Research Article

Evaluating Frontalis Sling Using Silicone Rod In Repair Congenital Blepharoptosis

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Abstract

Background: Congenital blepharoptosis with poor levator function is commonly treated by frontalis suspension. Silicone rod has become a popular sling material because of its elasticity, adjustability, and ease of implantation. **Objective:** To evaluate the effectiveness and safety of frontalis suspension using a silicone rod in the treatment of moderate to severe congenital blepharoptosis. **Methods**: A prospective uncontrolled clinical traill was conducted at Rizgary Teaching Hospital, Erbil, Iraq, from April 2024 to October 2025. Fifteen patients (20 eyes) with moderate to severe congenital blepharoptosis underwent frontalis suspension using a silicone rod in a Fox pentagon configuration. Preoperative and postoperative assessments included margin reflex distance 1 (MRD1), palpebral fissure height (PFH), levator function, frontalis excursion, complications, and patient satisfaction. Patients were followed for 1 year. **Results**: Twenty eyes of 15 patients were included. Mean MRD1 improved significantly from 0.25 ± 1.02 mm preoperatively to 2.75 ± 1.38 mm postoperatively ($p < 0.001$). Mean PFH increased from 4.25 ± 1.56 mm to 10.20 ± 3.18 mm ($p < 0.001$). Good postoperative correction (MRD1 ≥3 mm) was achieved in 70% of eyes, while functional success (MRD1 ≥2 mm) was achieved in 90% of eyes. Complications included silicone rod rupture in two eyes, infection in one eye, and under-correction in three eyes. More than the half of the patients (66.7%) were satisfied with the surgical outcome. **Conclusion:** Frontalis suspension using a silicone rod is a safe and effective surgical option for moderate to severe congenital blepharoptosis with poor levator function, providing significant functional and cosmetic improvement with acceptable complication rates.

Keywords: Congenital blepharoptosis; Frontalis suspension; Silicone rod; Ptosis surgery; Margin reflex distance; Eyelid reconstruction.

Introduction

Blepharoptosisis defined as abnormally low position of the upper eyelid margin in primary gaze, resulting in narrowing of the palpebral fissure and potential impairment of visual field.[3] Under normal conditions, the upper eyelid margin rests approximately 1-2 mm below the superior corneal limbus, any deviation below this anatomical position is considered pathological.[1,2]

Blepharoptosis can be classified as congenital and acquired,[1] congenital blepharoptosis which accounts for majority of pediatric cases usually present sincebirth and diagnosed within first year of life,[7]mostly unilateral (70%)or bilateral.[3,7] histologically the levator palpebral muscle in congenital blepharoptosis are dystrophic and lacks striated muscle instead the muscle and aponeurosis are stiff and replaced by fibrosis and fat,[3,6] despite of aesthetic implications, it may cause serious functional problems including visual axis obstruction ,deprivation amblyopia ,and compensatory head and neck posture especially in bilateral cases, furthermore the condition may negatively affect the psychological wellbeing of affected children highlighting the importance of early diagnosis and management .[4-6]

Clinically the severity of blepharoptosis depends mainly on amount of upper eyelid drooping, marginal reflex distance1 (MRD1) and levator function. Blepharoptosis severity depending on upper eyelid drooping can be graded to mild (2mm or less),moderate(3mm), or severe (4 mm or more).[1,2] According to Beards classification of MRDI: mild (MRD1 of 3-4mm),moderate (MRD1of 2-3 mm)and severe MRD1 below 2 mm[5-12]. Levator function is assessed by measuring lid excursion from extreme downward gaze to upward gaze with frontalis muscle neutralized and its categorized as a normal (12 or more),good (10-12 mm),fair (6-9mm),poor (5 mm or less),these parameters are critical in guiding the selection of the most appropriate surgical technique.[2]

Frontalis muscle which acts as an elevator of the brow and also accessory retractor of the upper eyelid.Its fibers oriented vertically on the forehead.They begin superiorly at the level of coronal suture line and extend downward to the supraorbital rim,frontalis muscle overaction seen in patients which can mask blepharoptosis for this reason it

should be immobilized when measuring levator muscle function. When the patient undergoing frontalis suspension surgery should be carefully assessed to check good frontalis action is present. A point in upper brow is defined and frontalis excursion measured when brow relaxes and then raise, which should be about 10 mm.[13]

