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Physiological correction of mild to moderate congenital blepharoptosis: A retrospective cohort study involving 97 Eastern Asian patients☆

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Abstract *Background:* Conventional blepharoptosis repair methods distort the normal anatomy of levator aponeurosis and often cause a visible depressed scar in the upper eyelid.
Methods: The levator aponeurosis was dissected as a flap from the pretarsal tissue in monoeyelid Asian patients who had mild to moderate congenital blepharoptosis. The flap base was advanced and repositioned on the tarsus. The margin of the distal flap was interposed and fused with orbicularis oculi muscles. Postoperative evaluation included ptosis correction, symmetry, and overall cosmetic outcomes.
Results: A total of 162 eyes on 97 patients were corrected using our method. Follow-up time ranged from 8 to 24 months (mean 12.4). In mild ptosis eyelids, out of 58 eyelids, 36.2% (21 eyelids), 56.9% (33), and 6.9% (4) required adequate correction, normal correction, and undercorrection, respectively, whereas in moderate ptosis, the results were 34.6% (36 eyelids), 53.9% (56), and 11.5% (12), respectively. For symmetry, 58.8% (57 cases), 32.0% (31), and 9.2% (9) resulted in good, fair, and poor outcomes, respectively. For cosmetic outcomes, 82.8% (48 eyelids), 15.5% (9), and 1.7% (1) of mild ptosis cases achieved good, moderate, and poor results in mild ptosis cases, whereas the results were 77.9% (81 eyes), 20.2% (21), and 1.9% (2),

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respectively, in moderate ptosis cases. The only complication among all cases was postoperative swelling.
Conclusions: We presented a new blepharoplasty for ptosis repair that allows both satisfactory ptosis correction and cosmetic outcomes in mild to moderate congenital blepharoptosis.

Introduction

Blepharoptosis is a disease characterized by an abnormal drooping of the upper eyelid.[1] It is considered as nonprogressive but may cause visual dysfunctions.[2] The ptotic eyelid is cosmetically unappealing. The choices of ptosis repair largely depend on the severity of ptosis and the levator function.[3] The levator-based procedures, for example, the levator advancement[4] and levator resection[5], have been usually applied in patients with fair to good levator function (≥5 mm), whereas frontalis suspension has been used in patients with poor levator function.[6] Unfortunately, none of them could spontaneously create natural-looking double eyelids for the Eastern Asian patients who do not have inherent supratarsal folds.[7] Anatomically, in individuals with inherent double eyelid fold, the levator aponeurosis centrally fuses with the orbital septum above the superior tarsal border and inserts primarily into the orbicularis oculi muscles and upper eyelid skin and secondarily on the anterior, inferior one-third of the tarsus.[8] In Asians without supratarsal folds, however, the levator aponeurosis fuses with the orbital septum below the superior tarsal border. Its extended fibers do not insert into the pretarsal skin, resulting in no invagination of the skin fold.[9] Additionally, the levator aponeurosis courses approximately 20° lateral to the sagittal plane, which directs the traction force laterally and causes asymmetric force delivery to the tarsus.[10]

Although anterior levator-based methods improve ptosis, it remains difficult to reconstruct physiological anatomy of the levator aponeurosis and causes complications such as recurrence of ptosis, exposure keratopathy, and difficult reoperation, as well as unsightly upper eyelid scar. Lee *et al.*[11] suggested that the lateral abnormal deviation of levator aponeurosis was a major cause of blepharoptosis in Asian patients. They repositioned the levator aponeurosis to correct mild to moderate blepharoptosis and achieved good results without major complications. We believe that the ideal ptosis repair method would combine good functional and esthetic results in the upper eyelid, which is particularly important to Eastern Asian patients.

To avoid the stiff and unsightly scar caused by the conventional methods mentioned above, here, we introduce a novel blepharoplasty for the correction of nonsevere congenital blepharoptosis by manipulating levator aponeurosis. The authors speculate that a natural-looking double eyelid and a good functional outcome of ptosis eyelid could be spontaneously achieved by complying with the anatomy basics of levator aponeurosis in Caucasians[12] and the theory of Lee's *et al.*[11] work.

