Frontalis Suspension for Upper Eyelid Ptosis: Evaluation of Different Surgical Designs and Suture Material

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• PURPOSE: **To compare two sling designs (single loop or double pentagon) and a variety of suture material that was used in frontalis suspension surgery for correction of upper eyelid ptosis.**

• DESIGN: **Retrospective, nonrandomized, comparative interventional case series.**

• METHODS: **Medical record review of 99 patients (164 surgeries) who underwent frontalis suspension surgery for upper eyelid ptosis was conducted at the Jules Stein Eye Institute in 1996 to 2002. Functional and cosmetic success, margin reflex distance (MRD) and lagophthalmos were evaluated.**

• RESULTS: **MRD increased an average of 1.1 mm after the operation ($P < .001$). Ptosis recurrence was noticed in 42 cases (26%); polytetrafluoroethylene achieved the lowest recurrence rate (15%), although not statistically significant. No difference in functional success, ptosis recurrence, or change in MRD was noticed between single loop and double pentagon design. A better cosmetic outcome was noted in cases in which nylon suture was used. Complications included four cases (2.4%) of overcorrection, three cases (1.8%) of suture infection (all in polytetrafluoroethylene), two cases of pyogenic granuloma (1.2%), and two cases (1.2%) of suture exposure.**

• CONCLUSION: **Frontalis suspension for upper eyelid ptosis resulted in 26% ptosis recurrence after a mean of 12 months from first surgery. Polytetrafluoroethylene showed the lowest incidence of ptosis recurrence. No statistically significant difference was found between different suture materials or loop shape that was used in the surgical technique. A better cosmetic outcome, as graded by different observers, was noted in cases in which a nylon sling was used. (Am J Ophthalmol 2005;140:877–885. © 2005 by Elsevier Inc. All rights reserved.)**

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FRONTALIS SUSPENSION IS A SURGICAL PROCEDURE that is performed to address myogenic ptosis. It creates a linkage between the frontalis muscle and the tarsus of the upper eyelid, which allows for a better eyelid position in primary gaze. Eyelid elevation is then performed with the use of the frontalis muscle.[1–3] Frontalis suspension is also used in cases of poor levator palpebrae superioris muscle function, neuromuscular diseases, and where linkage between the muscle and the eyelid is abnormal (such as Marcus Gunn jaw-winking phenomenon).[4,5]

Frontalis suspension surgery may use several surgical techniques and different sling materials.[6–9] Materials include autogenous or banked fascia lata and alloplastic materials that include chromic gut, collagen, polypropylene, silicone, stainless steel, silk, nylon monofilament, polyester and polytetrafluoroethylene (PTFE).[9–28] Autogenous fascia lata is considered more effective, with comparably low rates of recurrent ptosis and infections.[10,12–15,18,24]

Cosmetic issues that are raised with standard frontalis suspension surgery include scarring in young children,[11,12,18] unsatisfactory geometric tenting of the pretarsal and preseptal skin, obliteration of the eyelid crease, and a poor tarso-corneal interface noted with brow elevation and downgaze. These may be related to the choice of sling material and to the superficial location of the sling in the eyelid.[6] Several suture designs like single loop or double pentagon configurations were used for frontalis suspension surgery, with no apparent advantage of any single design.

The purpose of this study was to evaluate the functional and cosmetic success of frontalis suspension surgery by comparing two different sling designs (single loop and double pentagon) and the use of different suture material in a tertiary referral center over a period of 7 years.

MATERIAL AND METHODS

A RETROSPECTIVE MEDICAL RECORD REVIEW OF ALL PAtients who underwent frontalis suspension surgery for

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upper eyelid ptosis between January 1996 and December 2002 was performed. The data that were retrieved included age, gender, diagnosis, type of surgery, preoperative and postoperative digital or Polaroid photographs, visual acuity, margin reflex distance (MRD), lagophthalmos, and related complications. Patients were examined 1 day, 1 week, 1, 3, 6, and 12 months after the operation and every year thereafter. All surgeries were performed by two of the authors (R.A.G., J.D.M.). The study complies with the policies of the local Institutional Review Board.

Functional success was defined as improved eyelid position above the pupillary margin with good (>50%) linkage between the frontalis muscle and the upper eyelid, no ptosis recurrence during the follow-up period, and no severe complications such as suture exposure or infection. Linkage is measured by manual elevation of the eyebrow on the operated side and measurement of motility of the upper eyelid along with eyebrow elevation. If manual eyebrow elevation results in similar eyelid elevation, then 100% linkage was achieved with surgery. If only one half of the elevation is noticed in the eyelid, then 50% linkage was achieved with surgery.

