Modified levator muscle complex suspension on treating pediatric blepharoptosis with poor Bell’s phenomenon

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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.
Keywords  Ptosis · Poor Bell’s phenomenon · Conjoint fascial sheath · Levator muscle complex suspension · Case series analysis

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 10–22% 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 could not 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 is 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 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. This procedure may 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.

Materials and methods

Study design and patients

Forty-six out of 712 (7.1%) 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. LPSC suspension was 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 were obtained from all participants, in accordance with the Declaration of Helsinki.

Data collection and evaluation criteria

Patient’s 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, 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.

The following are the specific definitions of the main parameters mentioned above: (i) LF: on the premise of removing the effect of frontal muscle, relying solely on levator muscle, the maximum activity of upper eyelid, that is, the height difference between the horizontal line of the lowest edge of upper eyelid when looking down and up; (ii) severity of blepharoptosis: Details are described in “Blepharoptosis evaluation”; (iii) PFH: the height between the upper and lower eyelid margins of the same eye; (iv) visual acuity: results obtained by using the international standard e-word visual acuity chart; (v) MRD1: the distance between the upper eyelid margin and the light reflecting point of the cornea when the examinee faces the front; (vi) MRD2: the distance between the lower eyelid margin and the light reflecting point of the cornea when the examinee faces the front.

**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].

**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 (Figs. 1, 2). 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 of BP were also observed in these 46 patients.

**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 (manufactured by TearScience. Inc, located in 5151 McCormm Pkwy Ste 250. Morrisville, North Carolina, 27560, USA) which is able to measure the incomplete blink ratio was applied [14].
Surgical methods

Surgical design: We have designed LPSC suspension, which applies the levator muscle and the fascia sheath complex above the level of the Whitnall ligament to suspend the drooping eyelids (Figs. 3, 4, 5).

Surgical procedure: ①Design an incision with a height of about 5 mm. Dissect the pretrasal orbicularis muscle flap to expose the orbital septum. The orbital septum has been incised horizontally with scissors and preaponeurotic fat is identified. Remove excessive preaponeurotic fat. ②Turn over the upper eyelid and inject anesthetic into the conjunctival fornix for water separation of bubal conjunctival membrane and levator aponeurosis. ③The levator aponeurosis has been dissected from the upper border of the tarsal plate and conjunctiva until the Whitnall ligament could be identified. Abscise both laterals of the Whitnall ligament. Upward separate alongside

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 ligament; S: superior rectus muscle; surgical position demonstration: L and CFS rectangle

Fig. 3

Fig. 4 Surgical demonstration (preoperative). F: frontal muscle; B: brow; WL: Whitnall ligament; LPS: levator palpebrae superioris muscle; CFS: conjoint facial sheath; LPSA: levator palpebrae superioris muscle aponeurosis; TA: Tarsal plate

Fig. 5 Surgical demonstration (postoperative). F: frontal muscle; B: brow; WL: Whitnall ligament; TA: tarsal plate; LPS: levator palpebrae superioris muscle; CFS: conjoint facial sheath; LPSC: levator palpebrae superioris muscle and conjoint facial sheath complex
the fascia tissue, to expose the conjoint facial sheath (CFS). ④Continue to separate alongside the inner surface of CFS's upward to the levator muscle was exposed. ⑤Pull the tarsal to the levator muscle—CFS complex, fix 3–4 stitches to the upper edge of the tarsal plate and adjust the height and radian to make the tarsal margin suspended at the edge of the upper corneal limbus. ⑥Continue to release the ligaments above the muscle surface, so that the upper eyelid can be pulled down to the lower eyelid margin without tension, indicating that the function of eyelid closure is accessible after operation. ⑦The skin incision has been closed incorporating 3 or 4 deep bites through the levator muscle—CFS complex. A lower eyelid traction suture and topical antibiotic ointment have been used. Surgery done (Figs. 6, 7).

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 erythromycin eye ointment was administrated once daily at night. One week later, sodium hyaluronate eye drops, bFGF-containing eye ointment, and erythromycin eye ointment were administrated 4 times, 3 times, and once at night per day for 3 months.

Materials

During the whole process of our treatment, we used 2 kinds of sutures and 5 topical drugs (including 2 kinds of eye ointment and 3 kinds of eye drops). And here are their introduction in detail.

Suture 1: 5–0 absorbable suture with double needle, made in Polygactin 910, Model/specification: W9553, and produced by Ethicon, LLC, which is located in 475C Street, Los Frailes Industrial Park Suite 401, Guaynabo, Puerto Rico 00969, USA.

Suture 2: 5–0 fast-absorbable suture with single needle, made in Polygactin 910, Model/specification: W9915, and produced by Ethicon, LLC, which is located in 475C Street, Los Frailes Industrial Park Suite 401, Guaynabo, Puerto Rico 00969, USA.

Eye ointment 1: Recombinant Bovine Basic Fibroblast Growth Factor Eye Gel, composed mainly by recombinant bovine basic fibroblast growth factor and produced by Zhuhai Yisheng biopharmaceutical Co.,
Ltd, which is located in No. 88, Keji 6th Road, high-tech Zone, Zhuhai, Guangdong, China.

