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Factors Affecting the Outcome of Frontalis Sling Surgery in Patients with Severe Blepharoptosis

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Background: Several factors play a role in the outcome of severe blepharoptosis correction by frontalis sling surgery, including the age of a patient, sex, causes of ptosis, and its severity, among others. Identifying the factors that most severely affect surgical outcomes could reduce the complication rate and improve patients' satisfaction.

Methods: This was a retrospective analytical study using logistic regression statistics to evaluate the effects of the following 6 factors on frontalis sling surgical outcomes: age, sex, cause of ptosis, type of anesthesia used, eye side (right or left), degree of ptosis, and levator function. These factors were compared with 10 types of surgical outcomes. The study included 120 eyelids in 95 patients, of which 70 eyelids were unilateral and 50 eyelids were bilateral. Patient ages ranged between 2 and 75; patient sex distribution was 47.5% females and 52.5% males.

Results: The study yielded 60 comparison tables. Only statistically significant and clinically relevant data are presented and discussed. Overall, male patients showed better eye symmetry ($P < 0.026$) and better satisfaction ($P < 0.004$) than did females. Causes other than the congenital ptosis are characterized by better eye closure during sleep ($P = 0$), in comparison with congenital ptosis cases.

Conclusion: The use of silk suture as a sling material is recommended for male patients, as its use produces better results, including eye symmetry and patient satisfaction, with a lower complication rate compared with that in female patients.
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INTRODUCTION

Severe blepharoptosis is one of the challenging topics in ptosis surgery due to the complexity of the problem, as it is commonly accompanied by poor levator muscle function. Despite a variety of surgical techniques available for the correction of this problem, the outcomes are rarely satisfactory,[1–3] and making the patients look natural is very difficult. However, the expectations of patients tend to be high, as they wish to look as natural as possible. Therefore, surgeons should constantly update and improve their operative-technical skills.

Several factors affect the outcome of severe blepharoptosis, including age, sex, cause of ptosis, severity of ptosis, levator and frontalis functions, and surgical technique. Increased patient satisfaction could be achieved by identifying factors that are the most important in shaping the surgical outcomes. As frontalis suspension is one of the most popular techniques used to correct severe ptosis,[4] this was the technique adopted for all the patients in this study, to standardize the results. Further, the use of silk suture as a suspension material has lost its popularity in the clinic, as new materials like expanded polytetrafluoroethylene, for example, Gore-Tex, polyglycolic and polylactic acid PLA/PGA (Vicryl Ethicon, Somerville, N.J.), and nylon,[5,6] have been gaining popularity. Nevertheless, due to the unique properties of silk, including safety, low cost, good knot-tying properties, unique tissue reactions[6–11] and an average rate of infective complications,[5] the current report evaluates this suture material and reports its advantages when used in the ptosis surgery.

MATERIALS AND METHODS

This was a retrospective analytical study using logistic regression to evaluate the impact of each of the considered factors on the results of frontalis sling surgery, using the Statistical Package for the Social Sciences (IBM, SPSS statistics) software, version 22. This study included 120

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Fig. 1. Surgical procedure: right-sided severe ptosis.

Fig. 2. Incision.

Fig. 3. Medial loop—the first move.

Fig. 4. Medial loop—the second move.

Fig. 5. Medial loop—the third move.

Fig. 6. Medial loop—the fourth move.

patients with severe cases of ptosis with margin to reflex distance 1 ≤1;[12,13] the levator function (LF) was in the poor (≤4 mm)[14] or fair (5–7 mm)[14] range. In cases of severe ptosis and poor LF (≤4 mm), a frontalis sling or suspension surgery was performed.[15] In cases of severe ptosis and fair LF, only a frontalis sling surgery was performed. Although other options can be used in such cases, including levator advancement or plication, the levator resection in patients with minimal eyelid excursion frequently results in undercorrection,[16] and therefore frontalis sling was chosen for more optimal results.

All patients were subjected to the same surgical procedure of frontalis sling, with the use of the straight needle threading technique.[17] One hundred twenty eyelids were operated in 95 patients, of which 70 cases (70 eyelids) were unilateral and 25 cases (50 eyelids) were bilateral; 36 eyelids (30%) were operated under local anesthesia, and 84 eyelids (70%) were operated under general anesthesia. The minimum age was 2 years, the maximum was 75 years (median, 12; mean, 19.8). 47.5% of the patients were females, and 52.5% were males.

