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Original Article

Maximal Levator Resection Versus Frontalis Sling by Silicone Rod in Correction of Blepharoptosis with Poor Levator Function

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ABSTRACT

Background: Blepharoptosis with poor levator function poses significant challenges, often necessitating surgical correction. Maximal levator resection focuses on maximizing residual muscle function to elevate the eyelid, while frontalis sling using silicone rods employs frontalis muscle action for eyelid suspension.

Aim: This study aimed to compare the surgical efficacy of using Maximal levator resection versus silicone rod sling in the management of Blepharoptosis with poor levator function.

Patients and Methods: This prospective randomized controlled study included 50 eyes with blepharoptosis and poor levator function who were submitted for surgical correction. Patients were randomly assigned into to 2 groups; Group 1: included 25 eyes who underwent Correction of Ptosis Using Maximal levator resection. Group 2: included 25 eyes who underwent Correction of Ptosis Using Tarso Frontalis Sling by silicone rod. Assessment of ptosis was done by the assessment of Margin reflex distance [MRD1], Palpebral fissure height [PFH], Levator function, Lid crease, Cover test, and Bell's phenomenon.

Results: Preoperatively, the mean PFH was significantly higher in group 2 [sling] than group 1 [MLR] [P = 0.04]. After 6 months the mean PFH was also significantly higher in group 2 [sling] than group 1 [MLR] [P = 0.001]. Preoperatively, the mean MRD 1 was comparable in both groups [P = 0.7]. After 6 months the mean MRD1 was significantly higher in group 2 [sling] than group 1 [MLR] [P = 0.01]. As regards the success rate, it represents 76% of the eyes in group 1 versus 84% of the eyes in group 2, with no statistically significant difference between the two groups.

Conclusion: MLR and FS with silicon rod have comparable surgical outcomes in terms of postoperative MRD1, PFH, Success rate, and complications.

Keywords: **Blepharoptosis; Maximal Levator Resection; Silicone Rods; Poor levator function.**

INTRODUCTION

Blepharoptosis, or ptosis, occurs when the upper eyelid rests below its normal anatomical position in the primary gaz [1]. Simple congenital ptosis, the most prevalent form of ptosis in children, arises from impaired levator muscle function, typically caused by the muscle's under-development or malformation. In certain studies, isolated congenital myogenic ptosis represents 74% to 76% of pediatric ptosis cases. It is commonly characterized by non-progressive ptosis, occurring unilaterally in 75% of cases and displaying asymmetry when bilateral [2,3]. Surgical correction of ptosis depends on levator function: levator resection for fair to good function, and frontalis suspension for poor function [4].

The surgical correction of congenital ptosis is especially challenging due to its significant aesthetic and functional implications [5]. For severe ptosis with levator function of 4 mm or less, frontalis suspension [FS] is an excellent option. This technique involves attaching the frontalis muscle to the superior tarsal plate, aiding in eyelid alignment during primary gaze. The frontalis muscle compensates for weakened levator function by lifting the upper eyelid through contraction [6]. Silicone rods are the predominant synthetic material utilized for frontalis suspension, owing to its simplicity of insertion, adjustability, and elastic characteristics, which aid in reducing or eliminating lagophthalmos [1].

For severe levator insufficiency, frontalis sling surgery is standard, but studies show that maximal levator resection in congenital ptosis can offer similar results, with better cosmetic outcomes, a natural lid contour, no foreign material, and no brow scars [7]. Maximal levator resection is performed via a single skin crease incision, aiming to maintain the muscle's physiological vector while reducing its length to improve functionality. The excision that involves Whitnall's ligament is termed the Whitnall sling, with the ligament functioning as a supporting framework for the upper eyelid [8].

This study aimed to compare the surgical efficacy of using Maximal levator resection versus silicone rod sling in the management of Blepharoptosis with poor levator function.

