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Frontal Sling and Levator Resection Surgery for Ptosis Due to Third Cranial Nerve Paralysis

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ABSTRACT

Objective: To evaluate the effectiveness of levator resection and frontal sling surgery in patients with ptosis due to third cranial nerve (3rd CN) paralysis.

Methods: A total of 16 patients who underwent frontal sling surgery (n=9, group 1) and levator resection (n=7, group 2) during follow-up due to ptosis due to 3rd CN paralysis in the oculoplastic surgery unit of our clinic were included in the study. The surgical procedure, preoperative levator muscle function test, marginal reflex distance 1 (MRD1) and palpebral fissure height (PFH) were recorded during follow-up. The MRD1 and PFH values of the patients in both groups were recorded in the postoperative 1st month and 12th month examinations, and during the last examination. All data were statistically compared between the two groups.

Results: Seven (43.8%) patients were female and 9 (56.3%) were male. Preoperative mean MRD1 values in group 1 and group 2 were -1.78±1.56 mm (-4-0) and -1.29±0.76 mm (-2-0), respectively. In groups 1 and 2, both MRD1 and PFH showed a statistically significant increase compared with preoperative measurements (p=0.277). While postoperative success was 88.8% in the 1st month in group 1, it was 55.5% in the 12th month. In group 2, postoperative success rates were 85.7% in the 1st month and 71.4% in the 12th month examinations. In the comparison between the groups, MRD1 and PFH did not differ statistically (p=0.216).

Conclusion: Although patients with ptosis due to 3rd CN paralysis are difficult to treat, they can be effectively and safely treated with frontal sling surgery or levator resection.

Keywords: Frontal sling, levator muscle, levator resection, palsy, ptosis, third cranial nerve

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INTRODUCTION

Ptosis can occur due to damage to the third cranial nerve (3rd CN, oculomotor nerve) for various reasons. In the adult population, the most common cause of 3rd CN paralysis is ischemia (1). Other important causes include trauma, giant cell arteritis, and less frequent tumors and aneurysms (2-4). Congenital causes and trauma are the most common etiologic causes in children (5). The treatment of 3rd CN palsy is primarily based on etiology.

Surgery should be planned for ocular findings that do not improve by themselves after the etiologic cause has been eliminated or treated. The management and repair of paralytic ptosis, unlike other ptosis, can be complicated by corneal exposure after surgery due to the weak Bell phenomenon resulting from the dysfunction of the levator muscle (5).

In this case, the success of surgical intervention depends on patient selection, surgical expectations, and appropriate management of complications.

In our study, we aimed to evaluate the efficacy and safety of levator resection and frontal sling surgery in patients who underwent surgical treatment for 3rd CN palsy in the oculoplastic surgery unit of our clinic.

METHODS

The study was conducted by taking the principles of the Declaration of Helsinki into consideration. An approval statement was obtained from the Clinical Research Ethics Committee of University of Health Sciences Turkey, Başakşehir Çam and Sakura City Hospital (decision no: 348, date: 26.10.2022). We retrospectively reviewed the records of patients who were treated and who were followed up for ptosis caused by 3rd CN paralysis in the oculoplastic surgery unit of our clinic between February 2020 and January 2023. All patients included in the study had previously undergone strabismus surgery and did not have double vision in the primary position. Preoperative levator muscle function test (LFT) measurements, marginal reflex distance 1 (MRD1), palpebral fissure height (PFH), and Bell's phenomenon were noted in the oculoplastic surgery unit follow-ups of the patients included in the study. The mean MRD1 and PFH at the 1st and 12th, and last examinations were recorded in the postoperative controls. The frontal sling technique with silicone sling material (tarsal fixation) (group 1) was performed for ptosis surgery in patients with a preoperative LFT value of ≤4 mm, and levator resection surgery (group 2) was performed by the same surgeon (F.S.) in patients with LFT >4 mm. Revision surgery was applied to patients with MRD1 <1 mm in the follow-ups. Considering the general condition of the patients, both surgical techniques were performed under general or local anesthesia. Patients with partial 3rd CN palsy and those with less than 1 year follow-up were excluded from the study.