To evaluate the factors affecting the surgical outcomes, easy standardization of 2 elements of the study was carried out. First, the frontalis suspension (sling) using the straight needle threading technique[17] (mainly with silk suture material) was performed (Figs. 1–12). Second, the outcome was thoroughly evaluated in terms of 10 criteria concerning the results and possible side effects related to the procedure. The following parameters were used as possible surgical outcomes:

Fig. 7. Medial loop completed with a knot tied on the central's limb of the thread.

Fig. 8. Lateral loop completed similarly to the medial limb with knots tied in the central limbs and the lateral loop threads left longer than the medial loop limbs for easier recognition.

Fig. 9. Transparent view showing a quadrangular pattern of loops.

Fig. 10. Balancing of the lid by tying each loop separately.

Fig. 11. Closure.

Fig. 12. Photographs showing long-term follow up for bilateral severe blepharoptosis correction. Preoperative (top) and postoperative (bottom) views.

1. Correction—the level of correction in comparison with the untreated side (unilateral ptosis); in bilateral cases—the equality between both corrected eyes and the margin to reflex distance 1[12] between 3 and 5. ±1 mm difference present after the correction of ptosis was considered "normal"[5,18]; other studies, however,

tend to be less strict as up to 1.5 mm of under- or overcorrection (3 mm together) is often considered as "normal".[2,19] The values beyond "normal" were considered either as under- or overcorrection. These measurements were done by the author using Photoshop (Adobe Inc, San Jose, Calif.) ruler tool.

2. Symmetry—the shape of the palpebral fissure, divided into 4 groups: very good, good, fair, and poor. For simplicity, the first 2 groups (very good and good symmetry) were joined together, and the same was done with the fair and poor symmetry groups, so that together they represent the second group.
3. Satisfaction—dependent on a modification of the Baker criteria[18] and it is not a patient's satisfaction; it evaluates the results based on 4 factors and divides them into satisfactory or nonsatisfactory groups. In cases of normal correction with no severe lagophthalmos, entropion, and exposure keratitis, results are considered satisfactory, while nonsatisfactory results stemmed from an over- or undercorrection or the presence of lagophthalmos, entropion, or exposure keratitis.
4. Lid crease height (visible pretarsal height)—considered "good" if within the range 3–6 mm; considered "bad" if <3 mm or >6 mm.
5. Infective complications—infections such as stitch abscess and stitch granuloma.
6. Eye opening while sleeping. This factor was evaluated based on whether present or absent.
7. Lagophthalmos. This has been divided into 3 grades: mild (slight opening of the palpebral fisher on forceful closure), moderate (quarter of the palpebral fissure is open on forceful closure), and severe (half or more of the palpebral fissure is open during forceful closure) (only severe cases considered in satisfaction criteria).
8. Entropion (not encountered in this study cohort).
9. Lash eversion. This does not include ectropion only the lash line will evert, and it is a unique sequel of this technique as the sling goes down to the lid margin superficially.
10. Keratitis.

The following factors affecting the overall outcome were evaluated:

1. Age—divided into 2 groups: 1–12 years and above 13 years, the choice of 12 years was made, as it is the median age and it divides the study group into 2 equal halves.
2. Sex.
3. Cause of ptosis.
4. Type of anesthesia (local or general).
5. Eye side (right or left).
6. Levator function. Poor (≤4 mm), fair (5–7 mm).
7. Suture material. Silk and others (nylon and silicone rods).

In 92% (110 eyelids) of the cases, silk suture was used as the suspension material (3/0) and in the other 8% (10 eyelids) of the cases, nylon suture (3/0) or silicone threads (1 mm) were used. The causes of ptosis in this study are listed in Table 1.

Table 1. Distribution of Cases According to Causes of Ptosis

Cause	N (%)
Congenital	92 (77.3)
External progressive ophthalmoplegia	13 (10.9)
Senility	10 (8.4)
Cranial nerve 3 palsy	2 (1.7)
Trauma	2 (1.7)
Total	119 (100.0)

RESULTS

Using the SPSS program, logistic regression analysis was performed for all the 7 factors with the 10 outcome parameters. As the results amount to 70 tables, it would be inconvenient and difficult to report them all. Hence, only statistically significant data tables and clinically important results are presented and discussed in this report. Other data are summarized in Table 2.

Since not all data were available in every case, the total number of eyes ranges from 120 to 114 (Tables 1, 3-5).