Cosmetic outcome was graded on a 0 to 2 scale, with 0 score indicative of excellent results, 1 as good, and 2 as poor. Outcome was defined as excellent if the eyelids were within 1-mm height between the eyelids with an acceptable crease and contour, good if there was >1-mm difference in eyelid height and/or asymmetric crease, and poor if there was a poorly defined eyelid crease and contour asymmetry.[29] All pre- and postoperative photographs were reviewed and scored by three independent masked observers; all three observers were blinded to the score that was given by the other observers. Correlations in grading of each observer were calculated. The first observer was a fourth-year medical student; the second observer was not from the medical field, and the third observer was a fellow in ophthalmic plastic surgery. Interobserver agreement was calculated. All patients underwent cosmetic grading of outcome; however, only the autogenous fascia, PTFE, nylon, and silicone groups had the numbers to provide useful information.

• **SURGICAL TECHNIQUE[30]:** The upper eyelid was infiltrated with lidocaine 2% with 1:100,000 epinephrine. In children and adolescent patients, surgery was performed with general anesthesia; in adults, surgery was performed with monitored anesthesia care. An eyelid plate was used to prevent ocular trauma when the needles were passed.

A suture (alloplastic material or autogenous fascia-lata or temporalis) was passed in a closed cerclage-type fashion through skin entry by way of supralash or eyebrow incision. In cases of single loop design, two stab incision sites that were approximately 10 mm apart were marked 3 mm above the lash line that was centered over the area of desired maximal elevation; in cases of a double pentagon technique, one additional stab incision was made in the middle of the 2 previous incisions. A minor modification of eyelid stab incision was performed when eyelid crease incision had been used.

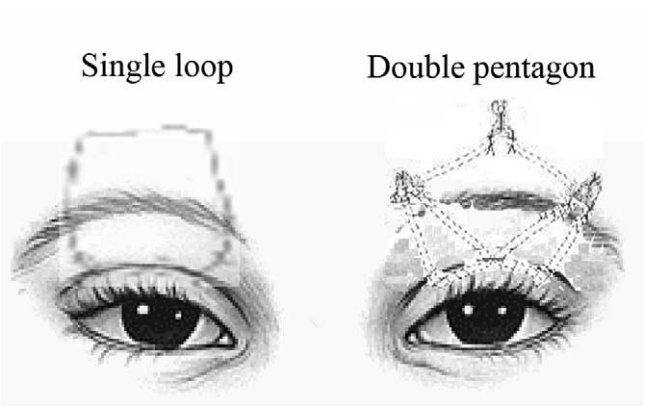

FIGURE 1. A line drawing shows the author placement of a "single loop" vs "double pentagon" sling design.

Another two stab incision sites were marked above the eyebrow, approximately in line with the lateral and medial canthi; additional stab incision sites were made above the eyebrow in the middle of the previous incisions in cases of double pentagon.

The path of the cerclage was marked out by the joining of the premarked incision sites. A free needle was dual threaded with sling material and a 4/0 Vicryl suture. It was then passed from one eyelid incision site towards the corresponding eyebrow exit site in a suborbicularis plane, with the globe protected by a lid plate. From this site, the needle was passed through the needle track to the adjacent eyebrow stab incision site and continued down towards the remaining eyelid incision site. The two ends of the suture were then maneuvered in a sawing fashion to release any skin dimpling at the eyebrow exit sites. The Vicryl suture was removed, and the sling suture was passed from one eyelid stab incision site to another (start-to-end point of the created cerclage) through a deep, partial thickness tarsal passage, with the eyelid everted to ensure no full-thickness penetration. Alternatively, when an eyelid crease incision was used, the sling material (alloplastic or autogenous fascia) was sutured to the superior 1/3 of the tarsus using 5/0 Vicryl suture on a spatulated needle. The two ends of the sling suture, which exited at one eyelid incision site, were tied and adjusted to achieve the desired eyelid elevation and contour. The incision sites were closed with a fast-absorbing gut suture.

In cases of double pentagon technique, additional incisions were made approximately 1 cm above the eyebrow. Between the three stab incisions, sling suture was passed with the use of a one-half circle free needle under the orbicularis muscle and tied in the superior eyebrow incisions when the desired lift was achieved. Figure 1 shows the various sling designs that were used in the current study.

Sling materials that were used included temporalis fascia or fascia lata, silicone, PTFE (Gore-Tex), nylon, nylon monofilament (Supramid), polypropylene (Prolene), polyester (Mersilene), and Silastic rod. Suture material was used according to the surgeon's preference.

