the CFS and the tarsal plate, there are conjunctiva, levator and Müller muscle, the distance between them can only be narrowed by tension suspension suture but can hardly adhere tightly. Therefore, this method is not appropriate for severe ptosis.

In addition to the minimal incision and insignificant trauma, this operation can be adjusted flexibly during the operation, i.e., the upper eyelid position can be modified by tuning the stretching force and the number of suspension sutures. For mild ptosis or eyelid asymmetry, implanting one or two suspension sutures can achieve the desired results. For moderate ptosis or those who were not satisfied with previous surgery, suspension sutures could be added to 3 to 5. In addition, the dynamic force consisting of the levator and superior rectus and conducted by the CFS well accord with the physiological and biodynamic characteristics of the upper eyelid. Thus, the upper eyelid adheres

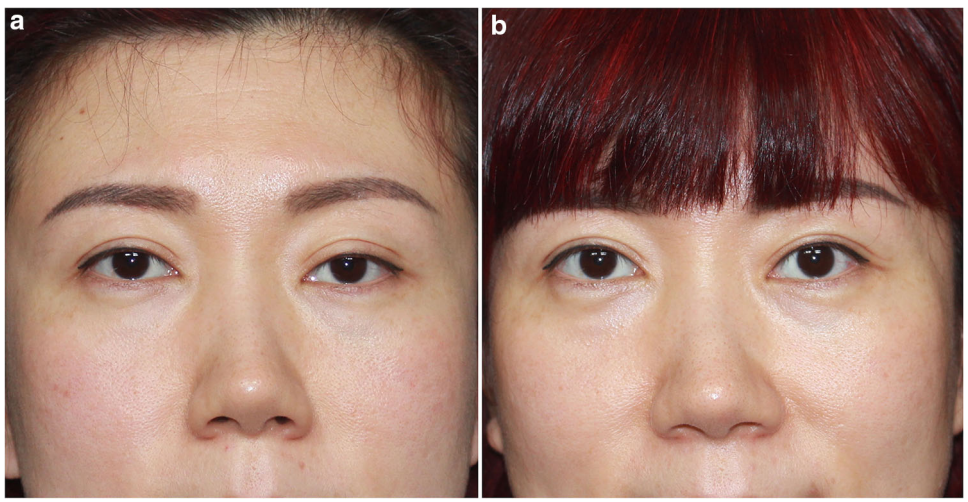


**Fig. 5** A 31-year-old female patient. The blepharoptosis correction with two CFS suspension sutures were performed on the left eye. **a** The preoperative photographic finding. The preoperative MRD1 measured 2.37 at the left eye. **b** The postoperative photographic finding after 15 months. The postoperative MRD1 measured 3.70 at the left eye

