Modified Levator Muscle Complex Suspension on Treating Pediatric Blepharoptosis with Poor Bell's Phenomenon

Rui Li

Shanghai 9th Peoples Hospital Affiliated to Shanghai Jiaotong University School of Medicine
<https://orcid.org/0000-0001-6282-7693>

Xiao-Wei Zhu

Shanghai 9th Peoples Hospital Affiliated to Shanghai Jiaotong University School of Medicine

Jia-Ying Zhang

Shanghai 9th Peoples Hospital Affiliated to Shanghai Jiaotong University School of Medicine

Xia Ding

Shanghai 9th Peoples Hospital Affiliated to Shanghai Jiaotong University School of Medicine

Xu-Sheng Wu

Shanghai 9th Peoples Hospital Affiliated to Shanghai Jiaotong University School of Medicine

Yue Xing

Shanghai 9th Peoples Hospital Affiliated to Shanghai Jiaotong University School of Medicine

Ming Lin

Shanghai 9th Peoples Hospital Affiliated to Shanghai Jiaotong University School of Medicine

Jin Li (✉ lijinabcd@sina.cn)

Shanghai 9th Peoples Hospital Affiliated to Shanghai Jiaotong University School of Medicine
<https://orcid.org/0000-0002-5632-5774>

Research Article

Keywords: ptosis, poor Bell's phenomenon, conjoint fascial sheath, levator muscle complex suspension, case series analysis

Posted Date: August 19th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-805703/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Purpose: To evaluate the surgical outcomes of pediatric congenital blepharoptosis with poor Bell's phenomenon (BP) treated with modified levator muscle complex suspension.

Methods: Forty-two pediatric congenital blepharoptosis patients with poor BP were treated with modified levator muscle complex suspension, and their major surgical outcomes such as marginal reflex distance¹ (MRD₁), palpebral fissure height (PFH), and postoperative lagophthalmos were retrospectively reviewed.

Results: The mean follow-up was 10.28 ± 9.89 months (range: 3-32 Months). Surgical success was achieved in 54 (87.1%) of 62 eyelids at the final visit, including excellent results in 46 (74.2%) eyelids, good results in 8 (12.9%) eyelids, and poor results in 8 (12.9%) eyelids, respectively. The postoperative PFH of affected eyes (7.97 ± 1.47 mm) was significantly improved compared with that before surgery (3.58 ± 1.31 mm). The mean MRD₁ was improved from -1.48 ± 1.36 mm before surgery to 2.94 ± 1.46 mm after surgery. The postoperative MRD₁ was ≥ 3 mm in 46 eyelids and < 3 mm in 16 eyelids. The mean lagophthalmos was 1.42 ± 1.20 mm 3 months after surgery. All of the patients presented complete blink postoperatively. Postoperative complications were rarely observed during follow-up. No patient had exposure keratitis, but blepharoptosis recurred in 6 patients (8 eyelids). All patients had satisfactory eyelid symmetry and contour. No complications were observed until the last visit.

Conclusions: The modified method results complete blink, mild and quick recovery of lagophthalmos, flexible eyelid motility, stable ocular surface, and it is simple to perform with few complications and a low recurrence rate at 12.9%, which is worth to wide application on poor bell's phenomenon blepharoptosis.

1. Introduction

Bell's phenomenon (BP) was first described by Sir Charles Bell, a British anatomist, in 1823 as an upward deviation of the eye during volitional eyelid closure [1]. Although the neural mechanism of this palpebral-oculogyric reflex still remains unclear, it may involve brainstem pathways between the seventh cranial nerve nucleus in the pons and the third cranial nerve nuclear complex in the rostral midbrain [1]. Hiraoka postulated that mesencephalic reticular nucleus linked the pathways controlling bilateral eyelid closure and upward movement of both eyes [2]. However, about 10% to 22% of individuals show neutral BP, in which small ocular deviation occurs during blinking instead of moving upward [3,4]. BP helps to stabilize the tear film, protect the ocular surface and prevent corneal desiccation by covering the cornea with the upper eyelid [5]. Absence of BP is, therefore, considered a relative contraindication for blepharoptosis correction. For pediatric congenital blepharoptosis with poor BP, the optical axis will be obstructed by the eyelid, causing various ophthalmological diseases such as amplyopia and strabismus, refractive abnormalities and impaired psychological development [6,7]. However, no accepted surgical treatment is currently available for this situation. Silicone rod frontal muscle suspension is the most commonly used technique, but it may lead to a high recurrence rate, which was about 19.6-44% [8,9]. The patients need repeated operations, and severe individuals will inevitably suffer from developmental ophthalmic