• **STATISTICAL ANALYSIS:** Statistical analysis was performed with the independent samples *t* test to evaluate pre- and postoperative data such as visual acuity, MRD, and lagophthalmos measurements. One sample *t* test was used to evaluate change in these variables by the calculation of delta values. Independent samples *t* test was used to compare variables between patients who required reoperation to patients who underwent a single successful surgery. Chi-squared nonparametric test was used to evaluate different sutures materials and suture shape on surgical success or reoperation rate. One-way analysis of variance (ANOVA) was used to evaluate different suture material on changes in MRD and lagophthalmos. Kaplan-Meier survival analysis was used to calculate cumulative survival in patients until failure or reoperation. Binary logistic regression was used to calculate the odds ratio for surgical failure. Pearson bivariate correlation was used to examine the similarity of scoring between three independent masked observers in esthetic outcome. We realize that we use an arbitrary 0 to 2 scale, but we assume the change in each point in the 0 to 2 scale is equivalent (that is, change from 0 to 1 is equal to change from 1 to 2). If these assumptions are not met, then the probability values are approximate. Statistical analysis was performed with Microsoft Excel 2003 (Microsoft Corporation, Redmond, Washington, USA) and SPSS (version 13.0; SPSS Inc, Chicago, Illinois, USA) programs. Conversion of Snellen acuity to logarithm of the minimum angle of resolution values was performed.

RESULTS

NINETY-NINE PATIENTS WERE OPERATED FOR UPPER EYELIDS ptosis by frontalis suspension surgery; 55 patients had bilateral surgery, and overall 164 surgeries were performed. Demographics of the study population are summarized in Table 1. Mean follow-up time was 20 months (range, 6 months to 9 years); patients with silicone or autogenous fascia had an average longer follow-up time than patients with PTFE or nylon sutures ($P = .001$, one-way ANOVA).

Autogenous fascia (temporalis or lata) was used to link upper eyelid to frontalis muscle in approximately 50% of the cases, and different alloplastic materials were used in the remainder (Table 1).

In all patients, MRD increased an average of 1.1 ± 1.7 mm, from a mean preoperative value of 0.1 ± 1.4 mm to 1.1 ± 1.4 mm after the operation ($P < .001$, one sample *t* test). Lagophthalmos measurements did not change after surgery by the final follow-up visit (Table 2).

TABLE 1. Demographics of Study Population, 99 Patients (164 Eyelids) Who Underwent Frontalis Suspension Surgery at the Jules Stein Eye Institute, 1996–2002

Variable	Cases (n)*
Gender (patients)	
Male	59 (60%)
Female	40 (40%)
Diagnosis	
Congenital	61 (37%)
Aponeurotic†	52 (32%)
Blepharophimosis	8 (5%)
Blepharospasm	8 (5%)
Oculofibrosis	4 (2.4%)
Myasthenia Gravis	4 (2.4%)
Other	27 (17%)
Neurogenic (10 cases)	
Mechanical/eyelid mass (7)	
Post-eyelid surgery (4)	
Traumatic (3)	
Combined mechanism (3)	
Surgery	
Alloplastic material	83 (51%)
Fascia (frontalis/lata)	81 (49%)
Incision type	
Stab	74 (45%)
Eyelid crease	84 (51%)
Suture material	
Silicone	27 (16.5%)
Fascia (frontalis/lata)	79 (48.2%)
PTFE	27 (16.5%)
Nylon	20 (12.2%)
Silastic rods	7 (4.3%)
Other	4 (2.4%)
Suture shape	
Single loop	129 (79%)
Double pentagon	32 (20%)

The mean age of the patients was 34 ± 28 years.

*When numbers in each category do not add to total number of cases, missing system could not be retrieved from the medical record.

†Patients with aponeurotic ptosis underwent frontalis suspension surgery only when they had poor levator function.

Most patients experienced good linkage between the frontalis muscle and upper eyelid after the operation (measured by manual elevation of the eyebrow on the operated side and by motility of the upper eyelid along with eyebrow elevation); no statistical difference was found between cases that were operated with single loop versus double pentagon or cases in which alloplastic material was used vs autogenous fascia.