PATIENTS AND METHODS

This prospective randomized controlled study included 50 eyes with blepharoptosis and poor levator function [< 4 mm] who were submitted for surgical correction. The eye clinics at Cairo's Al-Azhar University were the sites of this research. The guidelines presented in the Helsinki Declaration were followed by our research. The Al-Azhar University Faculty of Medicine's Institutional Review Board in Cairo gave its stamp of approval for the study's ethical aspects. Before enrolling each patient, we made sure to get their written informed permission. Two groups of patients were randomly assigned to the study. One group had correction of ptosis via maximal levator excision, and 25 eyes were part of that group. In Group 2, 25 eyes were subjected to Tarso Frontalis Sling Correction of Ptosis using a silicone rod. Patients were excluded if they presented with Horner's syndrome, jaw-winking, diminished corneal sensitivity, xerophthalmia, absent Bell's phenomenon, congenital ptosis accompanied by other ocular disorders, or traumatic/recurrent ptosis.

Data collection: All patients underwent complete medical history taking including Age, gender, preceding trauma, history if ptosis was associated with other ocular manifestations, history of diplopia, facial palsy, past surgical history mainly previous repair of ptosis, and family history of similar condition. Full ophthalmological examination was done including the assessment of the following; best corrected visual acuity, cycloplegic refraction, pupil size and reaction, slit-lamp bio microscopy, fundus examination, Extra ocular movements, orbicularis muscle action, frontalis muscle action, and Jaw-winking phenomenon. Assessment of ptosis was done by the assessment of Margin reflex distance 1, Palpebral fissure height [palpebral aperture], Levator function, Lid crease, Cover test, and Bell's phenomenon. Preoperative and postoperative photographic documentation was done for all cases [Figures 1- 4].

Surgical technique

Group 1 [MLR]: By opening the orbital septum, the preaponeurotic fat may be seen. Separation of Müller's muscle and the levator aponeurosis from the conjunctiva followed. With great care, the levator horns were incised, protecting Whitnall's ligament. A double-armed 5/0 polyester suture connected the tarsal plate to the levator aponeurosis then Medial and lateral sutures refined the contour and excess muscle was excised then Eyelid crease reformation and skin closure followed.

Group 2 [Sling]: Two Supraciliary incisions were made above the lash line, aligned with lateral and medial limbi. Another two Supra brow incisions were marked at the brow hairline.an additional incision site was marked 8-10 mm above and midway between the two supra brow incision marks. A silicone rod sling was implanted through a pentagon pattern [Fox technique] in the submuscular plane. The sling was secured through the eyebrow incision, adjusting eyelid contour and height. Bilateral cases aimed for 1 mm below the limbus, while unilateral cases prioritized symmetry. The sling was tightened and secured with 5-0 polyester sutures. The silicone rod ends were trimmed and buried beneath the frontalis muscle. Forehead incisions were closed with layered 5-0 Vicryl sutures.

Postoperative follow-up and evaluation: Postoperatively, the patient received systemic antibiotic, ant edematous drugs and analgesic. Locally the patient received lubricant eye drops [sodium hylornate 0.1%] four times daily for one month and topical antibiotic [tobramycin 0.3%] eye drops four times daily for one week and eye ointment once daily at night for one month. All patients were followed up at 1st week, 1st month and 6th month by the assessment of palpebral fissure height, eyelid crease height, and upper eyelid margin reflex distance, and complications. Cosmetic outcome assessment was done assessing the Eye lid contour, Symmetry of lid height, and Lid crease. Finally, photographs were obtained each visit.

Success rate: In our study, a postoperative MRD1 of 3 mm or higher, with lid symmetry of 1 mm or less, was considered a success. In instances that were first thought to have been successful, recurrence was defined as a reduction in MRD1 below 3 mm [9].

Statistical analysis: Statistical analysis was conducted utilizing SPSS software [version 26, IBM, Chicago, Illinois, USA], with normality evaluated via the Kolmogorov-Smirnov test. Qualitative data were expressed as frequencies and percentages, with comparisons conducted using either the Chi-square test or Fisher's exact test, contingent upon the data distribution. Quantitative data, presented as means and standard deviations, were evaluated utilizing the independent t-test or Mann-Whitney U test for non-normally distributed data. A p-value below 0.05 was deemed statistically significant.

ESULTS

A total number of 39 patients [50 eyes] were included in our study. The median [IQR] age of the studied patients was 6 [5-12] years, with a range of 3 – 34 years. Males represent 23 [59%] of the patients and females represent 16 [41%]. The two groups were comparable in terms of their age and sex [P =0.4, and 0.5 respectively] **[Table 1].**

As regards the laterality, Unilateral ptosis was present in 71.7% of the total studied patients. However, bilateral ptosis was present in 28.2% of the studied patients. Unilateral ptosis was significantly more in group 1 than in group 2 [19 vs 9 respectively] [P= 0.03]. In our study, 25 eyes were the right side, and 25 eyes were the left side. As regards the type of anesthesia, all of the studied eyes were operated under general anesthesia, only four patients in MLR group were operated under local anesthesia.