1. Sex compared with symmetry: males show better eye symmetry than do females ($P < 0.026$) (Table 3).
2. Sex compared with satisfaction: Males show significantly better satisfaction than do females ($P < 0.004$) (Table 4).
3. Age compared with eye closure during sleep: age group 13 and above show less eye opening during sleep ($P < 0.01$).
4. Congenital ptosis has a better correction than other causes of ptosis ($P < 0.04$).
5. Cause of ptosis compared with eye closure during sleep shows that patients with noncongenital ptosis are characterized by significantly better eye closure during sleep ($P < 0.0001$) (Table 5).
6. Ptosis of noncongenital origin has significantly less lagophthalmos than congenital ptosis ($P < 0.04$).
7. Eye opening during sleep compared with anesthesia type: local anesthesia shows less eye opening during sleep ($P < 0.0001$).

Other findings that were not statistically significant, but may be of clinical importance, are as follows:

1. Sex compared with lid crease height was equal in both groups.
2. Infective complications were more often in females than in males; however, it was not a statistically significant difference ($P < 0.07$).
3. Sex compared with eyelid closure during sleep was equal in males and females.
4. Sex compared with lagophthalmos reveals that lagophthalmos occurs more often in males than in females ($P < 0.1$).
5. Lash eversion was higher in females ($P < 0.056$).
6. Under and over correction was higher in the local anesthesia group ($P < 0.06$).

DISCUSSION

Frontalis slings are uncommonly made of silk sutures; also, studies concerning the effects of silk on the surgery

Table 2. Data Summary Table

	Dependent Factors	Outcome Factors	Results	Significance (*P*)
1	Age	Correction	No difference	0.5
	Below 12	Symmetry	No difference	0.6
	13 and above	Satisfaction	No difference	0.5
		Lid crease height	No difference	0.4
		Infective complications	Higher in the "13 and above" group	0.3
		Eye opening during sleep	Lower incidence rate in the "13 and above" group	0.01
		Lagophthalmos	No difference	0.4
		Entropion	Not applicable	
		Lash eversion	Higher in the "13 and above" group	0.2
		Keratitis	No difference	0.5
2	Sex	Correction	Better in males	0.06
	Male	Symmetry	Better in males	Table 3
	Female	Satisfaction	Higher in males	Table 4
		Lid crease height	No difference	0.8
		Infective complications	Higher rate in females	0.07
		Eye opening during sleep	No difference	0.6
		Lagophthalmos	Higher in males	0.1
		Entropion	Not applicable	
		Lash eversion	Higher lash eversion in females	0.056
		Keratitis	No difference	0.2
3	Cause of ptosis	Correction	Better in "Congenital" group	0.04
	Congenital	Symmetry	No difference	0.3
	Other causes	Satisfaction	No difference	1
		Lid crease height	Better in the "Other causes" group	0.2
		Infective complications	No difference	0.5
		Eye opening during sleep	Lower incidence in the "Other causes" group	Table 5
		Lagophthalmos	Lower rate in the "Other causes" group	0.04
		Entropion	Not applicable	
		Lash eversion	No difference	0.4
		Keratitis	No difference	0.4
4	Type of anesthesia	Correction	Higher under and overcorrection in the "LA" group	0.06
	Local anesthesia (LA)	Symmetry	No difference	0.4
		Satisfaction	No difference	0.5
	General anesthesia (GA)	Lid crease height	Better in the "LA" group	0.2
		Infective complications	Lower rate in the "GA" group	0.2
		Eye opening during sleep	Lower incidence in "LA" group	0.0001
		Lagophthalmos	Higher rate in the "GA" group	0.1
		Entropion	Not applicable	
		Lash eversion	Higher rate in the "LA" group	0.1
		Keratitis	No difference	0.1
5	Eye side	Correction	No difference	0.4
	Right	Symmetry	No difference	0.9
	Left	Satisfaction	No difference	0.6
		Lid crease height	No difference	0.4
		Infective complications	No difference	0.9
		Eye opening during sleep	No difference	0.3
		Lagophthalmos	No difference	0.7
		Entropion	Not applicable	
		Lash eversion	No difference	0.5
		Keratitis	No difference	0.5
6	Levator function	Correction	Better in the "Fair LF" group	0.1
	Poor LF	Symmetry	Better in the "Fair LF" group	0.5
	Fair LF	Satisfaction	Higher in the "Fair LF" group	0.2
		Lid crease height	Higher in the "Fair LF" group	0.2
		Infective complications	No difference	1
		Eye opening during sleep	Higher incidence in the "Poor LF" group	0.6
		Lagophthalmos	No difference	1
		Entropion	Not applicable	
		Lash eversion	Lower rate in the "Poor LF" group	0.6
		Keratitis	No difference	0.5
7	Suture material	Correction	Better in the "Non-silk" group	0.4
	Silk	Symmetry	Better in the "Non-silk" group	0.2
	Non-silk	Satisfaction	No difference	0.9
		Lid crease height	Better in the "Silk" group	0.2
		Infective complications	Higher rate in the "Silk" group	0.3
		Eye opening during sleep	No difference	0.6
		Lagophthalmos	No difference	0.8
		Entropion	Not applicable	
		Lash eversion	Higher rate in the "Non-silk" group	0.5
		Keratitis	No difference	0.2