Patients and methods

This work was approved by the Institutional Review Board of Shanghai Ninth People's Hospital affiliated with Shanghai Jiao Tong University School of Medicine and conducted in accordance with its ethical standards, as well as the *Helsinki Declaration*.

Patients

By retrospectively reviewing and screening the medical history and photographs of ptosis correction cases in the outpatient center of the Department of Plastic and Reconstructive Surgery in the Shanghai Ninth People's Hospital between July 2015 and July 2017, 97 monoeyelid patients who had mild to moderate congenital blepharoptosis were enrolled in this cohort study. Patients were excluded from the study if they had inherent double eyelids with ptosis, previous correction history, severe ptosis, negative Bell's phenomenon, noncongenital ptosis, loss of follow-up, or Marcus-Gunn syndrome. These patients with ptosis were all from the Han ethnicity with an age range of 18–36 years (mean 27.3 years), and they received blepharoplasty using our novel ptosis repair method by the same surgeon. Among them, there were 86 females and 11 males. Sixty-five patients received bilateral ptosis repair; the remaining 32 cases received unilateral blepharoplasty. Details regarding operation and subsidiary procedures were comprehensively described to patients, and written informed consent was obtained. Patient demographic data are summarized in Table 1. The normal position of palpebral superior margin (PSM) lines up within 2 mm below the superior cornea edge (SCE). In unilateral cases, severity of ptosis is determined by the distance between PSM and SCE. A ptosis is regarded as mild if the distance ranged from 2 to 4 mm, moderate if it ranged from 4 to 6 mm, and severe if it was greater than

Table 1 Demographics of patients.

Age (range)	Gender *n* (%)		Ptosis type *n* (%)		Ptosis side *n* (%)	
	Male	Female	Unilateral	Bilateral	Left	Right
27.3 (18–36)	11 (11.3)	86 (88.7)	32 (32.9)	65 (67.1)	77 (47.5)	85 (52.5)

Table 2 Preoperative evaluation.

Severity of ptosis	No. of eyes *n* (%)	Distance between PSM and SCE (mm)	Levator function (mm)
Mild	58 (25.8)	3.24 ± 0.23	8.83 ± 1.57
Moderate	104 (64.2)	5.42 ± 0.55	5.76 ± 1.26

PSM: Palpebral superior margin; SCE: superior cornea edge.

6 mm.[13] In bilateral ptosis cases, the normal eyelid level was assumed to be 1 mm below the SCE as described previously by Stasior and Ballitch.[14]

Preoperative evaluation

Levator function and severity of ptosis were measured as a part of preoperative evaluation using Berke's technique.[15] Briefly, levator function was considered as *good* if lid excursion was more than 8 mm, *moderate* if it ranged from 5 to 7 mm, and *poor* if it was less than 5 mm. Severity of ptosis was evaluated as previously described. The details of preoperative evaluation are presented in Table 2.

Surgical procedures

An appropriate palpebral crease was designed and marked preoperatively based on patients' desire and skin redundancy in the sitting position. The vertical height of palpebral fold, which is the distance between crease line and ciliary rim, was 5–7 mm for men and 6–8 mm for women in general. All procedures were performed using 2–3 ml of 2% lidocaine containing 1:100,000 epinephrine per eye. A skin incision was made using a No. 15 blade. Dissection extended medially and laterally through the orbicularis oculi muscles with a pointed, curved iris scissor. A thin strip of orbicularis, approximately 0 to 3 mm wide, was excised according to skin redundancy. The orbicular oculi muscles were dissected inferiorly to the lower border of tarsus using a monopolar electronic cautery to expose the surface of pretarsal levator aponeurosis (Figure 1(A)). The anterior adhesions of vertical oriented fibers between aponeurosis and septum were loosened and separated by blunt dissection. After incising the orbital septum, excessive orbital and preaponeurotic fat were removed and the levator aponeurosis was detached from the upper border. A horizontal incision was then made at the mid-level of the vertical length of the tarsal plate, and the dissection proceeded to form a superiorly based pretarsal levator tissue flap (Figure 1(B)). This flap was elevated over the upper border, pulled forward to the lower tarsal border, and anchored on the tarsus with 7–0 silk sutures (Figure 1(C)). Patients were necessarily required to make eye movements intraoperatively to help the surgeon adjust the proper anchoring point. The distal portion of levator flap was interposed and fused with orbicularis muscle stumps and upper lid skin using 8–0 silk thread interrupted stitches along palpebral crease line (Figure 1(D)). After final adjustments, the upper eyelid skin was closed with 8–0 silk thread using interrupted stitches. The skin dermal layer should not be included in the crease fixation, and it ensures tension-free procedures to retain a natural, soft skin surface contour.