Eye ointment 2: Erythromycin eye ointment, composed mainly by erythromycin and produced by Beijing Shuangji Pharmaceutical Co., Ltd, which is located in West Baolin temple, Feng Village, Yongding town, Mentougou District, Beijing, China.

Eye drops 1: Levofloxacin eye drops, composed mainly by levofloxacin(C$_{18}$H$_{20}$FN$_3$O$_4$·1/2H$_2$O) and produced by Santen Pharmaceutical Co., Ltd. Noto Plant, which is located in 2–14,Shikinami, Hodatsu-shimizu-cho, Hakui-gun, Ishikawa, Japan.

Eye drops 2: Prednisolone acetate ophthalmic suspension 1%, composed mainly by prednisolone acetate (C$_{23}$H$_{30}$O$_6$) and produced by Allergan Pharmaceuticals Ireland, which is located in Castlebar Road, Westport, Co Mayo, Ireland.

Eye drops 3: Sodium hyaluronate eye drops, composed mainly by sodium hyaluronate [(C$_{14}$H$_{20}$N$_{Na}$O$_{11}$)n] and produced by Santen Pharmaceutical (China) Co., Ltd, which is located in No. 169, Tinglan lane, Suzhou Industrial Park, Suzhou, Jiangsu, China.

Statistical analyses

Descriptive statistics were expressed as mean ± standard deviation.

Results

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. Before surgery, the mean LF was 2.55 ± 1.09 mm (range 1–6 mm) and the mean severity of blepharoptosis was 5.48 ± 1.36 mm (range 3–8 mm). 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).

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

| 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%)       |
| > 6 years                        | 2 (5%)         |
| Combined                         |                |
| Amblyopia                        | 10 (24%)       |
| Ocular upturn restriction         | 4 (9.5%)       |
| Intraocular rotation restriction  | 2 (5%)         |
| Oculomotor paralysis             | 2 (5%)         |
| Eyes involved (N=62)             |                |
| Right                            | 28 (67%)       |
| Left                             | 34 (53%)       |

Table 1 Basic characteristics of patients
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).

### 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 mesocephalic 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%.

Levator muscle aponeurosis resection contributes to complete blink and good eyelid closure function after surgery, which is suitable to treat poor Bell’s phenomenon. But applying this technique alone cannot correct severe ptosis thoroughly. So we choose to remove the levator aponeurosis below the Whitnall ligament and conduct levator muscle retraction and, 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 was conducted 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 a low recurrence rate; surgical success was achieved excellent results in 46 (74.2%) out

### Table 2 Preoperative and postoperative data of patients

| Indications                        | Mean ± SD              |
|------------------------------------|------------------------|
| Age at the time of surgery         | 4.38 ± 1.36 years      |
| Preoperative LF                    | 2.55 ± 1.09 mm         |
| Preoperative ptosis amount         | 5.48 ± 1.36 mm         |
| Preoperative PFH                   | 3.58 ± 1.31 mm         |
| Preoperative MRD1                  | −1.48 ± 1.36 mm        |
| Preoperative MRD2                  | 3.52 ± 1.21 mm         |
| postoperative PFH                  | 7.97 ± 1.47 mm         |
| postoperative MRD1                 | 2.94 ± 1.46 mm         |
| postoperative MRD2                 | 4.97 ± 0.18 mm         |
| postoperative lagophthalmos        | 1.42 ± 1.20 mm         |
| Follow-up done after               | 10.28 ± 9.89 Months    |

LF levator function, MRD marginal reflex distance, PFH palpebral fissure height
of 62 eyelids, good results in 8 (12.9%) eyelids, and the recurrence rate was 12.9%. 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 film 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 of 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 (Figs. 8, 9). For normal individuals, there are two main mechanisms to protect the ocular surface. One is intact eyelid with complete blink which forms stable lacrimal film 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

Fig. 8 Preoperative and postoperative view after modified levator muscle suspension. a, b: preoperative; c, d: postoperative

Fig. 9 Preoperative and postoperative view and poor Bell’s phenomenon observed postoperatively. a, b: preoperative; c, d: postoperative; e, f: postoperative BP
suspension managed to acquire stable blepharoposis effect and meanwhile minimize the potential damage to the ocular surface, thus reducing 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 5 mm) 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 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 film, 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.

**Author’s contributions**  
(I) JL, ML, YX, RL, XWZ contributed to conception and design; (II) JL and ML contributed to administrative support; (III) JL, YX, JYZ, and XD contributed to provision of study materials or patients; (IV) XWZ, XSW, RL, JYZ, XD, and YX contributed to data analysis and interpretation; (V) All authors contributed to manuscript writing; (VI) All authors contributed to final approval of manuscript.

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

**Code availability** Not applicable.

**Declarations**

**Conflict of interest** This study has no commercial or proprietary interest. The authors report no conflict of interest.

**Ethical approval** Ethical approval was given; the relevant judgment 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.

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