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ARTICLE

Conjoint fascial sheath suspension with levator muscle advancement for severe blepharoptosis

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ABSTRACT

In patients with severe blepharoptosis, the function of the levator muscle is usually weak. Even if a large amount of levator is resected, under-correction and recurrence often occur postoperatively. Frontalis suspension is the first choice for severe ptosis; however, the external orbital lifting force of the frontalis causes non-physiological eyelid movement. Conjoint fascial sheath (CFS) is a fibrous tissue which can provide dynamic movement of upper eyelids and has been applied for the treatment of mild and moderate blepharoptosis in recent years. This study aims to assess the efficacy and safety of CFS suspension combined with levator muscle advancement for treating severe blepharoptosis. A retrospective study included 44 patients (60 eyelids) with severe ptosis who underwent the modified technique. Preoperatively, levator muscle function and margin reflex distance 1 (MRD1) were measured. Surgical outcomes, symmetry results and complications were evaluated postoperatively. At the 12–18 months follow-up, adequate or normal correction was achieved in 56 eyelids (93.3%), and 37 patients (84.1%) presented good or fair symmetry results. The most common complication was conjunctival prolapse, which was observed in six eyelids (10.0%), followed by lid fold deformity and under-correction. No exposure keratitis was recorded. In conclusion, the modified technique can physically elevate the eyelid with limited tissue injury and is effective for the correction of severe ptosis. Both satisfactory functional and esthetic results were achieved, and severe complications (such as exposure keratitis) were not observed.

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Blepharoptosis; conjoint fascial sheath; levator muscle; Müller's muscle

Introduction

Blepharoptosis is characterised by the abnormal descent of the upper eyelid [1]. Patients with ptosis have an unappealing appearance and may even have functional visual deficits, such as amblyopia [2]. The degree of ptosis is categorised as mild, moderate and severe according to the difference between the ptotic and normal eyelid levels. Severe ptosis is defined as eyelid drooping of 4 mm or more compared to the position of normal eyelid margin [3]. Various surgical approaches have been reported for severe ptosis, such as maximal anterior levator resection, combined excision of the levator muscle and tarsus, frontalis suspension surgery with autogenous fascia lata, and frontalis muscle flap advancement [4–8].

The levator muscle is thought to enable the upper eyelid to move in a physiological direction. Approaches, such as levator advancement or resection, are commonly performed for mild or moderate ptosis [9,10]. However, in most cases of severe ptosis, poor levator muscle function impedes the application of these approaches. As reported, 4–5 mm of levator muscle advancement would elevate 1 mm of the upper eyelid; therefore, excessive resection of the levator muscle is often performed for severe ptosis [11]. Nevertheless, unsatisfactory correction results are common with excessive levator advancement, and complications, such as conjunctiva prolapse and corneal exposure, may occur [12,13].

To date, frontalis suspension is commonly selected to bypass poor levator muscle function in patients with severe ptosis [14]. However, it leads to unnatural eyelid elevation and has many complications, such as lagophthalmos, aggravated forehead furrows and a high recurrence rate [11]. Therefore, a technique that maintains the physiologic eyelid movement and achieves a better esthetic appearance is needed for severe ptosis.

The conjoint fascial sheath (CFS), also called the check ligament, is a special fibrous tissue between the levator muscle and the superior rectus that contains collagen, elastin and smooth muscle fibres, from which emanates extensions attached to the conjunctival fornix [15]. It was described in 1932 by Dr. Whitnall and was first applied for the correction of blepharoptosis in 2002 by Holmström and Santanelli [16]. 'Check ligament' suspension for the treatment of myopathic blepharoptosis was established by Santanelli [17]. In 2019, Zhou et al. developed the technique of minimally invasive CFS suspension for treating mild and moderate ptosis [18].