In group 1, the mean PFH was significantly increased from 3.6±0.6 mm preoperatively to 7.8±1.1 mm 6 months postoperatively [P =0.001]. In group 2, the mean PFH was significantly increased from 4±0.8 mm preoperatively to 9±1 mm 6 months postoperatively [P =0.001]. By comparing the two groups, preoperatively, the mean PFH was significantly higher in group 2 [sling] than group 1 [MLR] [P= 0.04]. After 6 months the mean PFH was also significantly higher in group 2 [sling] than group 1 [MLR] [P = 0.001] **[Table 2].** In group 1, the median [IQR] MRD1 was significantly improved from -0.12±0.7 mm preoperatively to 4.1± 0.8 mm 6 months postoperatively [P =0.001]. In group 2, the median [IQR] MRD1 was significantly improved from -0.28±1mm preoperatively to 3.5±0.65 mm 6 months postoperatively [P =0.001]. By comparing the two groups, preoperatively, the mean MRD 1 was comparable in both groups [P = 0.7]. After 6 months the mean MRD1 was significantly higher in group 2 [sling] than group 1 [MLR] [P = 0.01] **[Table 3].** The mean lid crease height in group 1 was 7.6±0.86 with arrange of 6 – 10. In terms of the symmetry, 16 patients [72.2%] in group 1 versus 13 [76.4%] patients in group 2 were symmetrical [P =0.9]. The most common complications in our study were Asymmetrical eyelids height which represent 20% of cases followed by Exposure keratopathy which represent 16% of cases, Recurrence of ptosis which represent 12%, and Overcorrection which represent 10% of cases with no statistically significant difference between the two groups **[Table 4].**

As regards the success rate, it represents 76% of the eyes in group 1 versus 84% of the eyes in group 2, with no statistically significant difference between the two groups [P =0.7].

Table [1]: Demographic data of the studied participants

Variables	Total [n= 39]	Group 1 [MLR] [n= 22]	Group 2 [Sling] [n= 17]	P value
Age [Years]				
Median [IQR]	6 [5-12]	7 [4.25 – 18]	6 [5- 8.5]	0.42
Range	3 - 34	3 - 34	3 - 15	
Gender				
Male	23 [59%]	12 [54.5%]	11 [64.7%]	0.55[b]
Female	16 [41%]	10 [45.5%]	6 [35.3%]	

a: Mann Whitney U test. b: Chi-square test

Table [2]: PFH of the studied patients all over the follow up periods

PFH	Group 1 [MLR] [n=25 eyes]	Group 2 [Sling] [n= 25 eyes]	P value [b]
Pre operative	3.6 ± 0.6	4 ± 0.8	0.04*
After 6 months	7.8 ± 1.1	9 ± 1	0.001*
P value [a]	0.001*	0.001*	

a: Paired t test. b: independent test.

Table [3]: MRD 1 of the studied patients all over the follow up periods

MRD 1	Group 1 [MLR] [n=25 eyes]	Group 2 [Sling] [n= 25 eyes]	P value [b]
Pre operative	0 [-1 – 0.5]	0 [-1 – 0.5]	0.7
After 6 months	4 [3.75 – 4]	4 [3 – 4]	0.01*
P value [a]	0.001*	0.001*	

a: Wilcoxon test [Preop vs postop]. b: Mann Whitney U test

Table [4]: Complications of the studied patients

Complications	Total [n= 50 eyes]	Group 1 [MLR] [n=25 eyes]	Group 2 [Sling] [n= 25 eyes]	P value [a]
Recurrence of ptosis	6 [12%]	3 [12%]	3 [12%]	0.9
Overcorrection	5 [10%]	3 [12%]	2 [8%]	0.9
Asymmetrical eyelids height	10 [20%]	6 [24%]	4 [16%]	0.72
High lid crease	1 [2%]	1 [4%]	0 [0%]	0.9
Exposure keratopathy	8 [16%]	5 [20%]	3 [12%]	0.9
Lash ptosis	1 [2%]	1 [4%]	0 [0%]	0.9
Dermatochalasis	2 [4%]	0 [0%]	2 [8%]	0.4
Infection	2 [4%]	0 [0%]	2 [8%]	0.4
Temporal dropping	2 [4%]	1 [4%]	1 [4%]	0.9

a: Fisher exact test.