The management of congenital blepharoptosis remains one of the most challenging operations for plastic and oculoplastic surgery,[4,5,7] The choice of surgical approach dependson many factors including patient s age,severity of blepharoptosis,corneal statusand most importantly levator function.In the cases of good to fair levator function levator resection or advancement is the preferred technique, [1-6]

In contrast, frontalis sling procedure is gold standard in treatment of sever blepharoptosis associated with poor levator function which suspends the eyelid with frontalis muscle to achieve elevation .[6,7]

Variety of material and techniques have been described for frontalis sling including autologous fascia lata, banked allograft fascia lata multiple types of synthetic material has been used for suspensionincluding (Polyester,polypropylene,expanded polytetrafluoroethylene (e-PTFE) and silicon rod).[6,7]

Silicone rod can be regarded as one of the best options for frontalis suspension surgery. Because of its biocompatibility and flexibility its widely used, Its smoother blinking and moderate elasticity provides good support and easier adjustment intraoperatively and post operative, simple removal or adjustment if revision needed ,silicon rods doesn't require additional surgical donor site ,with reducing the risk of pain, scarring and other donor site complications with reducing operation time. All these advantages of silicon rod make it suitable option for frontalis suspension sling surgry.[7-10]

To our knowledge this thesis has not been done in our region (Kurdistan- Iraq).Weaimed to evaluate the effect of using silicon rod as a frontal suspension sling in treatment of moderate to severe congenital blepharoptosis using pentagon technique.

Patients and methods

This is prospective uncontrolled clinical trial performed to evaluate the effect of silicon rod as a frontal suspension sling in the treatment moderate to severe congenital blepharoptosis at Rizgary teaching hospital in Erbil city, Kurdistan region -Iraq from April 2024 to October 2025. Patients with moderate to severe congenital blepharoptosis older than 3 years were included and also revision cases of moderate to severe congenital ptosis who underwent levator advancement operation still have poor levator function were included, totally 15 patients (20 eyes) of both gender (ten male and five female) undertook frontalis sling operation using silicon rod in pentagon design. Ten of them with unilateral and five of them with bilateral ptosis. All the operations performed by single surgeon, the same type of silicon rods (Aurosling) which its designed composed of flexible silicon rod of 40cm length ,7mm sleeve and two minimal invasive malleable needles (length 6.3cm and diameter 0,92 mm) has been used for all of patients.

In preop evaluation of patients, the type and severity of blepharoptosis have been diagnosed clinically from history and examination. MRD1, levator function, frontalis excursion, palpebral fissure height and bells phenomena have been checked and recorded, all the patients sent for ophthalmological consultation for checking visual field and visual acuity test. Exclusion criteria includes the patients with confirmed allergic reaction to silicon rods, those with poor frontalis muscle function or previous preorbital trauma or burn, those with psychologically unstable . Post op complications have been discussed with patients in detail and writing consent obtained from all the patients themselves or their guardian

FIG .1 . Silicon suspension set

Surgical techniques:

According to patients age, operation can be performed under local or general anesthesia, after marking and injection of lidocaine 2%mixed with 1:100 000 epinephrine to the incision sites. [4] Corneoscleral shield has been inserted. Five very small horizontal

incision was made using five fox pentagon fashion. The two upper eyelid incision lies 3mm away from upper eyelid margin in a line with temporal and nasal limbus.[4,10] The other three incisions lies above eye brow central one lies 1cm above eye brow in line with patients pupil ,the other two incision lies with highest brow hair slightly medial and lateral to eyelid incision using No 15 blade ,[4,7,10] Blunt dissection done in the upper most central incision to make a pocket for silicon insertion ,The lid plate will be used for protection,[10,11] then pre attached needle of silicone rods first passed from medial to lateral eyelid incision below orbicularis fiber above tarsus then its passed toward medial and lateral brow incisions and then to central brow incision(as shown in Fig.2.E.F.G).[4,11] And then the rod will be secured by sleeve which provided with suspension set .The silicon rod tension with position of sleeve adjusted until eyelid height reaches the superior limbus(as shown in Fig 2.H.I).[4,10]Then secured again(rod and sleeve) by using 6-0 polypropylene suture.[4,7] Excess silicon rod trimmed with preserving 2 to 3 mm of it and buried in superior central pocket ,then subcutaneous tissue is sutured using vicryle 6-0 and skin incisions sutured using polypropylene 6-0 suture,[4,10] frost suture was applied in all the patients for 24 hours (as shown in FIG.2.J.K.L).[10.11]
In post operative care all the patients received TobraDex eye drops for 5 days only, and artificial tear drops and ointment at night for 2 months. The patients visited our hospital at 1week,1 month ,6 months ,1 year. In each visit MRD1, palpebral fissure height, lid contour and corneal conditions were checked.[4,7]

Ethical Approval: Ethical approval for this study was obtained from the Research Protocol Ethics Committee of the Kurdistan Board of Medical Specialties (KBMS), Ministry of Higher Education and Scientific Research, Kurdistan Region, Iraq. Written informed consent was obtained from all participants or their legal guardians before enrollment.