Considering the aforementioned techniques, the CFS has emerged as a new suspension tissue for the treatment of ptosis. Moreover, the main driving force of the CFS comes from the superior rectus, which lifts the upper eyelid in the same direction as the levator muscle, mimicking its physiological characteristics [19]. Meanwhile, the involvement of the CFS can reduce the

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amount of levator muscle advancement and make it possible to apply the levator muscle in cases of severe ptosis, which is preferable for ptosis repair.

In this article, we introduce a procedure combining CFS suspension and levator advancement for the treatment of severe blepharoptosis. This study aimed to evaluate the efficacy and safety of this novel technique.

Methods

Patients

This retrospective study was reviewed by local ethics committee and determined to be exempt. All patients who had undergone levator muscle advancement combined with CFS suspension performed by the same surgeon were included from March 2020 to January 2021, in the Department of Plastic and Reconstructive Surgery, Shanghai Ninth People's Hospital, Shanghai Jiaotong University School of Medicine. Patient inclusion criteria were as follows: (1) at least one eyelid with severe congenital blepharoptosis (lid drooped 4 mm or more), (2) primary eyelid surgery and (3) a follow-up period of 12–18 months. To ensure the precision of pre- and postoperative evaluation, patients with superior rectus dysfunction, myasthenia gravis, negative Bell's phenomenon or Marcus Gunn jaw-winking syndrome were excluded. Written consents for the use of clinical data and face photos were obtained from all patients, and the study followed the Declaration of Helsinki.

Surgical technique

A curvilinear line was marked along the upper eyelid with methylene blue, usually 4–5 mm above the eyelid margin in children and 5–6 mm above the eyelid margin in adults. In patients older than 12 years of age, local infiltration anaesthesia with 2% lidocaine was applied to the eyelid, while general anaesthesia was preferable in younger patients. An incision was made along the labelled line, part of the skin, and the subcutaneous tissue, and the orbicularis oculi muscle was removed to expose the tarsus and orbital septum. The orbital septum was opened, and the bulgy orbital fat was partly excised to expose the levator aponeurosis–Müller's muscle composite. The composite was detached from the margin of the tarsus upward to the superior fornix, exposing the shiny tissue of the CFS (Figure 1(A)). The CFS was sewn to the upper margin of the tarsus using 3–0 silk sutures, with a total of three stitches (Figure 1(B)). A U-shaped suture was placed at the intermediate position of the upper one-third of the tarsus with 3–0 silk to suspend the tarsus to the levator aponeurosis–Müller's muscle composite (Figure 1(C)). To confirm the level of the upper eyelid margin, patients under local anaesthesia were instructed to sit up and open their eyes. In unilateral blepharoptosis, the corrected eyelid margin should be 1 mm higher than that of the unaffected side. In bilateral cases and in patients under general anaesthesia, the corrected eyelid margin was adjusted to 1 mm above the upper margin of the cornea. When a satisfactory eyelid level was achieved, a knot was tied, and two additional sutures were placed at the medial and lateral sides of the middle suture. The redundant composite was excised by maintaining 3 mm of the flap stump. The skin incision was closed with an interrupted 5–0 silk suture of the lower eyelid skin edge, broken end of the composite, and upper eyelid skin edge, forming a double eyelid. A Frost suture of