diseases eventually which seriously affect visual performance. Levator muscle aponeurosis resection results in effective blinking and eye closing function, but it couldn't correct severe ptosis which confines its application. It can only be used in patients with mild to moderate ptosis with poor Bell phenomenon. Frontalis muscle suspension are not suitable for patients with poor BP since they will lead to wide lagophthalmos and time-consuming recovery of upper eyelid lag with potential damages to ocular surface. Thus, we have designed a modified levator muscle operation called levator palpebrae complex (LPSC) suspension, which applies the levator muscle and the fascia sheath complex above the level of the whitnall ligament to suspense the drooping eyelids. This procedure not only preserve the advantages of maintaining stable ocular surface postoperatively, but also correct severe ptosis effectively. Here, we examined the surgical outcomes of modified levator muscle complex suspension in 42 pediatric congenital blepharoptosis patients with poor BP. To our knowledge, our study is the first of its kind in this field.

2. Materials And Methods

2.1 Study design and patients

Forty-six out of 712 congenital blepharoptosis patients were found to have poor BP in the Shanghai Ninth People's Hospital from November 2015 to December 2020. Four patients were lost to follow up, and the rest 42 patients were retrospectively reviewed in this study. Levator palpebrae complex (LPSC) suspension were performed by an experienced surgeon for all patients at a single center. Signed informed consent was obtained from all patients in accordance with the Declaration of Helsinki. Patients were aged 2-7 years with a mean age of 4.38 ± 1.36 years. Fourteen patients were females and 28 patients were males. Twenty patients had bilateral blepharoptosis and 22 patients had unilateral blepharoptosis. Patients with a history of eyelid surgery, ocular deformity, jaw-winking phenomenon, congenital fibrosis of extraocular muscles and myasthenia gravis were excluded. Patients with a follow up of less than 3 months were also excluded. Ethical clearance was obtained from the Institutes Ethics Committee. Institutional review board approval and signed informed consent was obtained from all participants, in accordance with the Declaration of Helsinki.

2.2 Data collection and evaluation criteria

2.2.1 Patients' data

The data of patients collected in this study included gender, laterality of blepharoptosis, age at the time of surgery, levator function (LF), severity of blepharoptosis, palpebral aperture height (PFH), visual acuity, marginal reflex distance 1 (MRD1), marginal reflex distance 2 (MRD2), presence or absence of lagophthalmos, BP, family history of blepharoptosis, ocular motor movements and associated ophthalmic or systemic problems. For postoperative evaluation, best-corrected visual acuity, postoperative refractive errors, PFH, MRD1, MRD2, lagophthalmos, symmetry of eyelid height, upper eyelid contour, length of follow-up, and complications such as dry eye, ecchymosis, exposure keratitis and lagophthalmos were recorded.

2.2.2 Blepharoptosis evaluation

LF was considered excellent if eyelid excursion was > 12 mm, good if 8–12 mm, fair if 5–7 mm, and poor if < 5 mm, respectively [10]. LF was evaluated by the excursion of the upper eyelid margin from extreme downgaze to extreme upgaze when patient's eyebrow was pressed to eliminate the interference of frontalis muscle [11]. The severity of blepharoptosis was classified as mild (1–2 mm), moderate (3–4 mm) or severe (> 4 mm), which were associated with good, fair, and poor LF, respectively [12]. In this study, the mean preoperative LF was 2.55 ± 1.09 mm and the mean severity of blepharoptosis was 5.48 ± 1.36 mm.