Ptosis recurrence was recorded in 42 cases (25.6%) after a mean 12 ± 15 months from first surgery; 26 of these eyelids were reoperated. Cumulative survival is shown in Figure 2. Time to recurrence was not equal between materials (silicone, 13 months; autogenous fascia, 12.2 months; nylon, 16.5 months; PTFE, 3.8 months; and Silastic rods, 6 months), but

TABLE 2. Pre- and Postoperative Data in 164 Cases Operated for Upper Eyelid Ptosis by Frontalis Suspension at the Jules Stein Eye Institute 1996–2002

Data	Preoperative	Postoperative	P Value*
Visual acuity	20/30	20/30	
MRD (mm)	0.1 ± 1.4	1.1 ± 1.4	<.001
Lagophthalmos (mm)	0.5 ± 1.0	0.5 ± 0.9	NS
Chin-up head posture	32 (20%)	6 (3.7%)	
Strabismus	59 (36%)		
Ptosis recurrence†		42/164 (26%)	
Cosmetic outcome‡		0.7 ± 0.5	
Linkage§		78% ± 22%	
Follow up (mo)	20 ± 22 (6 mo–9 y)‖		

MRD = margin reflex distance, distance between the upper eyelid margin and the pupillary light reflex (measured in millimeters), NS = not significant.

*Delta change was calculated for visual acuity, MRD and lagophthalmos; one samples *t* test was used to calculate significance.

†Defined as poor surgical outcome with upper eyelid at or below pupillary light reflex (unchanged or worse from pre-operative status).

‡Graded on a scale of 0–2, with 0 being excellent results, 1 good results, and 2 poor outcome; cosmetic outcome was evaluated by three independent masked observers.

§Linkage was evaluated between frontalis muscle and upper eyelid, in percentage.

‖Data in parentheses represent the range.

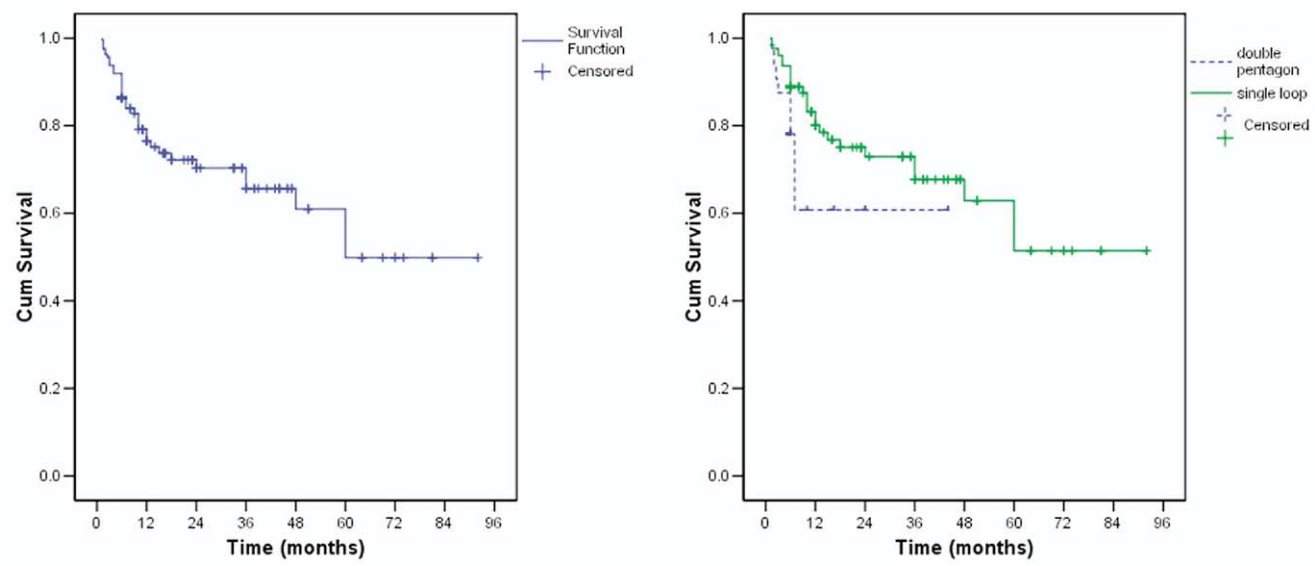

FIGURE 2. Cumulative survival plot (Kaplan-Meier) for 99 patients (164 cases) who underwent frontalis suspension surgery for upper eyelid ptosis at the Jules Stein Eye Institute, 1996 to 2002. (Left chart) All patients; (right chart) single loop vs double pentagon. Event was defined as ptosis recurrence or reoperation.

the difference was not statistically significant ($P = .6$, one-way ANOVA). Patients with ptosis recurrence had similar preoperative diagnoses to successful cases, but two cases of ocular fibrosis resulted in poor surgical outcome, even after multiple operations. A single loop was used in 32 cases (76.2%); the double pentagon was used in nine cases (21.4%), which was not significantly different from successful cases ($P = .2$, χ^2). The findings are also shown in survival plots (Figure 2).

