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Analysis of the Efficacy and Safety of Modified Levator Palpebrae Superioris Muscle Shortening Surgery in the Treatment of Mild to Moderate Blepharoptosis

Peixing Shen*
Nanjing Jiangning Suwang Cosmetic Hospital, Nanjing 211100, Jiangsu, China

Author to whom correspondence should be addressed.

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Abstract: *Objective:* To analyze the clinical efficacy and safety of modified levator palpebrae superioris shortening in the treatment of mild to moderate blepharoptosis. *Methods:* A total of 78 patients with mild to moderate blepharoptosis admitted to our hospital from January 2023 to December 2024 were enrolled and divided into two groups using a random number table, with 39 cases in each group. The control group received conventional levator palpebrae superioris shortening, while the observation group was treated with modified levator palpebrae superioris shortening. The clinical efficacy, incidence of complications and recurrence rate at 6 months after surgery were compared between the two groups. *Results:* The total effective rates of the observation group and the control group were 94.87% and 79.49%, respectively ($P < 0.05$). The incidence rates of complications (infection, failure of double eyelid fold formation, lagophthalmos and exposure keratitis) were 7.69% in the observation group and 25.64% in the control group. The recurrence rates at 6 months after surgery were 5.13% and 20.51%, respectively ($P < 0.05$). *Conclusion:* Modified levator palpebrae superioris shortening achieves a high clinical effectiveness rate in the treatment of patients with mild to moderate blepharoptosis. It can significantly improve postoperative upper eyelid position and eyelid opening-closing function, reduce complications such as infection and lagophthalmos, and present a low recurrence rate, demonstrating favorable clinical application value.

Keywords: Modified levator palpebrae superioris shortening; Blepharoptosis; Mild to moderate; clinical efficacy; Safety

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1. Introduction

Blepharoptosis refers to the downward displacement of the upper eyelid, either unilaterally or bilaterally, caused by weakened function of the levator palpebrae superioris muscle or related neural structures. It is characterized by increased corneal coverage by the eyelid margin, which affects facial appearance; in severe cases, it may block the visual axis and impair visual function [1]. Its etiologies include congenital dysplasia and various acquired diseases. Asians have a relatively higher risk of mild blepharoptosis due to the lower prevalence of congenital supratarsal folds (single eyelids) [2]. Although mild to moderate blepharoptosis does not severely obscure the pupil, it compromises ocular appearance and daily visual comfort, and some patients develop compensatory eyebrow lifting or appearance-related anxiety as a result.

Surgery is the mainstay treatment for blepharoptosis, and the specific procedure is selected based on the etiology and

severity of ptosis. Patients with severe ptosis mostly undergo suspension using frontalis muscle flaps or fascial sheaths to elevate the eyelid, whereas mild to moderate ptosis is more suitably treated with levator palpebrae superioris shortening. This procedure restores the eyelid margin to a functional height by shortening and reinforcing the elevating effect of the levator palpebrae superioris or its aponeurosis [3]. However, conventional blepharoptosis correction often involves insufficient dissection of Müller's muscle or excessive resection of pretarsal tissue, leading to ptosis recurrence, eyelid margin depression, or morphological abnormalities. These complications further result in unsatisfactory appearance, restricted visual field, dryness, irritation, and other discomforts [4]. As a newly developed corrective technique in recent years, modified levator palpebrae superioris shortening optimizes the handling of the levator palpebrae superioris and its aponeurosis based on the traditional aponeurotic shortening. It employs more refined dissection, fixation, and suturing designs, enabling more precise regulation of upper eyelid elevation force. Meanwhile, it can correct ptosis, improve eyelid margin morphology, and reduce postoperative upper eyelid ectropion and depression [5,6]. Therefore, this study enrolled 78 patients with mild to moderate blepharoptosis in our hospital to compare the therapeutic efficacy and safety of modified levator palpebrae superioris shortening versus the conventional procedure, so as to evaluate its clinical application value.