2.2.3 BP evaluation

An ocular deviation of > 4 mm was previously considered a normal response [1]. However, we observed that individuals with normal palpebral-oculogyric reflex had positive BP during shallow sleep (5 min after falling asleep), but poor and sometimes even negative BP during deep sleep (30 min after falling asleep). A small ocular deviation was observed in individuals with poor BP during both shallow and deep sleep. **Fig.102** Based on previous studies and our observations, BP was considered normal if the ocular deviation was > 4 mm during volitional eyelid closure or shallow sleep, and poor if < 4 mm. At the preliminary screening, BP was checked on attempted light closure of the eyelid after elevating patient's upper eyelids using the finger and thumb of one hand, and 46 out of 712 consecutive pediatric blepharoptosis patients were found to have poor BP. In order to minimize biases (such as pseudo-reflex and lack of cooperation), a second examination was performed on patients with negative BP at 5 and 30 min of falling asleep using the same procedures, respectively. Negative responses were also observed in these 46 patients.

2.2.4 Surgical outcomes

The surgical outcomes were evaluated by postoperative MRD1, which was defined as excellent if it was ≥ 3 mm, good if 2–3 mm, and poor if < 2 mm, respectively. Recurrence was defined as a decrease in MRD1 to less than 50% of initial postoperative MRD1 [13]. To evaluate postoperative eye blinking status, LipiView interferometer which is able to measure the incomplete blink ratio was applied [14].

2.3 Surgical methods

Surgical design: We have designed levator palpebrae superioris complex (LPSC) suspension, which applies the levator muscle and the fascia sheath complex above the level of the whitnall ligament to suspend the drooping eyelids. **Fig.30405**

Surgical procedure: Levator palpebrae superioris complex (LPSC) suspension were performed under general anesthesia. After marking the desired upper eyelid crease line, the skin was incised to the superior border of the tarsus through the orbicularis muscle and extended medially and laterally. The orbicularis muscle was dissected to identify the orbital septum. The inferior skin and pretarsal orbicularis muscle flap were dissected from the tarsal plate. The orbital septum was incised horizontally with a cautery device or scissors and preaponeurotic fat was identified. Excessive preaponeurotic fat was removed with

electrocauterization. The levator aponeurosis and Muller's muscle were dissected from the upper border of the tarsal plate and conjunctiva until the Whitnall ligament could be identified. Upward detach the levator aponeurosis from the Müller muscle until over the fornix about 5 mm, to expose appropriate region of the conjoint facial sheath(CFS). Keep the connection between Levator muscle and Conjoint facial sheath intact. Then fully dissociate the LM complex from the ligament level and pulled down to the tarsal plate. Suspend and suture the upper margin of the tarsal plate to the LM complex at 1 mm to 2 mm below the limbus. Sutures were adjusted if the eyelid height was unsatisfactory. The skin incision was closed incorporating 3 or 4 deep bites through aponeurosis. A lower eyelid traction suture and topical antibiotic ointment were used. **Fig.6**

2.4 Postoperational treatment

All patients received Levofloxacin and Prednisolone acetate eye drops 4 times/day and Sodium Hyaluronate eye drops 6 times/day for 7 days after surgery. Eye ointment containing Recombinant bovine basic fibroblast growth factor (bFGF) was administrated 3 times daily, and Eryphilin was administrated once daily at night. One week later, Sodium Hyaluronate eye drops, bFGF-containing eye ointment and Eryphilin were administrated 4 times, 3 times and once at night per day for 3 months.

2.5 Statistical analyses

Descriptive statistics were expressed as mean $\pm$ standard deviation. χ^2 test was performed for discrete and categorical data. Paired *t* test was performed to evaluate changes in surgical outcomes (PFH, MRD1, etc.). *P* values less than 0.05 were considered statistically significant.