Patients who underwent surgery with a single loop achieved similar MRD change as did those patients who underwent surgery with the double pentagon sling (1.2 and 0.9 mm, respectively; $P = .5$) and displayed a reduced precipitation of lagophthalmos after surgery (0.2 mm vs 0.64 mm; $P = .04$, independent samples *t* test). However, because autogenous fascia was the most common material to be used in single loop design (60%) and PTFE was the most common material to be used in double pentagon

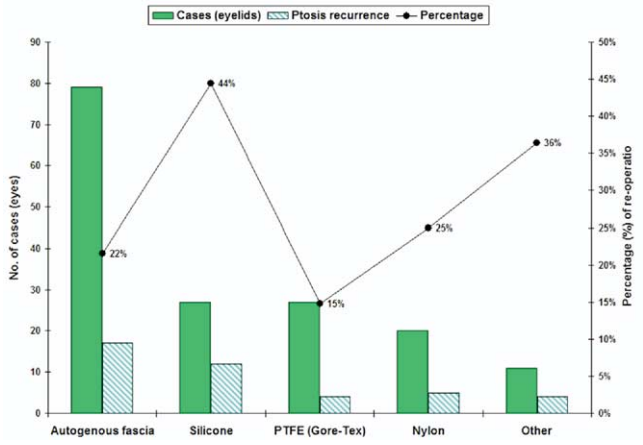

FIGURE 3. Ptosis recurrence rate according to different suture materials. PTFE achieved the lowest recurrence rate (15%); silicone and other materials had 44% and 36% recurrence rate, which was not statistically significant (χ^2).

design (80%), comparison between different suture designs may not be accurate.

PTFE achieved the lowest percentage of ptosis recurrence (15%) as compared with silicone or other materials (30%; Figure 3); the difference between groups was not statistically significant ($P = .13$, χ^2), and the same was noted when all alloplastic materials were compared vs autogenous fascia ($P = .33$, χ^2). Suture material did not influence outcome in MRD or lagophthalmos after surgery ($P = .3$ and $P = .06$, respectively, one-way ANOVA).

The odds ratio for ptosis recurrence was calculated with the use of binary-logistic regression. Age, gender, preoperative head posture, strabismus, surgery, material, delta MRD, or delta lagophthalmos have not influenced the probability for failure in regression equation.

Cosmetic outcome was graded on a scale from 0 to 2, with 0 being an excellent result, 1 being good, and 2 being poor by three independent masked observers. Positive correlation was noticed between observer 1 and 2 ($r = 0.34$; $P = .01$), observers 1 and 3 ($r = 0.37$; $P = .005$) and observers 2 and 3 ($r = 0.67$; $P < .001$). Most patients achieved good cosmetic outcome, with a mean score of 0.7 $\pm$ 0.5 on a 0 to 2 scale (0 = excellent; 1 = good, and 2 = poor). Similar outcome was noticed with different suture designs (single loop or double pentagon; $P = .9$, independent samples t test) and with alloplastic materials or autogenous fascia ($P = .4$). Nylon suture achieved the best score (mean, 0.88), and silicone achieved the lowest score (mean, 1.88; $P = .04$). Chi-squared analysis resulted in the same comparison between groups with a probability value of .01. Clinical photographs of cosmetic outcome are presented in Figures 4 through 6.

Similar functional outcome and ptosis recurrence was found for autogenous fascia and alloplastic materials, even when we included only cases of congenital ptosis ($P = .5$, χ^2 analysis); similarly, no difference was noted with the use