2. Materials and methods

2.1. General data

Approved by the Medical Ethics Committee (Ethics Approval No.:), a total of 78 patients with mild to moderate blepharoptosis admitted to our hospital from January 2023 to December 2024 were selected and divided into two groups using a random number table method, with 39 cases in each group. There were no statistically significant differences in baseline data between the two groups ($P > 0.05$), indicating comparability, as shown in **Table 1**.

Table 1. Comparison of baseline data [(mean ± SD), cases (n)]

Group	n	Male/Female	Age (years old)	Number of Eyes	Severity	
					Mild (2–4 mm)	Moderate (4–6 mm)
Observation Group	39	22/17	31. 19 ± 7.20	57 (73.08)	12 (30.77)	27 (69.23)
Control Group	39	19/20	30. 22 ± 6.79	55 (70.52)	15 (38.46)	24 (61.54)
t/χ^2		0.463	0.612	0.127	0.510	
P		0.496	0.542	0.722	0.475	

2.2. Inclusion and exclusion criteria

Inclusion criteria: (1) Meet the diagnostic criteria for blepharoptosis [7], with mild to moderate severity, defined as upper eyelid margin covering the upper corneal limbus by 2–6 mm and levator palpebrae superioris function ranging from 4 to 7 mm; (2) Normal extraocular muscle movement and frontalis muscle function; (3) Age ≥ 18 years old; (4) Complete clinical data and ability to complete follow-up for at least 6 months after surgery; (5) Signed informed consent.

Exclusion Criteria: (1) Severe blepharoptosis, defined as levator palpebrae superioris function < 4 mm or complete occlusion of the pupil by the upper eyelid; (2) Severe congenital dysplasia of the levator palpebrae superioris requiring frontalis suspension; (3) History of recent upper eyelid surgery or ocular trauma; (4) Severe ocular diseases, such as keratitis, severe dry eye syndrome, severe blepharitis, active eyelid infection, etc.; (5) Systemic diseases affecting postoperative healing, such as diabetes mellitus, immunodeficiency, coagulation disorders, etc.; (6) Pregnant or lactating women; (7) Poor mental status or poor compliance.

2.3. Methods

In both groups, levator palpebrae superioris function, ptosis severity, and eyelid opening and closing status were evaluated

preoperatively. Surgical treatment was performed after eyelid morphology examination and design line marking.

The control group received conventional levator palpebrae superioris shortening: The patient was placed in the supine position. After local anesthesia, the skin was incised along the designed line, and the orbital septum was dissected. The levator aponeurosis was exposed superiorly up to the level of the transverse ligament. According to the tension of the levator palpebrae superioris and the degree of ptosis, pre-placed sutures were inserted at the medial, middle, and lateral points of the aponeurosis and fixed respectively to the junction of the middle and lower 1/3 of the tarsal plate. After confirming the eyelid margin height, a skin suture was performed. Antibiotic eye ointment was applied to the surgical area, followed by pressure bandaging. Dressing change was conducted 24 hours postoperatively, and sutures were removed approximately 7 days after surgery.

The observation group was treated with modified levator palpebrae superioris shortening: After routine disinfection and draping, the patient was placed in the supine position. A mixture of ropivacaine and epinephrine hydrochloride (1: 200,000) was injected into the incision area for local anesthesia. The skin was incised along the designed incision line, and the subcutaneous tissue was dissected. Redundant skin and part of the orbicularis oculi muscle were removed, the orbital septum was fully exposed and opened, and herniated orbital fat was excised. Further upward dissection was performed to expose the levator aponeurosis of the upper eyelid. Subsequently, two rows of three points (medial, middle, and lateral) were marked on the upper margin of the levator aponeurosis and the corresponding tarsal plate, respectively. The required shortening length was determined according to the degree of ptosis. Transverse small incisions of approximately 3 mm were made at the six marked points, and three mattress sutures were placed between the corresponding upper and lower points using 50 absorbable sutures. After tying temporary knots, the patient was instructed to gaze forward. The suture positions were adjusted according to the height, curvature, and closure function of the upper eyelid. Once satisfactory results were achieved, the knots were ligated and fixed, so that the eyelid margin was positioned 0.5–1.0 mm below the corneal limbus at the end of surgery. After thorough hemostasis, interrupted suturing was performed with 60 absorbable sutures to form a double eyelid. Antibiotic eye ointment was applied postoperatively, followed by pressure bandaging. Dressing change was performed on the next day with continued pressure bandaging. The bandage was removed on the third day, and topical eye drops and ointment were administered. Sutures were removed one week after surgery.