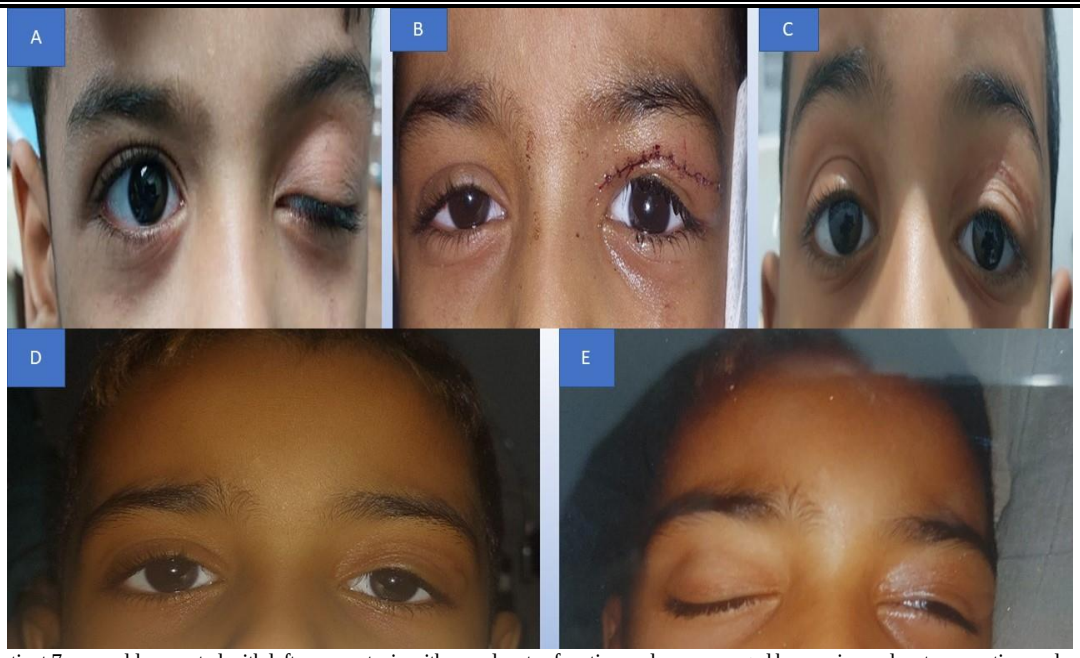

Figure [1]: Male patient 7 years old presented with left severe ptosis with poor levator function and was managed by maximum levator resection under general anesthesia. A: preoperative. B: post 1 week. C: post 3 months. D: post 6 months. E: during sleep

Figure [2]: Female patient 5 years old presented with bilateral congenital ptosis with poor levator function managed by maximum levator resection under general anesthesia. A: preoperative. B: post 1 month. C: Lagophthalmos

Figure [3]: Male patient 14 years old with right ptosis with poor levator function managed by sling under general anesthesia. A: preoperative. B: post 1 week. C: post 3 months. D: post 6 months

Figure [4]: female patient 6 years old with left ptosis with poor levator function managed by sling under general anesthesia. A: preoperative. B: post 6 months

DISCUSSION

This study compared maximal levator excision with silicone rod sling for treating any form of blepharoptosis with inadequate levator function. We examined 50 eyelids from 39 patients. Their median [IQR] age was 6 [5-12]. Patients were 23 males and 16 females. Our study's two groups had similar demographics [Age and Sex] [P > 0.05]. Unilateral cases outnumbered bilateral cases [71.7% vs 28.3%]. Bilateral instances were more common in group 2 [P=0.03]. Group 1's PFH improved from 3.6 ± 0.6 mm at baseline to 7.8 ± 1.1 mm at 6 months postoperatively [P = 0.001]. In group 2, it improved from 4 ± 0.8 mm at baseline to 9 ± 1 mm at 6 months [P=0.001]. Group 1's MRD1 increased from -0.12 ± 0.7 mm at baseline to 3.5 ± 0.65 mm at 6 months' post-op [P=0.001]. Group 2 showed a significant improvement from -0.28±1 mm to 4.1 ± 0.8 mm at 6 months' post-op [P=0.001]. PFH and MRD1 improvement at 6 months postoperatively was substantially larger in group 2 [Sling] than group 1 [MLR] [P=0.001], but the MLR group's progress is good and clinically acceptable.