Surgical Technique

Frontal Sling Surgery

Markings were made on the lid using the modified Fox pentagon technique with an open approach. Then, 20 mg/mL lidocaine and 0.0125 mg/mL adrenaline were applied locally to the marking areas. A skin incision was made in the lid fold using a 15/0 scalpel. The tarsal surface was dissected by blunt and sharp dissection. Bleeding control was achieved after eyebrow incisions were made. The silicone suspension material was sutured to the upper 1/3 of the tarsal with a 5/0 dacron. The silicone suspension material was then passed over the orbital septum and removed from the incisions on the eyebrow. After the lid heights were adjusted to the upper limbus level, the sling material was placed in the pocket prepared in the upper incision. In the lid incision, the lid fold was created with three 6/0 vicryl sutures, and all skin incisions were sutured with a 6/0 prolene. The operation was terminated by covering the eye with plenty of ointment to prevent corneal exposure.

Levator Resection

Marking was done from the cover fold. Then, 20 mg/mL lidocaine and 0.0125 mg/mL adrenaline were applied locally to the marking area. A skin incision was made in the lid fold using a 15/0 scalpel. The tarsal surface was dissected by blunt and sharp dissection. The orbital septum was opened, and the levator aponeurosis and muscle were dissected up to the upper orbital margin. The aponeurosis was carefully dissected from the underlying Müller muscle. The levator horns were cut, preserving the Whitnall ligament, and muscle attachments were dissected. A central double-arm 6-0 vicryl suture was placed three mm below the superior tarsal border. The suture was removed from under the Whitnall ligament and adjusted to bring the eyelid to the upper limbus level. If deemed necessary, medial, and lateral sutures were placed to obtain a satisfactory valve contour. Excess tissue was clamped and excised. After creating the lid fold with three 6/0 vicryl incisions, the skin incision was sutured with 6/0 prolene. The operation was terminated by covering the eye with plenty of ointment to prevent corneal exposure.

Success was defined as ≥2 mm MRD1 postoperatively. In the follow-up of the patient, MRD1 <1 mm was accepted as recurrence.

Statistical Analysis

The mean, standard deviation, median, minimum, maximum value frequency, and percentage were used for descriptive statistics. The distribution of variables was checked using the Kolmogorov-Smirnov test. Independent samples t-test and Mann-Whitney U test were used for the comparison of quantitative data. The Wilcoxon test was used for the repeated measurement analysis. The chi-square test was used for the comparison of qualitative data. SPSS 28.0 was used for statistical analyses.

RESULTS

A total of 16 patients, 9 patients in the group 1 (3 females, 6 males) and 7 patients in the group 2 (4 females, 3 males) were included in the study. The mean ages of the patients in the group 1 and group 2 were 28.6±23.3 (2-58 years) and 44.9±23.4 (10-70 years), respectively. In the preoperative examination, the mean LFT measured in the patients was 1.9±1.6 mm (0-4) in the group

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1 and 6.4±1.6 mm (5-9) in the group 2. When the group 1 and the group 2 were compared statistically, no significant difference was observed between patients' age, gender distribution, mean LFT, and mean follow-up time (p=0.187, p=0.615, p=0.775, p=0.146, respectively) (Table 1).

The MRD1 and PFH values recorded during the follow-up of the patients in the groups 1 and 2, and the comparison results between the groups are given in Table 2. Preoperative mean MRD1 values were similar between the groups 1 and 2 (p=0.515). In the group 1, the mean MRD1 value during the postoperative 1st month, 12th month, and last examination showed a significant increase compared with the preoperative period (p=0.008). In the group 2, the mean MRD1 value during the postoperative 1st month, 12th month, and last examination showed a significant increase compared with the preoperative period (p=0.018, p=0.17, p=0.17, respectively). The mean MRD1 change during the postoperative 1st month, 12th month, and the last examination did not differ significantly between the group 1 and the group 2 (p=0.669, p=0.306, p=0.455, respectively) (Figure 1).