Fig 2 :Showing steps of operation(**A**.Infiltration of local anesthesia ,**B.**cornescleral sheild insertion,**C**.Making incisions,**D**.Dissection for making submuscular pocket **,E,F,G.**Insertion of silicon rod from medial to lateral eyelid incisions then to medial and lateral brow incisions and lastly central brow incisions**,H.** Adjusting eyelid height

I,fixing the rod with sleeve **,J.**Trimming excesof silicon rod ,**K**.buried in submuscular pocket,**K.**Final result **,L**.Frost suture)

Results

A total of 15 patients (20 eyes) with moderate to severe congenital blepharoptosis underwent frontalis suspension using a silicone rod and were followed for 1 year. The ages of the patients ranged from 3 to 54 years. The mean age of the participants was 19.7 ± 5.2 years. Out of the 15 patients, 10 (66.7%) were male, and 5 (33.3%) were female. Ten patients had unilateral ptosis, and five had bilateral. 90 % of the operated eyes were suffering from severe ptosis. Most eyes (93.3%) had positive Bell's phenomenon, and four patients (26.7%) had previous levator advancement surgery. Details are shown in the table. 1

Table 1. The patient's characteristics (no of eyes = 20)

Variable		**No (%)**
Sex	Male	10 (66.7)
	Female	5 (33.3)
Unilateral/ bilateral	Unilateral ptosis	10 (66.7)
	Bilateral ptosis	5 (33.3)
Degree of ptosis*	Mild	0 (0.0)
	Moderate	2 (10.0)
	Severe	18 (90.0)
Previous levator surgery	Yes	4 (26.7)
	No	11 (73.3)
Bell's phenomenon	Positive	14 (93.3)
	Negative	1 (6.7)

* Degree of ptosis assessed according to MRDI: distance of superior lid margin to corneal light reflex. Normal MRD1 (4-5mm), good when MRD1 was ≥3.0 mm, moderate (fair)when MRD1 < 3 and ≥ 2 mm and poor when MRD1 was <2.0 mm.

After 1yearof follow-up a significant improvement in eyelid position following surgical intervention. The Marginal Reflex Distance 1 (MRD1) increased from a mean of 0.25 mm (±1.02) pre-operatively to 2.75 mm (±1.38) post-operatively, with a paired t-test value of 9.18 and a p-value of < 0.001, indicating a highly significant improvement. Similarly, the palpebral fissure height rose from a mean of 4.25 mm (±1.56) to 10.20 mm (±3.18), supported by a t-test value of 10.62 and a p-value of < 0.001, further confirming the effectiveness of the surgical procedure. These results underscore the positive impact of the surgery on both functional and aesthetic outcomes in patients with ptosis. Details are shown in Table 2.

Table 2 Comparison of preoperative and postoperative MRD1 and palpebral fissure height (n = 20 eyes)

Variable	Pre-op Mean ± SD	Post-op Mean ± SD	p-value
MRD1 (mm)	0.25 ± 1.02	2.75 ± 1.38	< 0.001
Palpebral fissure height (mm)	4.25 ± 1.56	10.20 ± 3.18	< 0.001
Levator function (mm) *	3.7 ± 1.8		
Frontalis excursion (mm) **	10.6 ± 0.92		

*Levator function and frontalis excursion have been measured post-operatively, but there is no significant change in their measurement.

The postoperative outcomes were categorized according to MRD1 at 1year . 70.0% of eyes (14 eyes) achieved good correction. A statistically significant improvement was observed in post operative outcomes, with a significantly greater proportion of eyes achieving good postoperative correction compared with moderate and poor outcomes' p- value was 0.005. details are shown in Table 3.

Table 3. Postoperative MRD1 outcome grading at 1 years

Post-operative MDR1 categories	NO (%)	p-value (with Fishers exact test)
Good (≥ 3.0 mm)	14 (70.0)	0.005
Moderate (2-3mm)	4 (20.0)	0.005
Poor (< 2 mm)	2 (10.0)	0.005
Total	20 (100.0)	

Out of the 20 operated eyes complications were assessed during the follow-up period. Under-correction was the most reported complication 15.0 %, followed by silicone rod rupture occurred in two eyes 10.0%, and infection has been occurred in a single. Over correction has been reported in all cases in first two months postoperatively followed by a return to neutral alignment. Details are shown in Table 4.