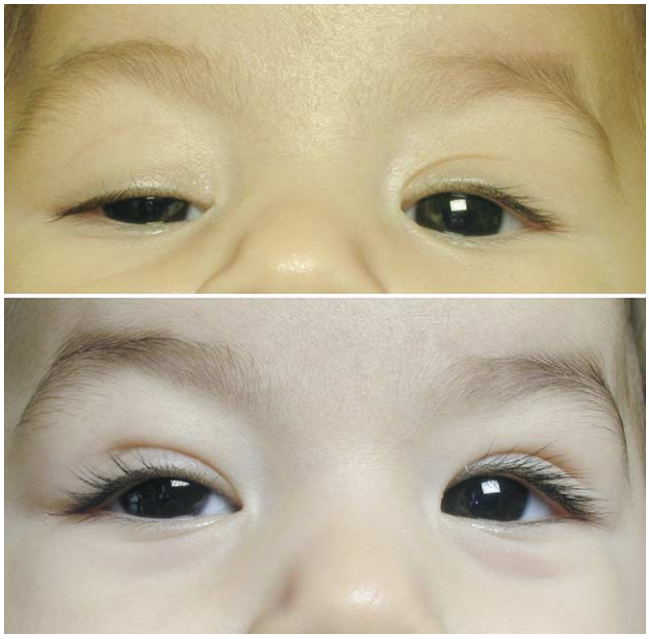

FIGURE 4. Pre- and postoperative clinical photographs of a patient with excellent functional and esthetic outcome. (Top) A 1-year-old boy with congenital ptosis oculus dexter and 3 months after frontalis suspension right side (bottom).

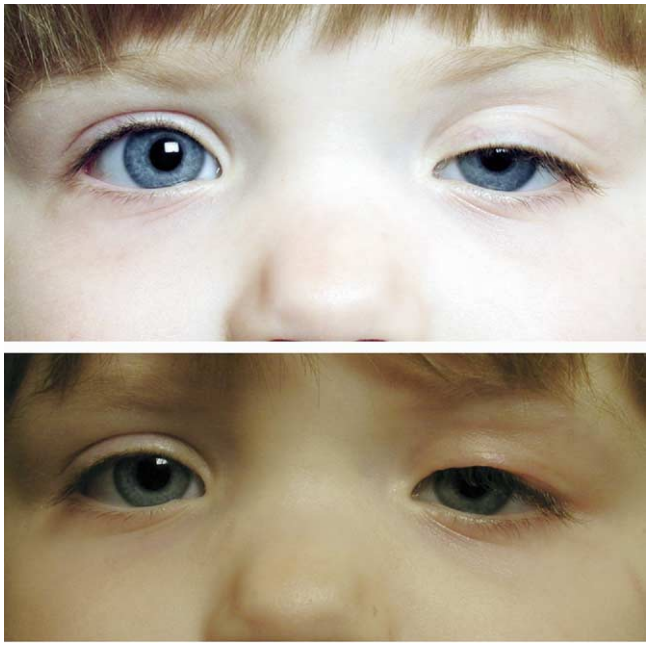

FIGURE 5. Pre- and postoperative clinical photographs of a patient with poor cosmetic outcome. (Top) A 3-year-old boy with congenital ptosis oculus sinister and 4 months after frontalis suspension left side (bottom). Although good functional outcome with surgical success, cosmetic outcome was graded as good or poor because of lid crease asymmetry and over-hanging eyelid skin left side.

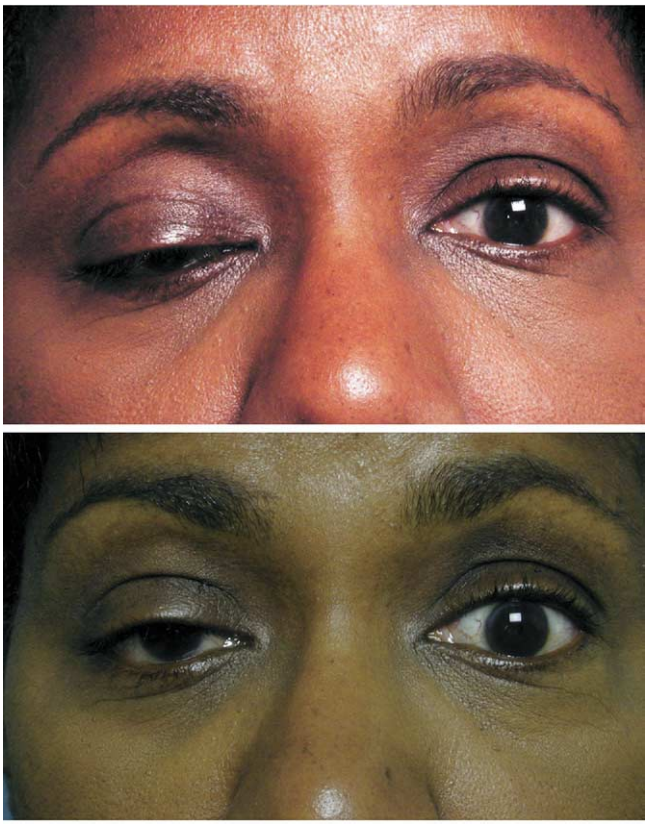

FIGURE 6. Pre- (top) and postoperative (bottom) clinical photographs of a patient with good surgical outcome. A 50-year-old woman 1 year after frontalis suspension right side, note eyelid position and contour asymmetry; cosmetic outcome was graded as good.

of single loop vs double pentagon design in this group of patients.