3. Results

3.1 Demographic characteristics

A total of 42 blepharoptosis patients (62 eyelids) with poor BP were retrospectively reviewed in our research. Of these 42 patients, 22 (47.6%) had unilateral blepharoptosis and 20 (52.4%) had bilateral blepharoptosis. Unilateral blepharoptosis occurred mainly in left eyes. After surgery, the mean LF was 2.55 ± 1.09 mm (range: 1-6mm) and the mean severity of blepharoptosis was 5.48 ± 1.36 mm (range: 3-8mm). The mean age at surgery was 4.38 ± 1.36 years (range: 2-7 years). Twelve patients (28.6%) underwent surgery at an age of 0-3 years, 28 patients (66.7%) at an age of 4-6 years, and 2 patient (4.8%) at an age greater than 6 years, respectively. The mean follow up was 10.28 ± 9.89 months (range: 3-32 months). Ten (24%) patients were diagnosed as amblyopia and 8 (19%) as ocular motor restriction, respectively. There was no significant correlation between preoperative BP status and ocular muscle function. Ocular upturn restriction, intraocular rotation restriction, and oculomotor paralysis occurred in 4 (9.5%), 2 (5%) and 2 (5%) patient, respectively. **Table 1.**

3.2 Treatment outcomes

Surgical success was achieved in 54 (87.1%) out of 62 eyelids at the final visit based on predetermined criteria, including excellent results in 46 (74.2%) eyelids, good results in 8 (12.9%) eyelids, and poor results in 8 (12.9%) eyelids, respectively. The postoperative PFH (7.97 ± 1.47 mm) of affected eyes was significantly improved compared with that (3.58 ± 1.31 mm) before surgery. It was 7-10 mm in the 54 eyelids with excellent or good results and ≤ 6 mm in the 8 eyelids with poor results, respectively. The mean MRD1 was -1.48 ± 1.36 mm (range: -4 to 1 mm) before surgery and 2.94 ± 1.46 mm (range: -1 to 5 mm) after surgery, respectively. The postoperative MRD1 was ≥ 3 mm in 46 eyelids and < 3 mm in 16 eyelids. The mean MRD2 was 3.52 ± 1.21 mm (range: 1-5 mm) before surgery and 4.97 ± 0.18 mm (range: 4-5 mm) after surgery, respectively. The mean postoperative lagophthalmos was 1.42 ± 1.20 mm (range: 0-4 mm) 3 months after surgery. All of the patients presented complete blink postoperatively. Postoperative complications were rarely observed during the follow-up. No patients had exposure keratitis. Blepharoptosis recurred in 6 patients (8 eyelids, 12.9%), all of which were accompanied with ocular upturn restriction but successfully treated with another surgery. All patients had satisfactory eyelid symmetry and contour, and there was no overcorrection (**Table 2.**)

4. Discussion

Three types of BPs have been reported in the literature. Very often, the eye will move upward and slightly outward during volitional eyelid closure. In inverse BP, the eye moves downward and inward. Last but not least, 10-22% of individuals show neutral BP [3,4]. BP is accompanied with volitional closure of upper eyelids [15], which may involve brainstem pathways between the seventh cranial nerve nucleus in the pons and the third cranial nerve nuclear complex in the rostral midbrain [1]. Hiraoka showed that pathways controlling bilateral eyelid closure and upward movement of both eyes might be linked by mesencephalic reticular nucleus [2]. Gupta et al. showed that under the control of cortical and subcortical regions, the superior rectus and inferior oblique muscles innervated by the third nerve could contract and act synergistically to move the eye upward when the orbicularis oculi innervated by the seventh nerve contracted, which elicited normal BP [16].

Inverse BP is observed in approximately 2% of normal individuals, and its incidence may be higher under certain pathological conditions such as peripheral seventh nerve palsies, eyelid swelling, conjunctival scarring, upper eyelid ectropion, and after blepharoptosis operation [16]. Francis et al. reported that 8% (42/508) of individuals had inverse BP as part of their response and 2% (10/508) of individuals had inverse BP as their only response [1]. Ferrer et al. reported that inverse BP occurred in 3.7% of individuals examined in their study [4]. However, no patient had inverse BP in this study. Several studies observed that some patients had positive BP before surgery, but a downward deviation of the eye during volitional eyelid closure after surgery [17-19]. However, it could be reversed 2-4 weeks later. This inverse BP could be viewed as an attempted protective mechanism, whereby the eye attempts to take cover under the lower eyelid instead of the upper eyelid, due to inflamed and edematous tissues in the superior fornix after extensive surgery and dissection [15].