Table 4. Postoperative complications of operated patients (n = 20 eyes)

Complication	No (%)
Under-correction	3 (15.0)
Silicone rod rupture	2 (10.0)
Infection	1 (5.0)

Exposure keratopathy	0 (0.0)
Overcorrection	0 (0.0)
Total	4 (20.0)

Patient satisfaction was assessed at the end of the 1-year follow-up period using 3-point Likert scale.More than the half of the patients were satisfied with the surgical outcome, while one-third were poorly satisfied. Details are shown in Table 5

Table 5 Patient satisfaction at 1 year (n = 15 patients)

Satisfaction level	No (%)
Highly satisfied	7 (46.7)
Satisfied	3 (20.0)
Poorly satisfied	5 (33.3)
Total	15 (100.0)

Discussion

The present prospective clinical study evaluated the effectiveness of frontalis suspension using silicone rod in the management of moderate to severe congenital blepharoptosis, including revision cases after previous levator advancement, at Rizgary Teaching Hospital, Erbil, Iraq. Fifteen patients (20 eyes) were followed for 1year after surgery. The present study demonstrated significant postoperative improvement in eyelid position. Mean marginal reflex distance 1 (MRD1) improved from 0.25 ± 1.02 mm preoperatively to 2.75 ± 1.38 mm postoperatively, while mean palpebral fissure height increased from 4.25 ± 1.56 mm to 10.20 ± 3.18 mm. Functional success, defined as postoperative MRD1 ≥ 2 mm, was achieved in 90.0% of eyes. In addition, 70.0% of eyes achieved good postoperative correction, 20.0% moderate correction, and 10.0% poor outcome. These findings indicate that silicone rod frontalis suspension is an effective method for the treatment of moderate to severe congenital ptosis with poor levator function, including revision cases.[13–15]

Frontalis suspension remains the preferred surgical procedure in severe congenital ptosis when levator function is poor and the levator palpebrae superioris muscle cannot provide adequate eyelid elevation. In such patients, eyelid elevation is transferred to the frontalis muscle. Silicone rod has gained increasing popularity because of its elasticity, adjustability, reversibility, relatively easy implantation, and the possibility of postoperative adjustment. These advantages are particularly relevant in pediatric patients and in revision cases, where tissue scarring from previous surgery may make levator-based procedures less predictable.[14–16]

The degree of postoperative improvement observed in the present study is comparable with recent international literature. In a large contemporary series, Landau Prat et al. evaluated 174 consecutive cases of congenital ptosis treated with silicone sling frontalis suspension and reported a mean postoperative MRD1 of 2.1 mm, with favorable outcomes in approximately two-thirds of patients.[15] The final mean postoperative MRD1 in the present study was slightly higher (2.75 mm). This difference may be related to differences in sample size, preoperative severity, age distribution, surgical technique, and follow-up duration. Nevertheless, both studies support the effectiveness of silicone rod suspension as a reliable treatment option in congenital ptosis.

The functional success rate observed in the present study (90.0%) is also comparable with recent evidence. Mukherjee et al. from India evaluated frontalis suspension using silicone rods in ptosis patients with poor Bell's phenomenon and reported satisfactory functional improvement in most patients, although postoperative lagophthalmos required careful monitoring.[16] Their findings are clinically relevant because patients with reduced protective ocular mechanisms may be more prone to exposure-related complications. In the present study, most patients had positive Bell's phenomenon, and no serious corneal complications were observed during follow-up. This may partly explain the favorable postoperative functional results.

A systematic review by Pacella et al. from Italy assessed suspensory materials used in ptosis surgery and concluded that silicone rod remains one of the most practical and versatile sling materials because of its adjustability, availability, and favorable safety profile.[17] The authors noted that although fascia lata remains an important option, silicone rod offers important advantages in younger children and in revision procedures where donor-site morbidity or previous surgery may complicate management. These observations support the surgical choice adopted in the present study.

Similarly, Vyas et al. from the United States reviewed frontalis sling procedures for congenital ptosis and emphasized that silicone rod provides acceptable functional and cosmetic outcomes with simplified surgical handling.[18] They also noted that frontalis suspension is especially useful in cases of poor levator function and in situations where levator surgery has previously failed. This is directly relevant to the present study, which included revision cases after levator advancement.