Postoperative evaluation

Postoperative results were classified by distance between the PSM and SCE. Repairs were considered adequate if the PSM was within 1 mm below the SCE, normal if it was between 1 and 2 mm below the SCE, and undercorrected if the distance was greater than 2 mm. When evaluating symmetry, results were considered good if the difference between the two PSMs was less than 1 mm, fair if it was 1 to 2 mm, and poor if it was greater than 2 mm. Adequate and normal categories were considered ideal corrections. Overall cosmetic outcomes were subjectively graded as good, moderate, or poor by the surgeon on the basis of the stability of palpebral fold, contour, and scar formation in the upper eyelid. Postoperative evaluation results are given in Table 3.

Statistical analysis

Statistical analysis was performed using SPSS 16.0 software for Windows (SPSS Inc., Chicago, IL, USA). Data were recorded as the mean ± standard deviation (SD). Paired samples t-tests were used to compare eyelid drooping change before and after ptosis blepharoplasty. P value < 0.05 was considered to be statistically significant.

Results

The follow-up time ranged from 8 to 24 months (mean 12.4). In mild ptosis eyelids, 93.1% (54 eyelids) achieved an ideal correction, of which 36.2% (21) required adequate correction and 56.9% (33) required normal correction. The remaining 6.9% (4) required undercorrection. The overall pattern of correction in moderate ptosis eyelids was similar as that in mild ptosis eyelids, with a slight decrease in ideal correction (88.5%, 34.6% of adequate correction, and 53.9% of normal correction) and slight increase in undercorrection (11.5%) (Figure 2(A)). For cosmetic outcomes, 82.8% (48 eyes), 15.5% (9), and 1.7% (1) of mild ptosis eyelids were scaled as good, moderate, and poor outcomes, whereas the results were 77.9% (81 eyes), 20.2% (21), and 1.9% (2) out of the 104 moderate ptosis eyelids, respectively (Figure 2(B)). These results demonstrated consistent and replicable outcomes using this ptosis repair technique.

In mild ptosis cases, the distance between the PSM and the SCE was 3.24 ± 0.63 mm before ptosis repair. After correction, it was reduced to 0.75 ± 0.38 mm ($p < 0.05$). In