Poor BP could occur in about 10% of individuals [3]. Ferrer et al. reported that BP occurred in 78% of normal individuals over 5 years of age, implying that the incidence of poor BP was about 22% [4]. In our study, 46 out of 712 consecutive congenital blepharoptosis patients had poor BP, resulting in an incidence of 7.1 %. Chamberlain showed that it was typical of pinealomas to have restriction of voluntary upward gaze with age, which could be attributed to the lower occurrence of the present study compared to other reports [20].

Blepharoptosis correction is one of the most complicated procedures in oculoplastic operation. However, it may be more challenging in blepharoptosis patients with poor BP as the surgical trauma may lead to delayed recovery of postoperative lagophthalmos, predisposing these patients to ocular surface complications. The appropriate procedure for blepharoptosis correction is determined depending on the blepharoptosis severity and LF [10]. Usually, mild to moderate blepharoptosis with poor to moderate LF can be treated using levator muscle resection or the Fasanella-Servat procedure, whereas moderate to severe blepharoptosis with poor LF needs to be treated with frontalis suspension [21-23]. Absence of BP is considered as a relative contraindication for blepharoptosis correction in case of exposure keratitis or other ocular complications. Silicone rod frontal muscle suspension is the most commonly used technique, but it may lead to a high recurrence rate, which was around 19.6-44% [8,9]. Levator muscle aponeurosis resection has been excluded because severe ptosis couldn't be well resolved by it. Other surgeries such as frontalis muscle suspension, are not quite appropriate for patients with poor BP, as they will result in wide lagophthalmos and time-consuming recovery of upper eyelid lag with potential damage to ocular surface, and exposure keratitis occurred eventually. Frontalis suspension is also associated with many postoperative complications, such as swollen appearance, upper eyelid lag, eyebrow raising, forehead wrinkles, separation of eyelid from eyeball and uncoordinated eye movement [24].

It remains controversial which surgical procedure is the most appropriate for pediatric congenital blepharoptosis with poor BP. In these patients, the optical axis is obstructed by the eyelid which causes various ophthalmological diseases such as amblyopia and strabismus, refractive abnormalities and impaired psychological development [5,6]. Levator muscle aponeurosis retraction qualifies in complete blink and good eyelid closure function, which is suitable to treat poor Bell's phenomenon. But applying this technique alone can't correct severe ptosis thoroughly. So we choose to remove the levator aponeurosis below the Whitnall ligament and conduct levator muscle retraction, meanwhile utilize CFS to reinforce the suspension strength. This modification not only retains the advantages of the levator aponeurosis retraction, but also solves the ptosis effectively. LPSC were performed in this study because: (i) this technique makes it possible to reserve the original function of the levator palpebrae muscle and utilize the power of the superior rectus muscle by conjoint fascial sheath, which provides adequate force to lift the upper eyelid and results in a low recurrence rate. Surgical success was achieved: excellent results in 46 (74.2%) out of 62 eyelids, good results in 8 (12.9%) eyelids, and the recurrence rate was 12.9%. The mean MRD1 improved from -1.48 ± 1.36 mm to 2.94 ± 1.46 mm postoperatively. The postoperative MRD1 was ≥ 3 mm in 46 eyelids and < 3 mm in 16 eyelids. (ii) due to the flexible elasticity of levator muscle complex,