Functional and cosmetic outcomes were similar when eyelid crease incision or stab incision were used; however, suture infection was more common in stab incision (3 vs 0), and over-correction was more common in eyelid crease incision (3 vs 1; $P = .045$, χ^2 analysis).

Complications included four cases (2.4%) of over-correction (defined in relation to the limbus and eyelid asymmetry with or without punctate keratopathy) who underwent successful adjustment at a later stage. One case displayed upper eyelid entropion that developed after surgery, which was surgically treated with medial suture release. Three cases (1.8%), including one bilateral surgery, resulted in presumed suture infection. In all of these cases, PTFE suture was used; one of the cases evolved to preseptal cellulitis and required systemic antibiotics. Suture exposure was noticed in two cases (1.2%) in which silicone and nylon sutures were used. All cases of presumed suture infection or suture exposure required suture removal (culture was obtained in one case and showed *Staphylococcus aureus*). Pyogenic granuloma developed in two cases in which silicone was used to engage the frontalis fascia; surgical treatment was required. Pyogenic granuloma was diagnosed clinically, and there was no pathologic confirmation. An 8-year-old girl with oculofibrosis syndrome who was operated three times experienced severe exposure keratopathy with corneal opacity and neovascularization.

DISCUSSION

FRONTALIS SUSPENSION SURGERY FOR UPPER EYELID PTOSIS resulted in good functional and cosmetic outcome, with a recurrence rate of 26% noted during a follow-up period of 20 months (Figure 3). Patients who underwent frontalis suspension with silicone or autogenous fascia had longer follow-up period (32 and 21 months, respectively), as compared with patients who were operated with other alloplastic materials (11 months; $P < .005$, one-way ANOVA). Similar success rates were achieved with different suture materials, which included autogenous fascia or alloplastic material; and no apparent difference was noticed in the use of single loop or double pentagon sling techniques (Figure 3). Patients achieved good cosmetic outcome at the end of follow-up time; nylon suture displayed a more favorable outcome as compared with other material.

In recent years, many studies have tried to evaluate the functional success of various sling materials in frontalis suspension surgery. Autogenous fascia has been considered to result in lower ptosis recurrence and lower complications rate and therefore has been considered the material of choice.[11–13,16,24] Recurrence rates after frontalis suspension vary and are reported to be between 0% and 100%; PTFE and autogenous fascia have the lowest recurrence rate, reported to be between 4% and 20%, and nylon or silicone have reported recurrence rates between 40% and 100% (Table 3). We believe that suture material serves as a temporary skeleton for scar formation by local inflammation. Scar tissue and not the sling material may be the actual bridge between frontalis muscle and the eyelid; therefore, no difference is anticipated between different suture materials as long as they remain in good position during the inflammation and scarring process. This may be true in our patient population who were mostly young adults but may be inaccurate for the pediatric population; our conclusions, therefore, may not apply to cases of isolated congenital ptosis. This, however, was not examined in the current study and merely represents our opinion. Furthermore, a longer follow-up period is required to compare the longevity of different suture materials.

Ptosis recurrence is a severe problem that evolves after surgery; many investigators believe that eventually all cases of congenital ptosis that are treated with frontalis suspension will recur. This is evident from a higher recurrence rate published in studies with longer follow-up periods, regardless of suture material (range, 7% to

TABLE 3. Previously Published Data of Ptosis Recurrence After Frontalis Suspension Surgery With Different Suture Material and Comparison to Current Study

Variable	Study								
	Wasserman[12]	Liu[16]	Mehta[14]	Bajaj[28]	Esmaeli[23]	Carter[25]	Wilson[11]	Wagner[13]	Current
Eyes (n)	102	112	32	60	132	61	112	145	164
Follow-up time (mo)	24	84	29	16	120	22	86		20
Material: Ptosis recurrence/failure (%)									
Autogenous fascia	4%							8.3%	22%
Banked fascia	51%				28%		43%		
Nylon/nylon monofilament	69%	100%						40.5%	25%
Polyester/polyester	27%		23%–25%	7%					36%
PTFE	0%								15%
Polypropylene	12%								
Ethibond				17%					
Silicone						7%			44%

100%).[11,16,23,25] The survival analysis described by Wilson and Johnson[11] shows decreasing success of frontalis suspension with lyophilized human fascia lata with longer follow-up period, from 90% at 2 to 3 years after surgery to 50% at 8 and 9 years after surgery. In cases of congenital ptosis, parents and children should realize that the ptosis recurrence rate is high after surgery and that the patient is likely to have additional surgeries.

