INTRODUCTION

Blepharoptosis is drooping of the upper eyelid, which may be congenital or acquired after birth. Correction of blepharoptosis is considered a challenge to oculoplastic surgeons. An ideal sling surgery should result in eyelids that are not deformed and are perfectly matched in all positions of gaze, normal blinking movement synchronous in the two eyes, eyelid folds that are of normal contour and are equal on both sides, eyelids that remain closed during sleep, and corneas that remain free of exposure keratitis. However, these results are less commonly seen, especially in sling surgery.

The role of sling surgery for ptosis correction is both therapeutic and cosmetic. Frontalis suspension is a surgical procedure that is performed to address myogenic and aponeurotic ptosis. It creates a link between the frontalis muscle and the tarsus of the upper eyelid.

RESULTS AND COMPLICATIONS OF SILICONE FRONTALIS SLING SURGERY FOR PTOSIS

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RESULTS

There were 38 eyes of 25 patients with ages ranging from 3 to 21 years (average: 10.68 ± 6.26 years). Of these 25 patients, 10 had blepharophimosis syndrome, 10 had congenital ptosis, 3 had third nerve palsy, 1 had double elevator palsy, and 1 had post-levator resection. Good cosmetic correction was achieved in 34 eyes (89.4%) after a mean follow-up of 18 months (range: 6 to 60 months). Complications observed included significant eyelid lag and lagophthalmos (5 eyes), undercorrection (4 eyes), suture granuloma (3 eyes), sling exposure at forehead incision (3 eyes), bilateral chronic eyelid edema (1 patient), and late recurrence of ptosis (1 eye).

CONCLUSIONS

Silicone is a safe material for frontalis suspension in patients with severe ptosis; however, recurrence, granuloma formation, sling exposure, and chronic inflammation can occur with use of silicone rod.

upper eyelid that improves ptosis. Eyelid elevation is then performed with the use of frontalis muscle. Frontalis suspension is indicated for severe ptosis (> 4 mm) with poor levator function (< 4 mm), Marcus–Gunn jaw-winking syndrome, blepharophimosis syndrome, ptosis associated with third nerve palsy, and an unsatisfactory result from previous levator resection.

Several materials have been used for frontalis sling surgery. Autologous or banked fascia lata is considered ideal for sling surgery because it has a long-lasting effect and functional success has been reported to be nearly 94%. Moreover, it has a low complication rate. However, there are difficulties in its harvesting and more time is required to recover from the leg wound and resultant postoperative scarring.

Several synthetic materials have become available in the armamentarium of the oculoplastic surgeons that include polypropylene monofilament nylon suture, Mersilene mesh (Ethicon, Somerville, NJ), GORE-TEX (W. L. Gore & Associates, Newark, DE), and silicone, which are being used more frequently compared to fascia lata. Use of these materials is not free from complications. We report our results and complications associated with the use of silicone rod (Aurosling, 0.92-mm diameter; Aurolab, Madurai, India).

**PATIENTS AND METHODS**

This is a retrospective observational cohort study of patients undergoing surgery from September 2008 to August 2013 by a single surgeon (RKB). All patients completed a minimum of 6 months of follow-up. Patients who had unilateral or bilateral severe ptosis of more than 4.00 mm and had levator function of less than 4.00 mm were included. Patients who had previous eyelid surgery other than levator resection, history of eyelid trauma, poor Bell’s phenomenon, and dry eye were excluded. In young children, parents were given the option of harvesting of fascia lata (banked fascia lata is not available), which was not accepted after the resultant scar was explained to them.

All patients underwent a complete eye examination in addition to ptosis work-up that included measurement of eyelid crease, palpebral fissure height (distance between the center of the upper and lower eyelid margins in primary gaze), levator muscle function, upper eyelid margin to corneal reflex distance (MRD 1), lower eyelid margin to corneal reflex distance (MRD 2), Bell’s phenomenon, and Marcus–Gunn jaw-winking syndrome. MRD 1 and eyelid fissure height were measured at each postoperative visit.