all of the patients present complete blinks postoperatively which form stable lacrimal membranes and attribute to protect the ocular surface, (iii) a milder and quicker recovery of lagophthalmos can be obtained, which will reduce the incidence of keratopathy and other ocular surface diseases, The mean postoperative lagophthalmos was 1.42 ± 1.20 mm after 3 months follow-up. All of the patients presented complete blinks postoperatively. (iv) postoperative PFH has been significantly improved, which was 7.97 ± 1.47 mm of affected eyes compared with that (3.58 ± 1.31 mm) preoperatively. (v) flexible eyelid motility and stable eyelid contour can be obtained, and (vi) it is less time consuming and less destructive to peripheral eyelid tissues. Overcorrection is essential for common blepharoptosis patients with good BP, as the operated eyelid may drop gradually over time after surgery. A conservative procedure was performed for patients with poor BP to prevent the exaggeration of lagophthalmos by ocular surface lesion. In the present study, the upper eyelid was fixed at a height same as the opposite one in patients with unilateral blepharoptosis, whereas in patients with bilateral blepharoptosis, the eyelid height was set at 1-2 mm below the corneal limbus. **Fig.8** For normal individuals, there are two main mechanisms to protect the ocular surface. One is intact eyelid with complete blink which forms stable lacrimal membrane with physical eyelid motivation. And the other is positive bell's phenomenon which helps to stabilize the tear film, protect the ocular surface and prevent corneal desiccation by covering the cornea with the upper eyelid. Since the postoperative lagophthalmos was inevitable after surgical correction. Absence of BP is considered as a relative contraindication for blepharoptosis correction because without the two protection mechanisms that mentioned above will make the ocular surface much more vulnerable to get injured. Owing to the features demonstrated above, this technique of modified levator muscle complex suspension managed to acquire stable blepharoptosis effect and meanwhile minimize the potential damage to the ocular surface, thus reduced the incidence of postoperative complications, particularly exposure keratitis. Which is especially appropriate to treat congenital blepharoptosis with poor bell's phenomenon. Of the 42 pediatric congenital blepharoptosis patients (62 eyelids) with negative BP reviewed in this study, 87.1% (54/62) had satisfactory MRD1 at the final visit, and the mean MRD1 was increased from -1.48 ± 1.36 mm (range: -4 to 1 mm) before surgery to 2.94 ± 1.46 mm (range: -1 to 5mm) after surgery. The mean lagophthalmos was 1.42 ± 1.20 mm (range: 0-4 mm) 3 months after surgery. Postoperative complications were rarely observed during follow up, but blepharoptosis recurred in 6 patients and was accompanied with ocular upturn limitation. Thus, we suspected that the function of ocular muscles might be related to the postoperative recurrence.

Our study is the first to examine the surgical outcomes of pediatric congenital blepharoptosis with poor BP treated with levator palpebrae complex (LPSC) suspension. However, this study also has several potential limitations that merit considerations, such as limited number of participants, the retrospective nature, and short-term follow-up. Despite these limitations, this study provides some insights into the treatment of pediatric congenital blepharoptosis with this modified technique. The incidence of abnormal BP is about 7.1% in pediatric congenital blepharoptosis in our study. The function of ocular muscle is not related to preoperative status of BP, but it is related to postoperative recurrence. This surgery results complete blink which provides stable lacrimal membrane, mild and quick recovery of lagophthalmos,

flexible eyelid motility, stable ocular surface, and it is simple to perform with few complications and a low recurrence rate at 12.9%. However, postoperative care is also important.

Declarations

Funding: This work was supported by the National Natural Science Foundation of China (grants 81870688 and 81970834), the Science and Technology Commission of Shanghai Municipality (grants 19441900800). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Conflict of Interest: This study has no commercial or propriety interest. The authors report no conflict of interest.

Availability of data and material: The datasets used or analysed during the current study are available from the corresponding author on reasonable request.

Code availability: Not applicable.

Authors' contributions: (I) Conception and design: J Li, M Lin, Y Xing, R Li, XW Zhu, (II) Administrative support: J Li, M Lin, (III) Provision of study materials or patients: J Li, Y Xing, JY Zhang, X Ding, (IV) Collection and assembly of data: XW Zhu, XS Wu, R Li, JY Zhang, X Ding, Y Xing, (V) Data analysis and interpretation: XW Zhu, R Li, XS Wu, Y Xing, (VI) Manuscript writing: All authors, (VII) Final approval of manuscript: All authors.

Ethical Approval: Ethical approval was given, the relevant judgement reference number is Ninth People's Hospital 2017-206.

Consent to participate: Patient consent was obtained to publish the clinical photographs. All figures in the manuscript were drawn and composed by ourselves.