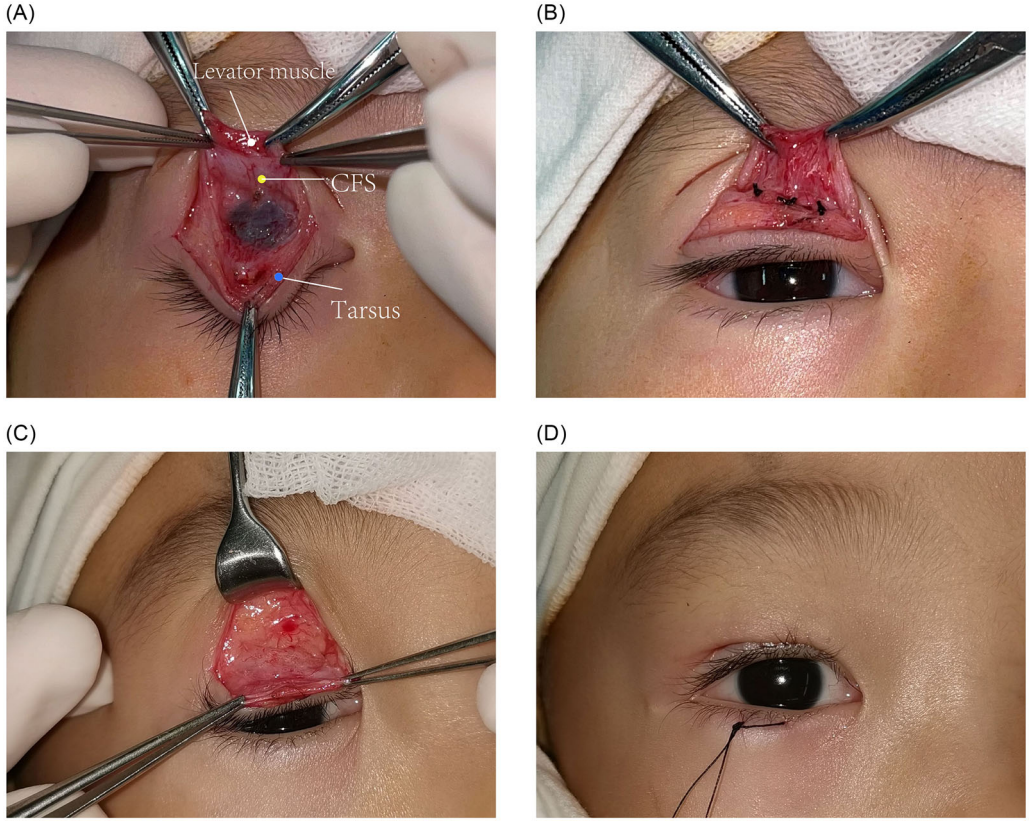

Figure 1. Operative procedure of levator muscle advancement combining CFS suspension. (A) Dissection of levator muscle to expose CFS. The white circle represented levator, the yellow one was CFS and the blue one was tarsus. (B) Suspension of the tarsus to CFS. (C) The levator aponeurosis–Müller's muscle composite was sewn to the tarsus. (D) An interrupted suture of the lower eyelid skin edge, broken end of the composite and upper eyelid skin edge to close the skin incision.