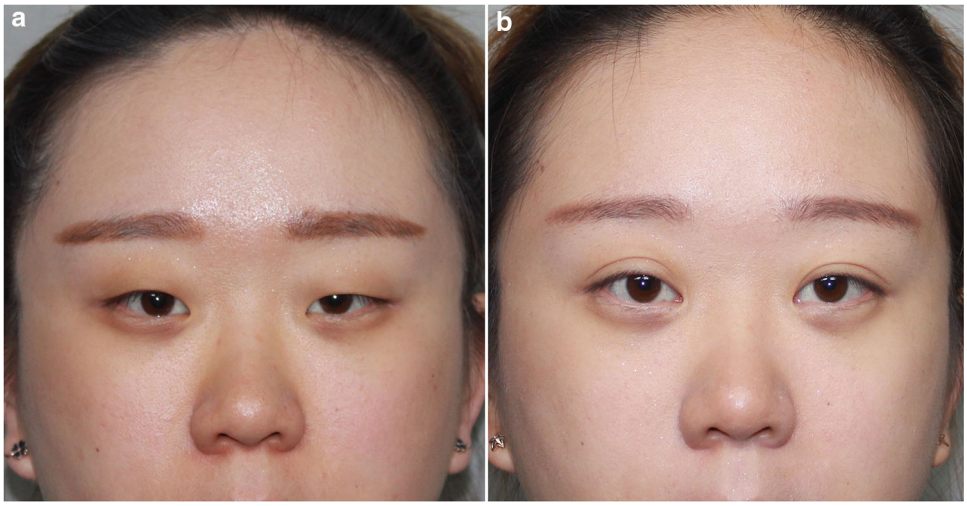


**Fig. 6** A 23-year-old female patient. The blepharoptosis correction with three CFS suspension sutures and medial epicanthoplasty were performed on both eyes. **a** The preoperative photographic finding. The preoperative MRD1 measured 2.34 mm at the right eye and 1.52 mm at the left eye. **b** The postoperative photographic finding after 17 months. The postoperative MRD1 measured 3.14 mm at the right eye and 3.16 mm at the left eye

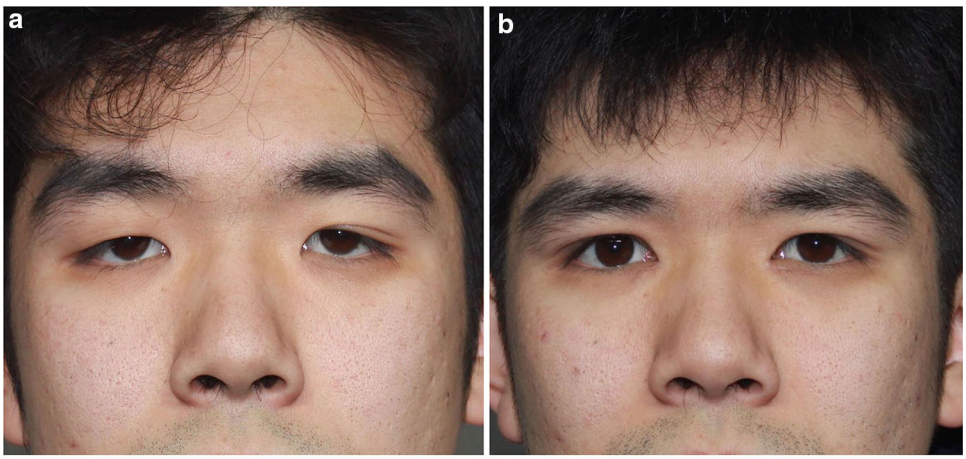


**Fig. 7** A 21-year-old male patient. Bilateral blepharoptosis correction with five CFS suspension sutures and medial epicanthoplasty were performed. **a** The preoperative photographic finding. The preoperative MRD1 measured 1.06 mm at the right eye and 1.16 mm at the left eye. **b** The postoperative photographic finding after 10 months. The postoperative MRD1 measured 3.29 mm at the right eye and 3.02 at the left eye

**Table 2** Postoperative evaluation

| | Operation outcome, *n* (%) | | | *P* |
|---|---|---|---|---|
| | Good | Fair | Poor | |
| Preoperative ptosis degree, *n* (%) | | | | |
| Mild (28) | 26 (92.86) | 2 (7.14) | 0 (0.00) | 0.371 |
| Moderate (27) | 22 (81.49) | 4 (14.81) | 1 (3.70) | |
| Total (55) | 48 (87.27) | 6 (10.91) | 1 (1.82) | |

**Table 3** Changes in MRD1

| Value (mm) | Preoperative ptosis degree (*n*) | | |
|---|---|---|---|
| | Mild (28) | Moderate (27) | Total (55) |
| Preop MRD1 | 3.37 ± 0.29 | 1.89 ± 0.52 | 2.64 ± 0.85 |
| Postop MRD1 | 4.45 ± 0.44 | 3.11 ± 0.44 | 3.79 ± 0.80 |
| Changes of MRD1 | 1.08 ± 0.30 | 1.22 ± 0.61 | 1.15 ± 0.48 |
| *P* | 0.000 | 0.000 | 0.000 |

well to the globe, and the period of eyelid lag is short after the operation. The incidence of exposed keratitis is extremely low, and the discomfort of the patients was significantly reduced.