**Surgical Technique**

Surgery was performed under general anesthesia in patients 18 years and younger and under local anesthesia in patients older than 18 years. After placing the eyelid plate, two horizontal incisions of 2 mm in length were made in the upper eyelid, 2 to 3 mm above the lash line through the skin and pre-tarsal muscle down to the tarsus. The temporal incision was placed over the 3-o’clock position of the limbus and the nasal incision was placed over the 9-o’clock position of the limbus. Two incisions (2 mm in length) were made above the upper border of the eyebrow in the skin and the subcutaneous tissues to reach the frontal periosteum; a middle incision was placed 5 mm above the eyebrow. The distance between the medial and lateral incisions from the middle incision was equal to the distance between the two upper eyelid incisions.

The silicone rod was then inserted in the ptotic eyelid in a pentagonal fashion. With the eyelid plate in place, the ptosis knife was inserted into the lateral eyelid incision and removed from the medial eyelid incision, sewing the silicone sling through the incisions. The silicone rod was sutured to the tarsal plate with a non-absorbable 5-0 Dacron (Aurolab, Madurai, India) suture. The silicone sling was then pulled between the orbicularis oculi and levator palpebrae superioris muscle and removed at the eyebrow margin incisions. The silicone sling was finally removed through the upper middle eyebrow incision down to the periostium. The ends were secured with the silicone sleeve and the height of the eyelid adjusted at the superior limbus. The ends of the rod were cut short and buried deep under the frontalis muscle. Eyebrow skin incisions were closed with a 5-0 silk suture.

After completion of the procedure, moxifloxacin 0.5% eye ointment was applied to the cornea and a modified Frost suture was placed using a 5-0 silk suture for corneal protection. The Frost suture was removed after 24 hours. Nonsteroidal anti-inflammatory tablets or syrup was given to every patient for 5 days during the postoperative period. Patients were followed up at 1 day, 1, 3, and 6 weeks, and 3 and 6 months.
RESULTS

There were 38 eyes (13 bilateral and 12 unilateral) of 25 patients (19 males and 6 females) with ages ranging from 3 to 21 years (average: 10.68 ± 6.26 years). Of these 25 patients, 10 had blepharophimosis syndrome, 10 had congenital ptosis, 3 had third nerve palsy, 1 had double elevator palsy, and 1 had post-levator resection. Y-V plasty was performed in all cases of blepharophimosis syndrome before ptosis correction.

Adequate cosmetic correction was achieved in 34 eyes (89.4%) after a mean follow-up of 18 months (range: 6 to 60 months). Four eyes had undercorrection and one eye had late recurrence of ptosis due to slippage of sling under the orbicularis. A second surgery was performed for this patient, in which the old sling was replaced with a new sling.

Other complications noticed were significant eyelid lag and lagophthalmos in 5 eyes, suture granuloma at the forehead incision (Figure 1) in 3 eyes, sling exposure at the forehead incision (Figure 2) in 3 eyes, and bilateral chronic eyelid edema (Figure 3) in 1 patient.

DISCUSSION

Frontalis suspension is commonly used to correct blepharoptosis where blepharoptosis is severe (> 4.00 mm) and levator function is poor (< 4.00 mm). Several naturally occurring and synthetic materials have been used for this purpose. Silicone material appears to be a safe and effective method to restore eyelid elevation while preserving eyelid closure function. It has been used for the past 50 years for frontalis suspension. It was used as a band by Tillett and Tillett in 1966 and later replaced by a silicone rod with an 0.8-mm diameter by Rowan and Hayes in 1977. Leone et al. were the first to use it as a 1.0-mm rod in 1981. We used a silicone rod with a 0.92-mm diameter (Aurosling) in 38 eyes of 25 patients and achieved good cosmetic results in 34 eyes (89.4%). Four eyes had undercorrection and one eye developed late recurrence of ptosis. Carter et al. used a silicone rod in 61 eyes of 35 patients and found good to excellent eyelid height in 61 eyes, although revision was required in 4 eyelids (7%). Bernardini et al. used a silicone rod in 16 eyes of 10 patients with myogenic ptosis and achieved good cosmetic results in all of the eyes. Carter et al. reported recurrence of ptosis in 7% of the eyes, which required either replacement or revision for final outcome. One of 16 eyelids reported by Bernardini et al. also had undercorrection that required revision. Lee et al. compared the results of the silicone sling with fascia lata in 123 patients and found better cosmetic results in the silicone group after 3 years of follow-up. Recurrence of the ptosis up to 44% was reported by Ben Simon et al. because silicone does not integrate with the eyelid tissues and may slip through the tissues, leading to recurrence.