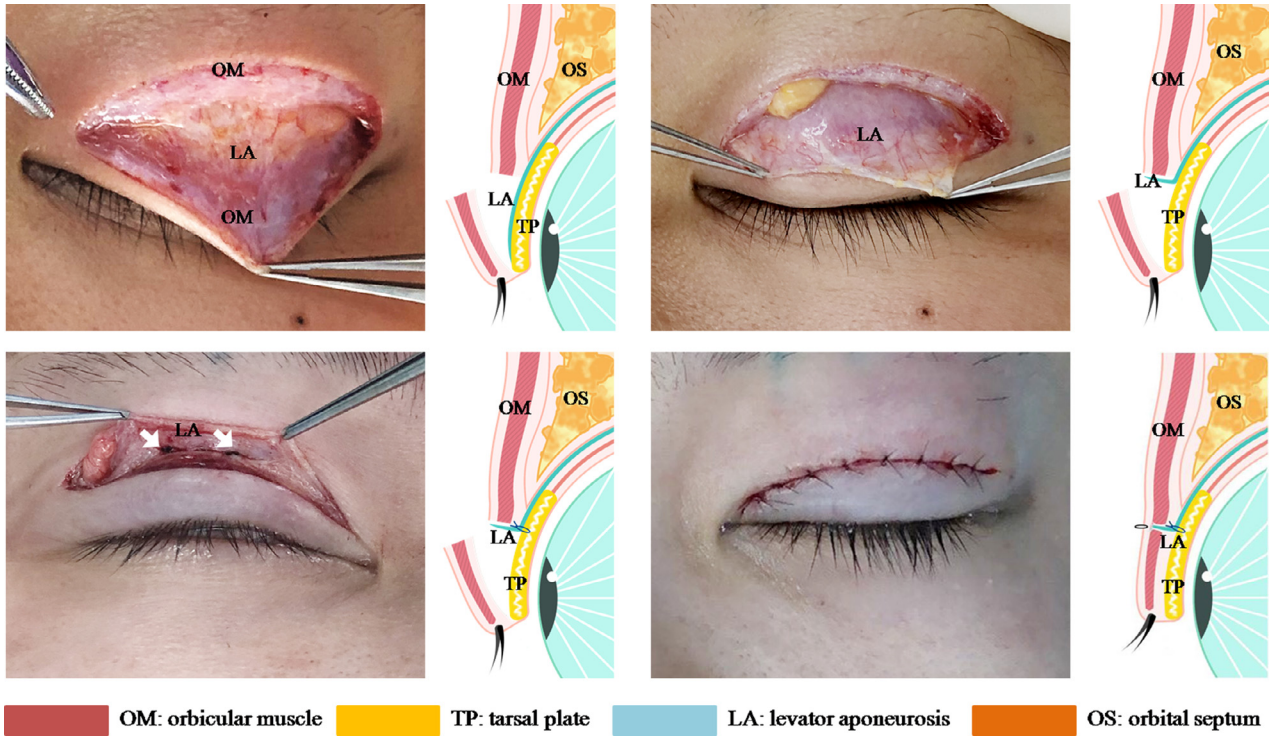

Figure 1 Photographs and schema of surgical procedures. (A) Pretarsal levator aponeurosis was exposed by properly dissecting the orbicularis muscles. (B) Design of pretarsal levator aponeurosis flap. (C) The levator aponeurosis flap was elevated and anchored to the tarsus plate. White arrows indicated the interrupted silk sutures. (D) The flap margin was interposed and fused with pretarsal orbicularis muscles.

Table 3 Postoperative results.

Severity of ptosis	Distance between PSM and SCE (mm)	Ptosis correction *n* (%)			Symmetry results *n* (%)			Cosmetic outcomes *n* (%)		
		Adequate	Normal	Undercorrection	Good	Fair	Poor	Good	Moderate	Poor
Mild	0.75 ± 0.38	21 (36.2)	33 (56.9)	4 (6.9)	57 (58.8)	31 (32.0)	9 (9.2)	48 (82.8)	9 (15.5)	1 (1.7)
Moderate	1.09 ± 0.36	36 (34.6)	56 (53.9)	12 (11.5)				81 (77.9)	21 (20.2)	2 (1.9)

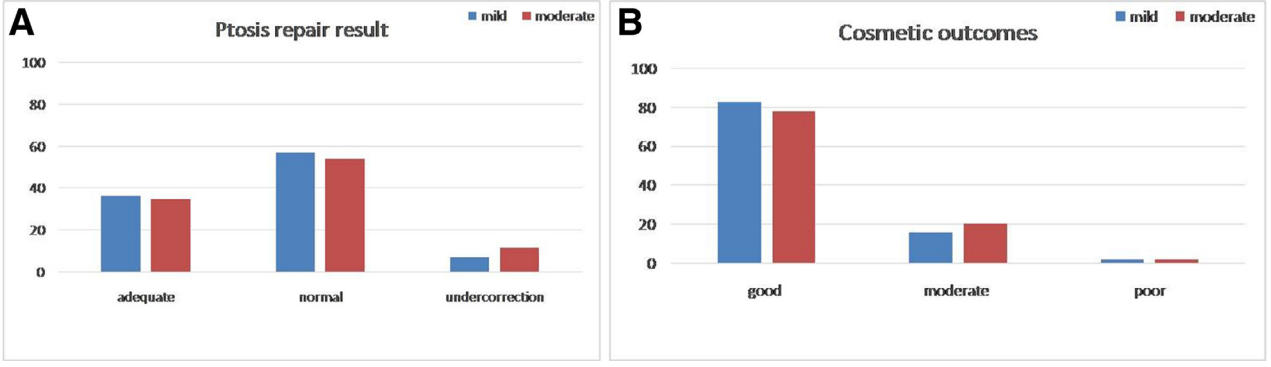

Figure 2 (A) Compared with moderate ptosis eyelids, the rate of ideal correction was slightly higher in mild ptosis eyelids. (B) The majority (~80%) of patients achieved good cosmetic result both in mild and in moderate ptosis eyelids.