The traditional anterior levator aponeurotic approach uses full incision, resulting in more bleeding and edema, which interferes with intraoperative observation and requires a long recovery time [20]. Moreover, simple levator plication may induce recurrence [21]. By combining levator aponeurosis and Muller muscle plication with levator sheath advancement, Byun et al. [22] reported greater improvement in MRD1 than levator aponeurosis and Muller muscle plication alone, indicating that extra tension from the levator sheath, an eyelid-elevating structure, can promote the postoperative effect. But its long-term surgical effect has not been proven nor had the tensile strength of levator. Besides, the incision and dissection areas are still larger than non-/minimal-incisional approaches.

Levator aponeurosis–Muller muscle complex advancement has been claimed to be an effective technique for

young patients with mild-to-moderate blepharoptosis [23–25]. These minimally invasive procedures can be combined with a double eyelid fold operation. But the correction is beset by the question of longevity and accuracy of repair [22] because the suture only narrows the distance between the tarsus and the distal part of the levator by "accordion pleated like" multilayer folding adhesion of the levator and the Müller's muscle, rather than suspending the muscle to a fixed, stable structure [26].

Ahn et al. used a one-/two- loop CFS suspension technique to correct blepharoptosis. In their method, CFS is positioned at the apex of the cone. The needle pierces and exits CFS at the same point, suspending little CFS tissue [12]. The suspension suture may burst CFS tissue. Thus, shortened tissue release prematurely, and the adhesion that has not yet been finalized is abandoned halfway. At this stage, there is no reliable adhesion above, once the scar can no longer resist the daily frequent eyelid movement, it will loosen and lead to failure. Meanwhile, in addition to the suspension suture applied to the crease fold level, the "triangle single-knot suture" technique was used to create a double eyelid crease [12]. In such a case, the overladen eyelid may lead to immunological rejection or ptosis aggravation.

In our method, the needle transversely passes through CFS 1–2 mm. By expanding the suspension area, it reduces the cutting pressure of the suture line and prevents bursting CFS. In addition, a double eyelid crease was formed simultaneously without the need for extra blepharoplasty. Besides lifting the ptotic eyelid, we design the new fold on the ptotic side 1 mm narrower than the normal side. On the one hand, it alleviates the preload. The ptotic eyelid elevates due to CFS suspension and less preload; on the other hand, soon after the surgery, as the lesion eye being corrected, the tarsus on the normal side drops a bit and the width of normal eyelid fold widens. By designing the fold of the ptotic side 1 mm narrower than the normal side, the bilateral eyelids become more symmetrical after the treatment effect gradually decreases.

We also reflect on the complications and possible preventions: firstly, insufficient or ineffective correction, which might be caused by adrenaline interference. False relief of blepharoptosis degree interferes with observation, leading to inadequate elevation. To avoid such a phenomenon, little or no epinephrine should be added. Secondly, overcorrection and upper eyelid retraction. Intraoperative anesthesia, edema or hematoma causes difficulty in lifting the upper eyelid, which will interfere with surgeon judgment, resulting in overladen with suspension. Therefore, after local anesthesia infiltration, if the eye opens abnormally, surgeons had better stop the operation. Lastly, since CFS and the superior rectus are adjacent and related, the suture should not be too deep to avoid affecting the function of the superior rectus muscle.

In terms of limitations, as a retrospective study, our study lacks a control group, and it would be more persuasive if there is a gold standard for blepharoptosis correction that could serve as a control. Furthermore, larger sample size and longer follow-up term, across a 3-year or longer period, would contribute to the verification of the postoperative effect, which is especially necessary when comparing with other surgeries.

## Conclusion

The minimally invasive suspension of CFS can effectively correct mild and moderate blepharoptosis and form double eyelid simultaneously. The surgery involves little trauma, short recovery time and the satisfactory postoperative effect is worth popularizing.

### Compliance with Ethical Standards

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

**Ethical Approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the clinical research committee of plastic surgery hospital (12100000400266049B) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

**Informed Consent** Informed consent was obtained from all patients and can be seen by the editors.

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