Histologic studies in rabbits have shown less inflammatory response with autologous fascia lata as compared with silicone and polypropylene; autogenous fascia was found to survive unchanged in living tissue with viable fibroblasts and normal collagen fiber arrangement. It has been postulated that autogenous fascia serves as a bridge for host fibroblasts and inflammatory cells that grow into the graft. Histopathologic studies in humans 42 years after frontalis suspension with autogenous fascia lata describe viable tissue, fibroblastic infiltration, and incorporation with surrounding tissue structure.[31] We would expect better biocompatibility of autogenous fascia in relation to alloplastic material.[32] However, despite the fact that autogenous fascia has better biocompatibility than alloplastic materials, similar functional and cosmetic outcomes may be achieved with alloplastic materials. Similar functional outcome and ptosis recurrence were found for autogenous fascia and alloplastic materials even when we included only cases of congenital ptosis.

An important goal of ptosis surgery is symmetric and natural-appearing cosmetic results. Tenting of pretarsal and preseptal skin, obliteration of eyelid crease, and pulling away of the upper eyelid from the globe with brow elevation may all influence cosmetic outcome.[6] The superficial location of the sling in the eyelid may result in poor outcome, and deeper placement of the sling behind the superior orbital rim may yield better cosmetic and functional results.[6] Other surgical modifications of suture placement or suture shape have been described to improve contour and crease.[6,33–36]

We analyzed cosmetic outcome on the basis of eyelid position, contour, and symmetry on a scale of 0 to 2, with 0 being excellent outcome and 2 indicating poor outcome. Three independent masked observers (including one lay observer) have graded the outcome for all patients on the basis of pre- and postoperative photographs. Positive agreement was noted between observers. Cosmetic improvement is of particular importance in young children with congenital ptosis at kindergarten or school age. Teacher or peer attitude towards a child with any kind of disability may be of great importance to the child's well-being.[37–40]

Common complications that are associated with frontalis suspension include early postoperative exposure keratopathy (15%), inflammation or pyogenic granuloma, suture infection with preseptal cellulitis, and suture exposure. Rates of each complication vary with different sling material and are reported to be 2% to 17% for suture granuloma, 3% to 7% for suture infection or preseptal cellulitis, and 5% to 17% for suture extrusion.[13–16,22,23,25] Higher rates of complications are associated with nylon monofilament and PTFE.[12,16] In the cases of extrusion or chronic infection, surgical excision of sling suture is required.[15] We had a relatively low rate of postoperative complications, with 2% pyogenic granuloma or suture infection (one was cultured and yielded *S aureus*), 1.2% of suture exposure, and 2.4% of over-correction. We believe that, in any case in which the sling material is inadvertently passed full-thickness through the eyelid to the conjunctival fornix, infection is more likely, even after the sling is repositioned to the correct anatomic plane. Preoperative irrigation of the conjunctival fornices with diluted iodine may be warranted in frontalis suspension surgery to prevent suture infection. Others believe that skin flora is the source of these infections and recommend closing all skin wounds or burying the knots deeper, both to avoid exposure and as a wick for skin flora infection.

Pitfalls of the current study stem from its retrospective design. The study presents data on different groups of

patients with an average age of 34 years and on 61 cases of congenital ptosis. Older patients may represent different ptosis pathologic conditions and different surgical cases, but comparative statistical analysis was applied to the group as a whole. We had a mean follow-up period of 20 months; most likely a longer follow-up period would have changed the results of functional success and ptosis recurrence or postoperative complications. Patients with silicone or autogenous fascia had an average longer follow-up period than did patients with PTFE or nylon sutures; therefore, it may be that the latter were not followed long enough to find more recurrence. Also, some of the materials that were used in the current study, such as Silastic rods or polypropylene sutures, were used in only a small number of cases. Therefore, comparative analysis could not be calculated for these cases. Suture design, single loop or double pentagon, was performed according to the surgeon's preference. Each surgeon does mostly one suture design, and this difference may play a bigger part in the differences between the technique results than any other factor.

In summary, in this group of patients, frontalis suspension surgery for upper eyelid ptosis resulted in similar functional and cosmetic outcomes with different materials, which included autogenous fascia and alloplastic materials. PTFE and autogenous fascia resulted in a lower recurrence rate, although that rate was not statistically significant. The surgical design (single loop or double pentagon) did not alter surgical outcome. Prospective studies are needed to evaluate the true outcome of different sutures materials and sling designs in frontalis suspension surgery.

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