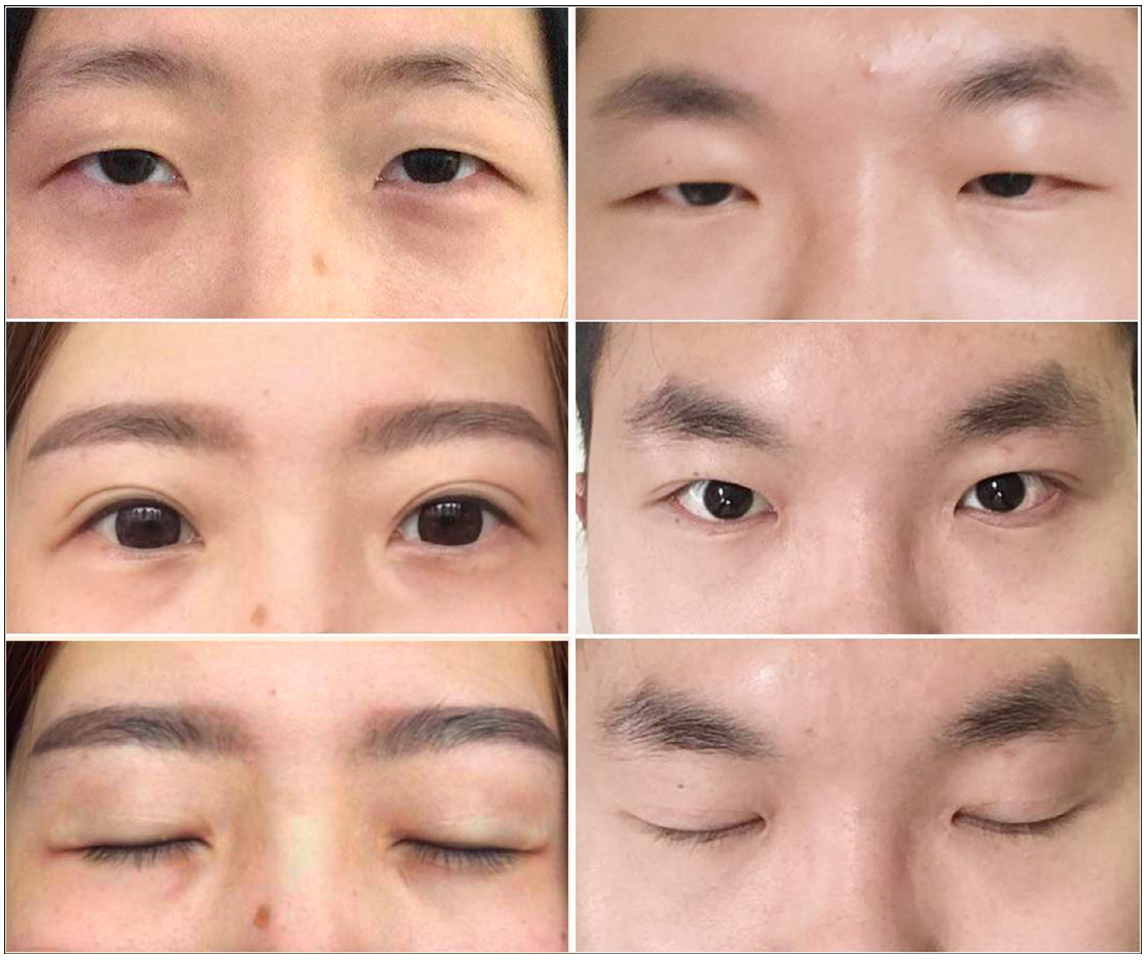

Figure 3 Representative results of a 25-year-old man and a 27-year-old woman with mild to moderate bilateral ptosis who underwent ptosis repair in our hospital demonstrated both good functional and esthetic outcomes with minimal scar formation in the upper eyelid.