Levator excision preserves dynamic blinking, creates a more natural eyelid contour, improves symmetry in unilateral ptosis, and reduces frontalis muscle dependency for eyelid elevation. The literature on levator excision in severe ptosis is growing [10].

Our results come in accordance with multiple previous studies either comparing both techniques or studied each one alone. **Kumar *et al.*** [11] reported increased palpebral fissure height and marginal reflex distance-1 post-surgery in both frontalis sling and levator resection groups, which was consistent with our findings. **Young *et al.*** [12] found a significantly lower postoperative MRD1 in the FS group [2.5±1.0 mm] compared to MLR [2.8±0.8 mm], which contrasts with our findings. This difference may be due to the use of silicone rods in our study versus fascialata in theirs, as well as the inclusion of all types of blepharoptosis in our study, while theirs focused on congenital ptosis only. Also, **Dawood *et al.*** [13] noted MRD1 improvement from ~0.3 mm to ~2.8 mm across FS and MLR groups. **Balsak *et al.* [14]** reported a reduction in ptosis severity from 5.136 mm to 0.818 mm post-surgery [p < 0.001], with successful outcomes in 78% of eyes, satisfactory in 12%, and unsuccessful in 9%. Both **Lee *et al.*** [15] and **Press and Hübner** [16] found that the maximal levator resection proves to be effective for congenital ptosis, even with ≤2 mm function, yielding excellent outcomes. **Idris *et al.*** [17] reported a rise in MRD1 from −0.1±1.5 mm pre-operatively to 3.9 ± 1.0 mm post-operatively, with a 90.1% success rate over 6 months to 5 years, likely due to their larger sample size of 123 eyes.

The success rate in our study was 76% in cases who underwent MLR versus 84% in cases who underwent Sling [P = 0.7] which reflect the clinical efficacy of MLR in patients with blepharoptosis associated with poor levator function. **Lee *et al.*** [15] **and Mete *et al.*** [18] showed 93 %, 91.4 %, and 69.6 % success rates with levator excision in congenital ptosis.

According to the **Dawood *et al.*** [13]**,** the recurrence rate was 7.8% in the tarsofrontalis sling group and 5.9% in the supramaximal levator resection group. **Rizvi *et al.*** [19]**, Bernardini *et al.*** [20] **and Kersten *et al.*** [21] reported a success rate of 77–95% of patients.

According to the complications, the most common complications in our study was Asymmetrical eyelids height which represent 20% of cases followed by Exposure keratopathy which represent 16% of cases, Recurrence of ptosis which represent 12%, and Overcorrection which represent 10% of cases.

Postoperative problems can occur with either FS or MLR, according to **Lee *et al.*** [15]**.** There were less problems with MLR than with FS, according to research by **Gazzola *et al.*** [22] **and Young *et al.*** [12] also noted a favorable finding for MLR.

Common complications after surgery include exposure keratopathy and lagophthalmos. Ptosis severity, levator function, and degree of levator excision are key risk factors for lagophthalmos after levator surgery [23]. **Mete *et al.*** [18] identified lagophthalmos accompanied by punctate epithelial keratitis in 7 eyes [24.1%]. Three cases resolved autonomously within weeks, but two continued to persist.

This study differs from others in several ways. It is the second study to do such comparison. Additionally, it is both prospective and randomized. Finally, we randomly assigned an equal number of eyes to each group, with surgeries performed by two surgeons to avoid bias.

Our study had **limitations**: a small sample size, unmeasured levator resection, and a short follow-up. Larger studies and longer follow-ups are needed to confirm these findings.

Conclusion: Both MLR and FS with silicone rod demonstrate comparable surgical outcomes, with no significant difference in postoperative MRD1, PFH, success rates, or complications, suggesting that either approach can be equally effective for achieving favorable results.

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