2.4. Observation indicators

(1) Clinical efficacy: Evaluated comprehensively according to postoperative upper eyelid position, corneal exposure, and recovery of eyelid opening and closing function. **Markedly effective**: The upper eyelid position was well restored. For unilateral cases, the difference in eyelid margin height was no more than 1 mm when gazing forward; for bilateral cases, the upper eyelid only slightly covered the cornea within 2 mm, with normal eyelid opening-closing function and coordinated eyebrow position. **Effective**: The upper eyelid position was significantly improved compared with the preoperative status, but with mild deviation. For unilateral cases, the difference in eyelid margin height ranged from 1 to 3 mm; for bilateral cases, corneal coverage was slightly increased but without affecting pupillary exposure, and eyelid opening function and eyebrow position were basically normal. **Invalid**: Obvious under-correction with corneal coverage exceeding 2 mm, or over-correction with upper eyelid position higher than the upper corneal limbus, or accompanied by abnormal eyelid opening-closing function. **Effective rate = (Markedly effective + Effective) / 39 × 100%**

(2) Complications included infection, failure of double eyelid fold formation, lagophthalmos and exposure keratitis. The recurrence rate at 6 months after surgery was recorded. Recurrence rate = (Number of recurrent cases / 39) × 100%.

2.5. Statistical Analysis

Statistical analysis was performed using SPSS 25. 0 software. Enumeration data were expressed as n (%) and analyzed by the χ^2 test; measurement data were expressed as mean ± standard deviation (SD) and analyzed by the t-test. A value of $P < 0.05$ was considered statistically significant.

3. Results

3.1. Clinical Efficacy

The total effective rates of the observation group and the control group were 94. 87% and 79. 49%, respectively ($P < 0.05$). See **Table 2**.

Table 2. Comparison of clinical efficacy [n (%)]

Group	n	Show efficacy	effective	invalid	Total effective rate
Observation group	39	19 (48. 72)	18 (46. 15)	2 (5. 13)	37 (94. 87)
control group	39	11 (28. 21)	20 (51. 28)	8 (20. 51)	31 (79. 49)
χ^2					4. 129
P					0. 042

3.2. Incidence of complications and recurrence rate at 6 months postoperatively

Compared with the control group, the observation group had a lower incidence of complications and a lower recurrence rate at 6 months after surgery ($P < 0.05$). See **Table 3**.

Table 3. Comparison of the incidence of complications and recurrence rate at 6 months postoperatively [n (%)]

Group	n	The incidence of complications					Recurrence rate 6 months after surgery
		Infection	No formation of the double eyelid line	Incomplete eyelid closure	Exposure keratitis	Total incidence rate	
Observation group	39	0 (0.00)	1 (2.56)	0 (0.00)	2 (5.13)	3 (7.69)	2 (5.13)
Control group	39	1 (2.56)	3 (7.69)	2 (5.13)	4 (10.26)	10 (25.64)	8 (20.51)
χ^2						4.523	4.129
P						0.033	0.042