Other complications have been reported with the use of silicone rod. Eyelid lag and lagophthalmos are unavoidable complications of any sling surgery. Significant eyelid lag was noticed in 5 eyes and 1 eye developed exposure keratopathy. Carter et al. reported chronic exposure keratopathy in 15% of the eyes with inadequate Bell’s phenomenon.
Suture granuloma was seen at the central forehead incision in 3 eyes and at the eyelid incision in 1 eye, which were first treated with systemic antibiotics and anti-inflammatory agents; however, it required surgical excision in one case. Carter et al.\textsuperscript{31} reported lumps at the frontalis incision in 2 patients, most likely due to suture granuloma. Tillett and Tillett\textsuperscript{28} did not observe any infection or granuloma in any of their 6 patients.

Exposure of the silicone ends at the frontalis incision was seen in 3 eyes, requiring reopening of the frontalis incision and burying the ends deep in the frontalis. Carter et al.\textsuperscript{31} reported extrusion of sling at the forehead incision in 3 eyes of 2 patients (5%), requiring removal of the sling in all eyes.

Chronic eyelid edema was seen in one case, which persisted even after 4 weeks of sling surgery and did not resolve with systemic antibiotics and anti-inflammatory drugs. It was presumed to be due to allergy to the silicone material. The silicone sling was removed in this patient, leading to resolution of the eyelid edema. No such case has been reported in the literature. One case of non-tubercular infection was reported in a 65-year-old case of myopathy ptosis that occurred 2 years after the silicone frontalis suspension.\textsuperscript{35}

Various materials have been used for frontalis suspension. Autologous fascia lata\textsuperscript{4-7} has been used for more than 100 years and remains the tissue of choice for frontalis suspension because of its long-lasting effect and lower rate of complications; however, it was not used in our cases because the parents refused its harvesting when told about resultant scarring. To overcome this difficulty, even banked fascia lata has been used; however, long-term success of banked fascia lata decreases to 50% and there is also a risk of cross-infection.\textsuperscript{8-14} Other circumstances where use of fascia lata may be inappropriate include severe dry eye, lack of adequate Bell's phenomenon, and decreased corneal sensation.

Several synthetic materials have become available during the past 50 years and are used more frequently. Monofilament polypropylene\textsuperscript{15,16} and monofilament nylon\textsuperscript{16-18} have been used for temporary eyelid suspension to prevent amblyopia in young children. These sutures may have the disadvantage of breaking, leading to recurrence of ptosis in 25% to 69% of cases.

Mersilene mesh (polyester fibers) has been used extensively because it is readily available and has high tensile strength. It can act as a permanent scaffold and support fibrovascular growth. Use of Mersilene mesh has been associated with extrusion and granuloma formation at the brow skin incision site. Most of these cases required surgical intervention for removal of excess mesh, skin repair, and control of infection.\textsuperscript{19-25}

GORE-TEX is one of the most biologically and chemically inert materials. It is made of synthetic microporous polymer of 0.3-mm sheets and has been used for frontalis suspension. Recurrence rate is low with this material; however, its porous nature may allow bacterial contamination and lead to abscess formation.\textsuperscript{26,27}

Use of silicone rod has been found to be safe and has the advantage of it allows complete eyelid closure because of its elasticity and therefore may be useful in patients with poor Bell's phenomenon and dry eye; however, its use is not free from complications.

REFERENCES