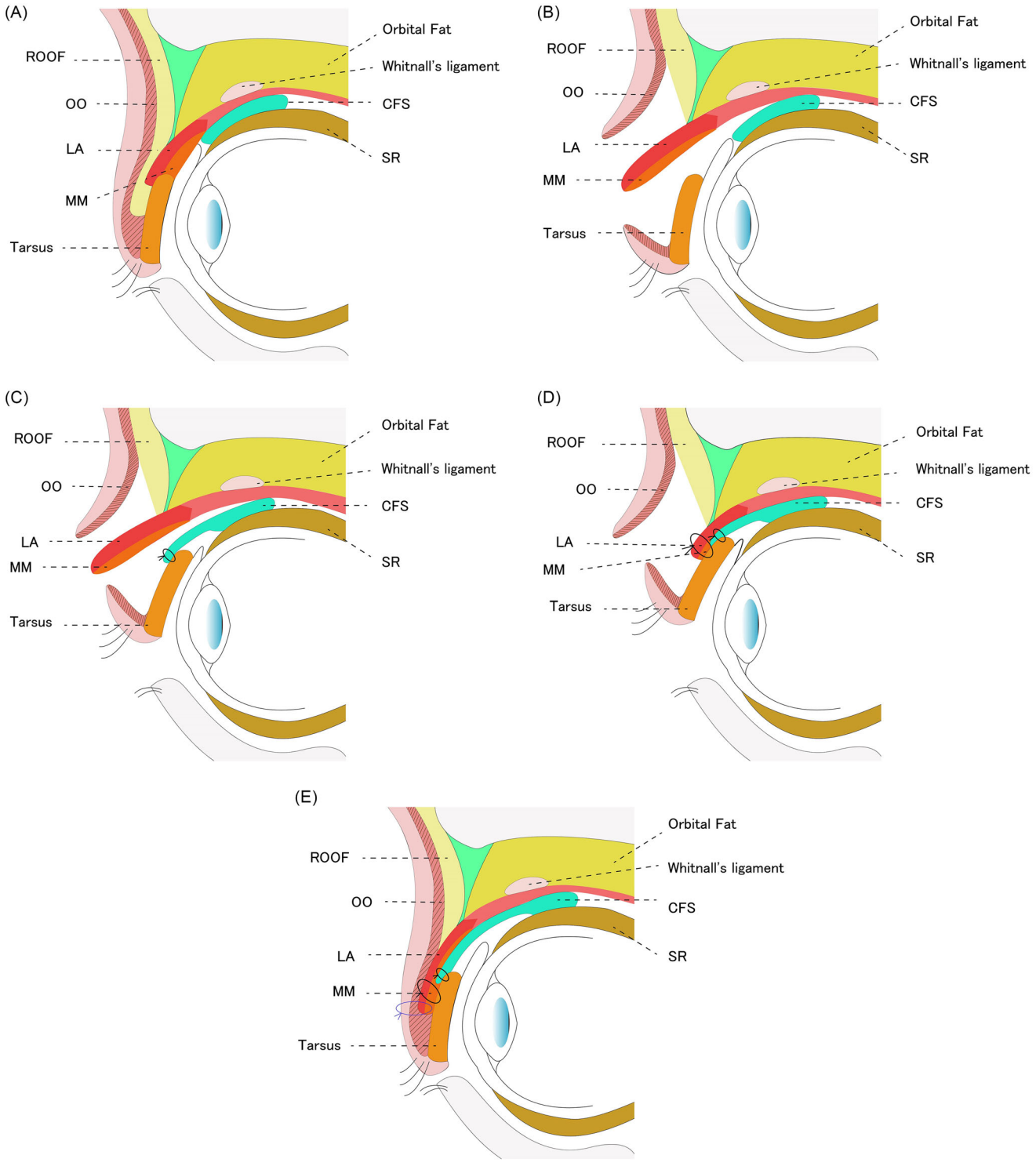

Figure 2. Diagram of operative procedure. (A) The anatomy of the upper eyelid. (B) Excision of the skin and the orbicularis oculi, dissection of levator muscle and exposure of CFS. (C) Suspension of CFS to the tarsus. (D) Fixation of the levator aponeurosis–Müller's muscle composite to the tarsus. (E) Closure of the skin incision and stitching of the Frost suture. ROOF: retro-orbicularis oculi fat; OO: orbicularis oculi; LA: levator aponeurosis; MM: Müller's muscle; CFS: conjoint fascial sheath; SR: superior rectus.

the lower eyelid was made using 3–0 silk to protect the cornea, and standard postoperative care was adopted (Figure 1(D)). A diagram of the surgical procedure is presented in Figure 2.

Pre- and postoperative evaluation

Levator muscle function and the margin reflex distance 1 (MRD1) were evaluated preoperatively. The former was measured by Berke's method, which blocked the movement of the frontalis muscle [20]. The MRD1, which refers to the distance between the corneal light reflex and the level of the centre of the upper eyelid margin in the primary gaze position [21], was the primary assessment standard of efficacy. If the drooping eyelid covered the light reflex, then the eyelid was raised until the reflex was seen, and the distance of the eyelid being raised was documented as the MRD1 in negative numbers. A postoperative evaluation was

Table 1. Demographics and preoperative evaluation of patients.