Preoperative mean PFH values were similar between the groups 1 and 2 (p=0.277). In the group 1 and group 2, the mean PFH values during the postoperative 1st month, 12th month, and the last examination showed a significant increase compared with the preoperative period (p<0.05) (Table 2). The mean PFH change at the postoperative 1st month, 12th month, and last examination points did not differ significantly between the group 1 and the group 2 (p=0.483, p=0.914, p=0.556) (Figure 2). Although postoperative success was 88.8% at 1 month interval in group 1, it was 55.5% at 12 month's examination point. In the group 2, the postoperative success rate was 85.7% at the first month and 71.4% at the 12th month points. During the last examination, there was a clear visual axis in all cases (Figure 3, 4). During the follow-up period, revision was performed once in 2 (22.2%) patients in the group 1 and twice in 1 (11.1%) patient, in total 3 patients (33.3%). There was no need for revision in the group 2. There was no statistically significant difference in revision requirement between the two groups (p=0.213) (Table 1).

In all patients, corneal epithelial defects due to exposure to various degrees occurred in the first postoperative week and were successfully treated with topical treatments in the early period. No serious ocular complications were observed in any patient.

DISCUSSION

3rd CN palsy is a clinical and difficult-to-manage condition presenting itself with diplopia and ptosis. The ptotic eyelid may cause amblyopia in visually immature children as well as functional and cosmetic problems in adults by closing the pupil. The presence of amblyopia, involvement of other cranial nerves, and alteration of paretic and spastic function in cyclic oculomotor palsy affect patient selection and treatment outcomes (6). The presence of ptosis temporarily masks existing diplopia in adult patients.

For this reason, strabismus surgery should be given priority to prevent diplopia that may occur after ptosis surgery. Permanent diplopia may contraindicate ptosis surgery in acquired oculomotor nerve palsy (6). In our study, ptosis surgery was not performed on any patient with diplopia in the primary position. Because of the neurological characteristics of oculomotor nerve palsy, not all affected patients may benefit equally from surgery; therefore, the appropriate selection of suitable candidates whose functional and cosmetic disabilities can be corrected by surgical intervention is essential.

Frontal sling operation is usually required in patients with ptosis who have no or poor levator function (7). Among the many sling materials used for frontal sling operations, silicone allows easy adjustment in eye blinking and revision surgery because of its flexibility (7-10). Apart from silicone, autologous fascia lata has been used for many years in frontalis sling surgery (11-13). However, it is very difficult to obtain autologous fascia lata in children.

Table 1. Statistical results of the demographic data, revision rates, and mean follow-up times of groups 1 and 2

		Group 1			Group 2			p-value
		Mean ± SD/n-%	Median	Min-max	Mean ± SD/n-%	Median	Min-max	
Age (years)		28.6±23.3	25.0	2-58	44.9±23.4	50.0	10-70	0.187[t]
Gender	Female	3 (33.3%)	-	-	4 (57.1%)	-	-	0.615[X²]
	Male	6 (66.7%)	-	-	3 (42.9%)	-	-	
Lateralization	Right	2 (22.2%)	-	-	3 (42.9%)	-	-	0.596[X²]
	Left	7 (77.8%)	-	-	4 (57.1%)	-	-	
LFT		1.9±1.6	2.0	0-4	6.4±1.6	6.0	5-9	0.775[m]
Revision	(-)	6 (66.7%)	-	-	7 (100.0%)	-	-	0.213[X²]
	I	2 (22.2%)	-	-	0 (0.0%)	-	-	
	II	1 (11.1%)	-	-	0 (0.0%)	-	-	
Follow-up time		18.7±5.6	18.0	12-24	14.6±4.2	12.0	8-24	0.146[m]