outcomes are scarce. Silk sutures are permanent, non-absorbable, and induce unique biological responses and tissue reactions. This suture type triggers a strong inflammatory response around itself,[7–10] which is eventually encapsulated by fibrous tissue.[11] Silk tends to be encapsulated by a rim of connective tissue, while histocytes, giant cells, and lymphocytes are often found in the suture's proximity.[11] Of note, the histological reaction to silk was

Table 3. Comparison of Symmetry by Gender

	Symmetry		
	Good + Very Good	Fair + Poor	Total
Gender	N (%)	N (%)	N (%)
Male	63 (92.6)	5 (7.4)	68 (100.0)
Female	36 (78.3)	10 (21.7)	46 (100.0)
Total	99 (86.8)	15 (13.2)	114 (100.0)

$\chi^2 = 4.97$; df = 1; $P = 0.026$.

Table 4. Comparison of Satisfaction by Gender

	Satisfaction with Outcome		
	Satisfied	Unsatisfied	Total
Gender	N (%)	N (%)	N (%)
Male	58 (85.3)	10 (14.7)	68 (100.0)
Female	31 (63.3)	18 (36.7)	49 (100.0)
Total	89 (76.1)	28 (23.9)	117 (100.0)

$\chi^2 = 7.59$; df = 1; $P = 0.006$.

Table 5. Association of Eye Closure during Sleep to Cause of Ptosis

	Eye Closure during Sleep		
	Eye Closed	Eye Does Not Close	Total
Cause of Ptosis	N (%)	N (%)	N (%)
Congenital	8 (9.1)	80 (90.9)	88 (100.0)
Other causes	14 (51.9)	13 (48.1)	27 (100.0)
Total	22 (19.1)	93 (80.9)	115 (100.0)

$\chi^2 = 24.42$; df = 1; $P = 0.0001$.

shown to be the strongest among all suture materials.[8] In other conditions, such robust inflammatory response and fibrous tissue encapsulation could be considered as adverse reactions; however, in the frontalis sling, the fibrous capsule acts as a sleeve surrounding the silk suture, maintaining the effect and strengthening the sling to hold the lid in its position.

This article demonstrates that the use of silk suture as a sling material in frontalis suspension improves surgical outcomes in male patients in terms of correction, symmetry, and satisfaction. Men also had less infective complications than women, despite there being no statistical significance attached to that trend.

The differences in surgical outcomes relating to sex could be explained by a stronger inflammatory response and fibrous capsule formation around the silk suture in male patients, resulting in firmer holding of the lid in its place, improved aesthetic results, and fewer complications. This explanation, however, will need to be assessed histologically. Females, on the other hand, had a lower incidence of lagophthalmos than males. Lagophthalmos results from putting the lid in an overcorrection position intraoperatively.[17] The problem usually resolves after the surgery, but in males, due to the tightening effect of the silk sling, the complete eye closure may be more difficult to achieve.

Lid lag and eye closure during sleep commonly occur in patients after the frontalis sling surgery.[20] This study did not show any significant relation between those events and patients' sex, suture material, or anesthesia type. However, the eye opening and lagophthalmos during sleep happened significantly more frequently in patients with congenital ptosis. As such, congenital ptosis is usually the most severe, resulting in overcorrecting during the surgery, which increases the chances of eye opening while asleep.

The biggest limitation of this study is the sample size. Multiple statistical analyses were not considered due to a low cell count (below 5).

There are no studies that discuss the differences in the body response to silk suture between males and females. Reports on the outcomes and complications related to the use of silk sutures in frontalis sling surgery are also scarce.

CONCLUSION

The use of silk suture as a sling material is recommended in male patients, as it results in better symmetry and higher satisfaction and produces fewer complications, compared with silk sutures in female patients.

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PATIENT CONSENT STATEMENT

The patient provided written consent for the use of his image.

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