	Sex, *n* (%)		Ptosis side, *n* (%)		
Average age (range)	Male	Female	Unilateral	Bilateral	Levator function (mm)
24.6 (5–53)	15 (34.1)	29 (65.9)	28 (63.6)	16 (36.4)	2.40 ± 1.21

conducted at the six-month follow-up visit. The MRD1 of the operated side was measured, and ptosis correction was considered adequate if the MRD1 was ≥4.5 mm with the sclera invisible, normal if 4.5 mm > MRD1 ≥ 3.5 mm, and undercorrected if MRD1 was <3.5 mm.

In terms of symmetry evaluation, a difference between bilateral upper eyelid margins of less than 1 mm was considered a good result, while a difference between 1 and 2 mm (including 1 mm) was considered a fair result, and a difference greater than 2 mm was considered a poor result [11].

Complications, such as under-correction, overcorrection, conjunctival prolapse, lid fold deformity, short-term lagophthalmos and exposure keratitis, were recorded during the 6-month postoperative follow-up.

Statistical analysis

Statistical analyses were conducted using IBM SPSS version 23.0 (IBM Corp., Redmond, WA). Measurement values are presented as mean ± standard deviation. We analysed the differences in MRD1 values pre- and post-surgery using the paired *t*-test. Differences were considered statistically significant at $p<.05$.

Results

A total of 44 patients (60 eyelids) with severe blepharoptosis, including 15 men and 29 women, underwent this novel technique and were included in this study. The patients' ages ranged from 5 to 53 years (mean age, 24.6 years); 28 of the patients had unilateral eyelid ptosis, and 16 had bilateral ptosis (Table 1). In this series, the average levator muscle function value was 2.40 ± 1.21 mm (Table 1). All patients were followed after the surgery, and the mean follow-up period was 14.1 months (range, 12–18 months).

The average preoperative MRD1 value was 0.27 ± 0.44 mm, while the average postoperative MRD1 value was 4.21 ± 0.52 mm, presenting a significant difference in the value between before and after surgery ($p<.05$) (Table 2 and Figure 3).

As for ptosis correction, 23 (38.3%) eyelids exhibited adequate correction, 33 (55.0%) presented with normal correction, and under-correction was seen in four (6.7%) eyelids (Table 3). With regard to the symmetry results, 17 (38.6%) patients obtained good results, 20 (45.5%) showed fair results, and seven (15.9%) achieved poor results.

Postoperative complications were recorded, including four eyelids with under-correction (6.7%), two with overcorrection (3.3%), six with conjunctival prolapse (10.0%), three with lid fold deformity (5.0%), two with short-term lagophthalmos (3.3%) and no exposure keratitis (Table 4). Four patients with under-correction underwent reoperation of the levator muscle with further advancement, while two with slight overcorrection did not require a revision; three patients with lid fold deformity underwent deformity repair, and the other complications recovered spontaneously within seven days.

Table 2. MRD1 value.

Preoperative MRD1 (mm)	Postoperative MRD1 (mm)	*p* Value
0.27 ± 0.44	4.21 ± 0.52	<.05*

*p Value <.05 was considered statistically significant.

Discussion

The CFS emanates from the sheaths of the levator muscle and superior rectus and attaches to the conjunctival sac at the level of the superior fornix, which stabilises the fornix [15,19]. Previous studies have found that the ligament is 8–14 mm long, 0.5–1.5 mm wide and 1–1.2 mm thick [16,22]. Although anatomical knowledge of the CFS has existed for some time, its role in the treatment of severe ptosis has only been reported in the last 10 years. Holmström and Santanelli reported a simple CFS suspension for the treatment of ptosis in 2002, which marked the beginning of CFS application for ptosis.