4. Discussion

Blepharoptosis is a structural and functional disorder caused by abnormal function of the levator palpebrae superioris muscle, its aponeurosis, or the neural regulatory system, resulting in the eyelid margin descending below the upper corneal limbus during forward gaze, leading to corneal coverage of more than 2 mm, reduced palpebral fissure height, or abnormal eyelid margin position. Its etiologies can be divided into congenital and acquired categories. Congenital blepharoptosis is mostly associated with hypoplasia of the levator palpebrae superioris, decreased muscle fiber quantity, insufficient myoglobin expression, and abnormal aponeurotic structure development, with obvious pathological changes such as disordered arrangement of muscle fibers, fatty infiltration, and connective tissue hyperplasia [8]. In contrast, the causes of acquired blepharoptosis are relatively complex. In addition to senile relaxation and rupture of the levator aponeurosis, as well as aponeurotic thinning and degeneration of collagen and elastic fibers due to long-term traction, fibrosis and fatty degeneration of Müller's muscle and weakened muscle strength caused by oxidative stress are also involved in the pathogenesis [9]. Some patients may also develop ptosis due to neurogenic, myogenic, or mechanical factors, and a few cases present with transient limited palpebral elevation upon waking, which is mostly related to insufficient levator activation or short-term abnormal neural regulation [10]. The severity of blepharoptosis is mainly determined by the extent of corneal coverage by the eyelid margin and the contractile capacity of the levator palpebrae superioris. Mild to moderate ptosis is typically characterized by eyelid margin descent of 2–6 mm or levator excursion of 4–7 mm, with relatively limited structural damage, mostly presenting as aponeurotic relaxation, partial fiber degeneration, or mild

muscle weakness. Visual development is generally not severely affected, but it can cause problems such as difficulty in eye opening, visual fatigue, appearance changes, and compensatory eyebrow lifting, impairing quality of life [11].

The present study showed that the total effective rate was 94.87% in the observation group and 79.49% in the control group ($P < 0.05$). Chen Yuan et al. [12] reported that the total cure rate of modified levator palpebrae superioris shortening for mild to moderate blepharoptosis was 97.78%, which was similar to the results of this study, indicating that modified levator palpebrae superioris shortening can effectively improve mild to moderate blepharoptosis. The modified procedure conforms more closely to the original anatomical mechanics of the levator palpebrae superioris in terms of exposure, dissection and fixation of the levator aponeurosis, allowing for more precise control of the shortening length under adequate exposure of the aponeurosis. Marking six points (medial, middle and lateral) in upper and lower rows and applying mattress sutures stably connect the levator aponeurosis to the tarsal plate at multiple stress points. This not only strengthens the traction force of the levator muscle but also maintains a natural transition of the eyelid margin curvature, reducing the risk of uneven local stress and undercorrection caused by singlesuture fixation. Relevant literature has reported that such multipoint fixation can significantly reduce aponeurotic retraction and maintain longterm lifting efficiency of the levator muscle postoperatively [13]. In addition, moderate excision of herniated orbital fat, removal of loose orbicularis oculi muscle, and reconstruction of the pretarsal fascia during surgery help the levator palpebrae superioris exert a fuller lifting effect during contraction, while reducing resistance against aponeurotic advancement from pretarsal tissue, thereby improving the range of upper eyelid movement. Furthermore, the modified procedure emphasizes preserving the functional length at the junction of Müller's muscle and the aponeurosis, avoiding decreased levator tension caused by excessive dissection. This helps reduce the incidence of undercorrection and exerts a positive effect on levator function recovery in patients with mild to moderate ptosis. In this study, both the complication rate and the 6month postoperative recurrence rate were significantly lower in the observation group ($P < 0.05$), which is consistent with the above mechanisms and reflects favorable safety.

5. Conclusion

In conclusion, modified levator palpebrae superioris shortening achieves a high clinical effectiveness rate in the correction of mild to moderate blepharoptosis. It can reduce complications such as infection, failure of double eyelid fold formation and lagophthalmos, as well as lower the recurrence rate at 6 months postoperatively, indicating that this procedure demonstrates favorable clinical value in both efficacy and safety.

Disclosure statement

The author declares no conflict of interest.

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