Recent studies evaluating other sling materials also provide useful comparative context. Ghiam et al. from the United States evaluated expanded polytetrafluoroethylene (ePTFE) frontalis sling in congenital ptosis and demonstrated satisfactory postoperative eyelid elevation with acceptable complication rates.[19] Although the material differs from silicone rod, the study supports the broader principle that frontalis suspension remains effective in congenital ptosis with poor levator function. Compared with ePTFE, silicone rod may offer greater elasticity and easier postoperative adjustment.

A recent study from Egypt by Abdelaziz MA et al reported favorable outcomes after silicone sling frontalis suspension with significant postoperative improvement in MRD1 and acceptable cosmetic results.[20] The authors emphasized that meticulous fixation and appropriate sling tension are important determinants of postoperative stability and long-term durability. These observations are consistent with the present study, in which standardized surgical technique and intraoperative tension adjustment were used in all cases.

Regional literature from South Asia and the Middle East has also demonstrated that silicone rod frontalis suspension is a reliable option in congenital ptosis. Recent reports from India and neighboring countries have consistently shown significant postoperative eyelid elevation, improvement in visual axis exposure, and acceptable complication rates.[16,20,21] These findings suggest that the present results from Erbil are consistent with regional experience.

From the Iraqi perspective, published studies specifically evaluating silicone rod frontalis suspension remain limited. Most available local studies have addressed congenital ptosis surgery in general or have focused on fascia lata and alternative sling materials. However, available Iraqi ophthalmic experience supports frontalis suspension as the principal treatment for severe congenital ptosis with poor levator function. Therefore, the present study contributes useful local evidence from Erbil and adds regional data regarding the use of silicone rod in both primary and revision congenital ptosis surgery.[20]

Postoperative complications in the present study were limited. Silicone rod rupture occurred in two eyes (10.0%), both approximately six months after surgery. These two eyes represented the poor outcome group. Recurrence and sling-related failure are recognized limitations of silicone rod frontalis suspension. Recent reports have shown that recurrence may occur because of material fatigue, slippage, migration, loss of elasticity, or inadequate fixation.[17,20,23] The complication rate observed in the present study is acceptable and falls within the range reported in recent literature.

Patient satisfaction in the present study showed that 46.7% of patients were well satisfied, 20.0% were neutral, and 33.3% were poorly satisfied. Satisfaction after ptosis surgery depends not only on eyelid height but also on eyelid contour, symmetry, blink dynamics, scar visibility, and patient expectations. This is particularly relevant in unilateral ptosis, where perfect symmetry is difficult to achieve. Recent literature has similarly shown that anatomical success does not always completely correlate with subjective cosmetic satisfaction.[15,18,21]

Several factors may explain the favorable outcomes observed in the present study. First, all operations were performed by a single surgeon using the same silicone suspension system and the same Fox pentagon design, which minimized technical variability. Second, most patients had preserved frontalis excursion and positive Bell's phenomenon, both recognized favorable prognostic factors. Third, standardized postoperative follow-up allowed early recognition of complications and objective assessment of eyelid position over time.

The present study has several limitations. The sample size was relatively small, which limits generalizability. The study was uncontrolled and lacked direct comparison with other suspension materials such as autogenous fascia lata or expanded polytetrafluoroethylene. In addition, although the follow-up period of 1 year was sufficient for intermediate-term assessment, longer follow-up would be valuable to determine long-term recurrence and durability of silicone rod suspension.

In conclusion, the present study demonstrates that frontalis suspension using silicone rod is a safe, practical, and effective surgical option for moderate to severe congenital blepharoptosis with poor levator function, including revision cases after failed levator advancement. Significant improvement in MRD1 and palpebral fissure height, high functional success, and acceptable complication rates were observed. These findings are broadly consistent with recent regional and international literature and support the use of silicone rod frontalis sling as a valuable technique in congenital ptosis surgery.

Conclusion

The present study demonstrated that frontalis suspension using silicone rod provided significant improvement in eyelid position and palpebral fissure height in patients with moderate to severe congenital ptosis. At 1.5 years of follow-up, 70% of eyes achieved good correction and 90% achieved functional success. Complications were limited mainly to silicone rod rupture in two eyes. Nearly half of the patients reported being well satisfied with the surgical outcome.

Recommendation

It is recommended to use frontalis sling (silicone rod) as the procedure of choice in the treatment of congenital ptosis

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