Frontalis suspension is the most common treatment for severe blepharoptosis. Nevertheless, because of the external orbital lifting force of the frontalis, it often changes the elevating direction of the upper eyelids and results in complications, such as lagophthalmos, aggravating forehead furrows and exposure keratitis. Postoperatively, a high recurrence rate and low satisfaction rate are common [23,24]. The novel technique described in this study utilises the levator muscle and CFS as suspension forces. Compared with the frontalis, the levator provides an internal orbital lifting force and lifts the upper eyelid in a physiological manner. The driving force of the CFS relies on the superior rectus, which moves parallel to the levator muscle. Therefore, our technique creates a more dynamic eyelid and eyeball coordination movement, and the occurrence rate of severe complications, such as exposure keratitis and lid lag, is low, as recorded in this study. Compared to the 6.7% recurrence rate of the described technique, the recurrence rates in reports of frontalis suspension by Lee et al. [25] and Bouazza et al. [26] were 12.5% and 14.3%, respectively, indicating that levator muscle suspension combining CFS suspension provides a lower relapse rate. Moreover, with a 93.3% adequate or normal correction rate, the modified technique provided a better efficacy than simple CFS suspension, compared to the 75% correcting rate of severe ptosis group in Santanelli et al.'s report [17].

No exposure keratitis was recorded in this study compared to the 9.43% exposure keratitis rate in Pan et al.'s report of frontalis suspension [27], indicating that our technique is relatively safe. As an elastic tissue, the CFS can correct severe blepharoptosis while maintaining a better eye-closing function. Postoperative conjunctival prolapse, which occurred in 10.0% of our patients, could be attributed to the high anatomical position of the CFS. This complication can be treated by placing a 4–0 double-armed suture into the superior fornix entering the conjunctiva and exiting the skin, then tying the suture over a cotton pledget, and leaving it in for one week. Besides, attention should be paid when dissecting the deep CFS to avoid damage to the superior rectus muscle that could lead to postoperative hypotropia and diplopia.

This technique has several advantages over previous approaches. The structures of the eyebrows were not dissected to expose the frontalis muscle during this surgery, inducing less