Consent for publication: Written informed consent for publication was obtained from all participants.

References

1. Francis F I C, Loughhead D J A. Bell's phenomenon. A study of 508 patients. Aust J Ophthalmol, 1984,12:15-21.
2. Hiraoka M. Physiological study of the Bell's phenomenon in human (Japa). Acta Soc Ophthalmol Jpn 1979, 83: 2184-90.
3. Hall AJ. Some observations on the acts of closing and opening the eyes. Br J Ophthalmol 1936, 20: 257-95.
4. Ferrer JA. Conclusions from Bell's phenomenon variants. Trans Am Acad Ophthalmol Otolaryngol 1973,77:OP714-20.

5. Yoon J S, Lew H, Lee S Y. Bell's phenomenon protects the tear film and ocular surface after frontalis suspension surgery for congenital ptosis.[J]. *Journal of Pediatric Ophthalmology & Strabismus*, 2008, 45(6):350.
6. Stein A, Kelly JP, Weiss AH. Congenital eyelid ptosis: onset and prevalence of amblyopia, associations with systemic disorders, and treatment outcomes. *J Pediatr* 2014;165(4):820-4 e2.
7. Griepentrog GJ, Diehl N, Mohney BG. Amblyopia in childhood eyelid ptosis. *Am J Ophthalmol* 2013;155(6):1125-1128 e1.
8. Simon GJB, Macedo AA, Schwarcz RM, et al. Frontalis Suspension for Upper Eyelid Ptosis: Evaluation of Different Surgical Designs and Suture Material[J]. *American Journal of Ophthalmology*, 2005, 140(5):0-885.
9. Lee M J , Oh J Y , Choung H K , et al. Frontalis Sling Operation Using Silicone Rod Compared with Preserved Fascia Lata for Congenital Ptosis A Three-Year Follow-up Study[J]. *Ophthalmology*, 2008, 116(1):123-129.
10. Zhang L, Pan Y, Ding J, et al. Surgical correction of myogenic ptosis using a modified levator resection technique.[J]. *Canadian Journal of Ophthalmology-journal Canadien D Ophtalmologie*, 2015, 50(6):471-475.
11. Göncü T, Cakmak S, Akal A, et al. Improvement in Levator Function After Anterior Levator Resection for the Treatment of Congenital Ptosis.[J]. *Ophthalmic Plastic & Reconstructive Surgery*, 2015, 31(3):197.
12. Lee J H, Nam S M, Kim Y B. Blepharoptosis correction: levator aponeurosis-Müller muscle complex advancement with three partial incisions[J]. *Plastic & Reconstructive Surgery*, 2015, 135(2):388-95.
13. Ho Yeen-Fey, Wu Shu-Ya, Tsai Yueh-Ju. Factors Associated With Surgical Outcomes in Congenital Ptosis: A 10-Year Study of 319 Cases.[J] .*Am. J. Ophthalmol*, 2017, 175: 173-182.
14. Jinhwan P , Joohyun K , Hwa L , et al. Functional and structural evaluation of the meibomian gland using a LipiView interferometer in thyroid eye disease[J]. *Canadian Journal of Ophthalmology*, 2018, 53(4):373-379.
15. Goel R, Kishore D, Nagpal S, et al. The Relationship of Amount of Resection and Time for Recovery of Bell's Phenomenon after Levator Resection in Congenital Ptosis.[J]. *Open Ophthalmology Journal*, 2017, 11(1):24-30.
16. Gupta JS, Chatterjee A, Kumar K. Inverse bells phenomenon as a protective mechanism. *Am J Ophthalmol* 1965, 59: 931-3.
17. Shitole S, Jakkal T, Khair B. Inverse Bell's Phenomenon: Rare Ophthalmic Finding Following Ptosis Surgery[J]. *Journal of Clinical & Diagnostic Research Jcdr*, 2015, 9(3):01-2.
18. Betharia S M, Sharma V. Inverse Bell's phenomenon observed following levator resection for blepharoptosis[J]. *Graefes Archive for Clinical & Experimental Ophthalmology*, 2006, 244(7):868-870.
19. Na K S, Yang S W. Two cases of inverse Bell's phenomenon following levator resection: a contemplation of the mechanism[J]. *European Journal of Ophthalmology*, 2009, 19(2):285.