the moderate cases, the distance was 5.42 $\pm$ 0.55 mm preoperatively and 1.09 $\pm$ 0.36 mm postoperatively ($p < 0.05$). Among all patients, 58.8% (57 cases) achieved good symmetrical outcomes and 32% (31) were graded as fair. Only 9.2% (9) had a poor symmetry. Six of them (66.7%) were bilateral ptosis cases and eventually demanded a secondary operation 6–13 months postoperation. Overall, cosmetic outcomes were favorable in both the mild and moderate ptosis cases. Minimal scar formation was observed in more than 98% ptosis cases in our patients (Figure 3). The most common complaint was temporary swelling without other complications.

Discussion

Resection and advancement of the levator aponeurosis have usually been used for the correction of mild to moderate ptosis with satisfactory results in most cases.[16] Although it is effective, this technique distorts the normal anatomy of the levator aponeurosis and frequently results in an unsightly scar in the upper eyelid. Interestingly, a large proportion is featured by monoeyelid in Eastern Asians. Among young patients who have congenital ptosis disease, most of them prefer to have their ptosis corrected and double eyelid created simultaneously. It would be both a social and a physiological burden, however, if their double eyelids looked unnatural to the public. Considering this, the aforementioned conventional ptosis repair method is not an ideal choice for Asian ptosis patients.

In our ptosis blepharoplasty, the levator aponeurosis extension route was repositioned to incorporate the creation of a palpebral fold. Furthermore, the traction force delivery to tarsus was improved. It was similar to Lee's work[11] in which the levator aponeurosis was rotated to correct the asymmetric levator transmission force. Two key points deserve to be given emphasis. First, the flap size was designed bigger in the moderate ptosis cases to ensure enough eyelid uplifting. The distal portion of levator aponeurosis flap was interposed and fused with pretarsal orbicularis at crease line, ensuring a solid motor mechanism for the dynamic power transmission. This flexible manipulation allowed a sufficient motor power of levator to be transmitted. Additionally, unlike traditional techniques, levator and orbicularis muscles were preserved rather than removed. The pretarsal connection between tarsus and eyelid skin was bridged by levator aponeurosis fibers rather than stiff scar. Furthermore, the height of palpebral fold was restricted by the width of tarsus plate in traditional techniques. In new ptosis blepharoplasty, the height was

determined only by where the levator aponeurosis flap base was anchored. It also allowed patients' preference to be considered to a large extent during preoperative consultation.

During the follow-up, some patients returned to the outpatient center after initial correction, as contralateral ptosis was observed. This delayed occurrence of ptosis causing the pseudo retraction of the contralateral eyelid is known as the Hering's law, a term specifically used to explain the conjugacy of saccadic eye movements.[17-19] The rationale is that after appropriate ptosis repair in the primary eye, the innervation signal from the brain to levator palpebrae in both eyes is decreased.[20] Patients, as mentioned above, were subsequently categorized as bilateral ptosis in this study. Hering's law did not apply to most unilateral cases; however, many of them returned for the purpose of subsequent symmetry. Double eyelidplasty was performed to create a palpebral fold for the contralateral eye 6 months after ptosis correction. Overall, in unilateral cases, the standard upper eyelid level was lifted 1 mm above the contralateral side, whereas in bilateral cases, it was lifted 1 mm below the upper corneal limbus in a primary gaze position.

It should be noted that local anesthesia was recommended for mild to moderate ptosis repair in the study to ensure the appropriate amount of correction. This study analyzed only the data from adult patients who received local anesthesia; these conclusions cannot be applied to children. Another limitation of the study is that the presented technique is unsuitable for severe ptosis with poor levator function (<5 mm). At least a fair function of levator is required to act as a sold bridge to conduct the levator force power and reconstruct the physiological anatomy of levator aponeurosis.

Conclusions

Our novel ptosis blepharoplasty is an effective technique to correct mild to moderate congenital blepharoptosis, while simultaneously achieving excellent cosmetic outcomes with minimal scar formation in Eastern Asian patients.

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Disclosures

The authors have no financial interest to declare in relation to the content of this article.

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