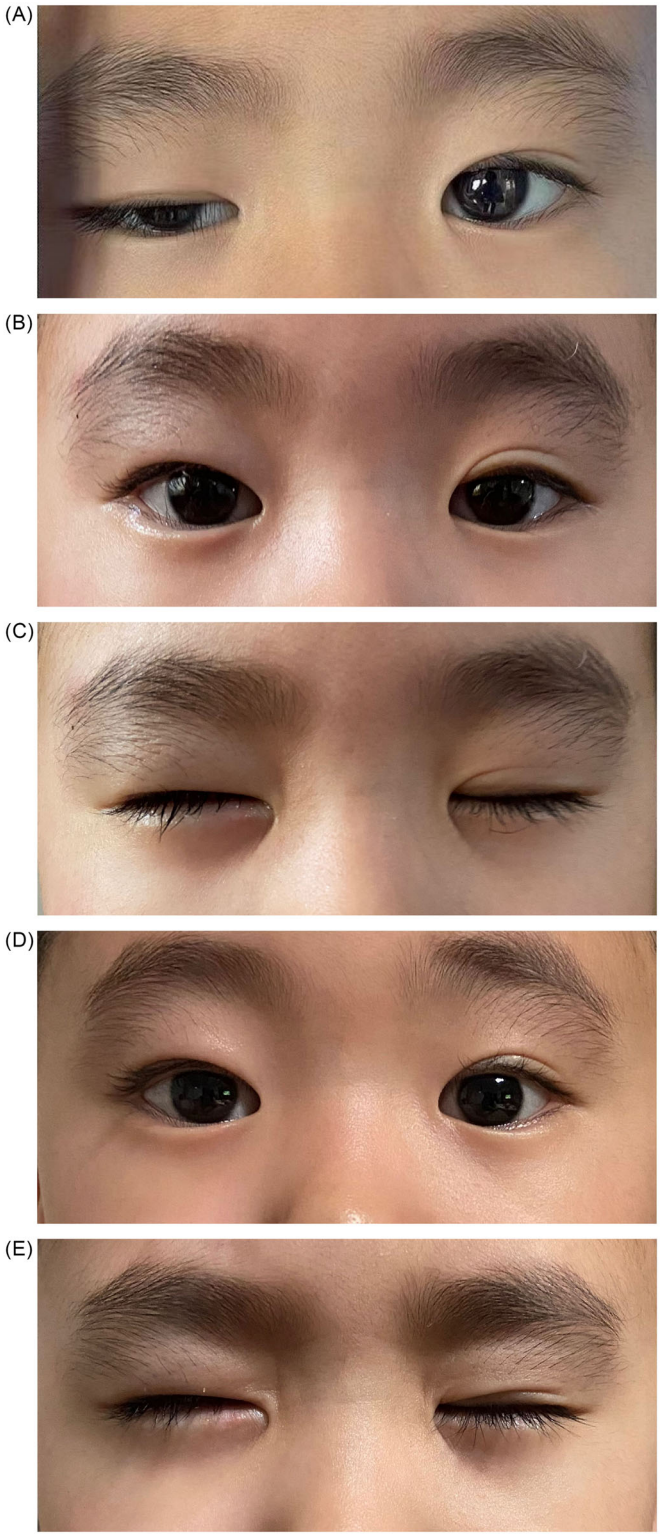

Figure 3. A 6-year-old child presented with severe unilateral blepharoptosis who underwent the described surgery and achieved good outcomes. The preoperative MRD1 value was −0.4 mm, and his levator muscle function was 1 mm. (A) Preoperative straight-ahead gaze (B) 6-month postoperative result with eyes open. (C) 6-month postoperative result with eyes closed. (D) 14-month postoperative result with eyes open. (E) 14-month postoperative result with eyes closed.

Table 3. Correction and symmetry results.

Ptosis correction results, *n* (%)			Symmetry results, *n* (%)		
Adequate	Normal	Under-correction	Good	Fair	Poor
23 (38.3)	33 (55.0)	4 (6.7)	17 (38.6)	20 (45.5)	7 (15.9)

Table 4. Complications *n* of eyelids (%).

Conjunctival prolapse	6 (10.0%)
Undercorrection	4 (6.7%)
Lid fold deformity	3 (5.0%)
Short-term term lagophthalmos	2 (3.3%)
Overcorrection	2 (3.3%)
Exposure keratitis	0 (0%)

tissue injury than in frontalis suspension. In addition, the eyelid opening is not powered by the frontalis, which reduces the appearance of forehead furrows [21,28]. In patients with severe blepharoptosis, there may not be enough levator to be removed because the ratio between the levator resection amount and the eyelid elevation is 5:1. With the combined suspension of CFS, the amount of levator muscle removed is greatly reduced, and the modified technique can provide stronger power to ameliorate ptosis, compared with simple CFS suspension or levator shortening surgery.

The levator aponeurosis–Müller's muscle composite and the CFS are separately sutured to the tarsus, which enables the surgeon to conveniently adjust the amount of levator muscle advancement according to the level of the eyelid margin. In some cases, a satisfactory eyelid margin was achieved after suspending the tarsus to the CFS, and further resection of the levator muscle was avoided. Another advantage of our technique is that it can be a revision procedure for patients who have undergone primary surgery. The CFS can be easily sewn to the tarsus after careful dissection of eyelid tissues, and the limited anatomical scope makes the procedure quick and repeatable.

The limitations of our technique are as follows: (1) the period of follow-up in this study was relatively short for severe blepharoptosis and needs to be prolonged to further evaluate the efficacy; (2) the procedure is not easy to master and attention should be given when dissecting the deep CFS to avoid superior rectus injury, which may cause abnormal eye position and diplopia; (3) randomised controlled trials with frontalis suspension and simple CFS suspension are needed to better evaluate the efficacy of our technique.

Conclusions

CFS suspension combined with levator muscle advancement is an effective method for the treatment of severe blepharoptosis. By preserving more of the anatomic structure and keeping the eyelid movement more natural, this technique enabled the achievement of both satisfactory ptosis correction and esthetic appearance. Serious postoperative complications, such as long-term lagophthalmos or exposure keratitis, were not observed.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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