20. Chamberlain W . Restriction in upward gaze with advancing age. Am J Ophthalmol 1971, 71: 341-6.
21. Lee V, Konrad H, Bunce C, et al. Aetiology and surgical treatment of childhood blepharoptosis. Br J Ophthalmol 2002,86(11):1282-6.
22. Cetinkaya A, Brannan PA. Ptosis repair options and algorithm. Curr Opin Ophthalmol 2008,19(5):428-34.
23. Berry-BrincatA, WillshawH. Paediatric blepharoptosis: a 10-year review. Eye(Lond) 2009,23(7): 1554-9.
24. Xing Yue, Wang Xi, Cao Yuan, et al. Modified Combined Fascia Sheath and Levator Muscle Complex Suspension With Müller Muscle Preservation on Treating Severe Congenital Ptosis.[J] .Ann Plast Surg, 2018, undefined: undefined.

Tables

TABLE 1. Basic characteristics of patients

Characteristics	No. of patients
Laterality (N=42)	
Unilateral	22 (52%)
Bilateral	20 (48%)
Sex	
Male	28 (67%)
Female	14 (33%)
Age	
0-3 years	12 (28%)
4-6 years	28 (67%)
>6years	2 (5%)
Combined	
Amblyopia	10 (24%)
Oculomotor limitation	8 (19%)
Eyes involved (N=62)	
Right	28 (67%)
Left	34 (53%)

TABLE 2. Preoperative and postoperative data of patients

Indications	Mean ± SD
Age at the time of surgery	4.38±1.36years
Preoperative LF	2.55±1.09mm
Preoperative ptosis amount	5.48±1.36mm
Preoperative PFH	3.58±1.31mm
Preoperative MRD1	-1.48±1.36mm
Preoperative MRD2	3.52±1.21mm
postoperative PFH	7.97±1.47mm
postoperative MRD1	2.94±1.46mm
postoperative MRD2	4.97±0.18mm
postoperative lagophthalmos	1.42±1.20mm
Follow-up done after	10.28±9.89Months
LF, levator function; MRD, marginal reflex distance; PFH, palpebral fissure height.	

Figures

Figure 1

Positive Bell’s Phenomenon after falling asleep

Figure 2

Poor Bell's phenomenon after falling asleep

Figure 3

Abbreviate anatomy of surgical position and peripheral structures CFS:Conjoint facial sheath; OS: Orbital septum; MM: Muller's muscle SC: Sclera; A: Levator muscle aponeurosis; L: Levator muscle W: Whitnall ligment; S: Superior rectus muscle Surgical position demonstration LM and CFS rectangle

Figure 4

Surgical demonstration(preoperative) F:Frontal muscle; B:Brow; WL: Whitnall ligment; LPS:Levator palpebrae muscle; CFS:Conjoint facial sheath; LPSA:Levator palpebrae muscle aponeurosis; TA:Tarsal plate;

Figure 5

Surgical demonstration(postoperative) F:Frontal muscle; B:Brow; WL: Whitnall ligment; TA:Tarsal plate
LPS:Levator palpebrae muscle; CFS:Conjoint facial sheath; LPSC:Levator muscle and conjoint facial
sheath complex;

Figure 6

Surgical procedure of modified levator muscle suspension a: Conjoint facial sheath(CFS) b: Levator muscle(LM) and Conjoint facial sheath(CFS) c: Levator muscle aponeurosis

Figure 7

Immunohistochemistry of the levator muscle-conjoint facial sheath complex A: Levator muscle; B: Conjoint facial sheath

Figure 8

Preoperative and postoperative view after modified levator muscle suspension a, b: preoperative; c, d: postoperative

Figure 9

Preoperative and postoperative view and poor Bell's phenomenon observed postoperatively a, b: preoperative; c, d: postoperative; e, f: postoperative BP