[t]: t-test, [m]: Mann-Whitney U test, [X²]: chi-square test (Fisher test), [w]: Wilcoxon test, group 1: frontal sling surgery, group 2: levator resection, SD: standard deviation, min-max: minimum-maximum, LFT: levator muscle function test

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Table 2. Mean MRD1 and PFH values and statistical results of group 1 and group 2 in preoperative, postoperative 1st month, 12th month, and last control examinations

	Group 1			Group 2			p-value
	Mean ± SD	Median	Min-max	Mean ± SD	Median	Min-max	
MRD1							
Pre-op	-1.78±1.56	-2.00	-4-0	-1.29±0.76	-1.00	-2- 0	0.515[m]
1st month post-op	2.56±0.77	2.50	1.5-4	2.43±1.17	2.00	1.5-5	0.405[m]
12th month post-op	1.39±0.93	1.00	0- 3	2.29±1.07	2.00	1- 4	0.112[m]
Last visit	2.28±0.83	2.50	1- 3	2.29±1.07	2.00	1- 4	0.871[m]
Difference with preoperative							
1st month post-op	4.33±2.02	4.50	2- 8	3.71±1.15	3.50	2.5-6	0.669[m]
Intra-group Difference p	**0.008[w]**			**0.018[w]**			
12th month post-op	3.17±1.90	3.00	1- 7	3.57±0.73	3.50	3- 5	0.306[m]
Intra-group Difference p	**0.008[w]**			**0.017[w]**			
Last visit	4.06±2.04	4.00	1- 7	3.57±0.73	3.50	3- 5	0.455[m]
Intra-group Difference p	**0.008[w]**			**0.017[w]**			
PFH							
Pre-op	3.67±1.58	3.00	2- 6	4.57±0.79	4.00	4- 6	0.277[m]
1st month post-op	8.22±1.48	8.00	7- 11	8.71±1.70	8.00	7- 12	0.439[m]
12th month post-op PFH	7.11±1.69	7.00	5- 10	8.43±1.90	8.00	6- 11	0.162[m]
Last visit	7.89±1.36	8.00	6- 10	8.29±1.98	8.00	6- 11	0.871[m]
Difference with preoperative							
1st month post-op	4.56±1.94	5.00	2- 8	4.14±1.77	4.00	3- 8	0.483[m]
Intra-group Difference p	**0.007[w]**			**0.016[w]**			
12th month post-op	3.44±2.07	4.00	0- 7	3.86±1.68	3.00	2- 7	0.914[m]
Intra-group Difference p	**0.011[w]**			**0.017[w]**			
Last visit	4.22±1.99	4.00	1- 7	3.71±1.80	3.00	2- 7	0.556[m]
Intra-group Difference p	**0.008[w]**			**0.018[w]**			

[m]: Mann–Whitney U test, [w]: Wilcoxon test, group 1: frontal sling surgery, Group 2: levator resection, SD: standard deviation, min-max: minimum-maximum, PFH: palpebral fissure height, MRD1: marginal reflex distance 1

Although various synthetic materials have been tried before for temporary suspension, their recurrence rates are quite high (14). In our study, we also used silicone sling material in patients with poor LFT for whom we planned frontal sling surgery because of its easy accessibility and good flexibility. Choi and Kim (15) reported that anterior suspension surgeries using silicone suspenders safely and effectively corrected ptosis without serious corneal complications in 18 patients with 3rd CN paralysis. We did not observe any serious ocular complications due to exposure during the first postoperative days in our patients to whom we applied the silicone sling.

Malone and Nerad (6) determined the effectiveness of surgery in ptosis due to 3rd CN paralysis. They performed levator surgery in 16 patients and frontal sling surgery in 4 patients. Functional and cosmetic improvements in these patients they evaluated; reported that functional improvement was 83%, cosmetic improvement was 100%, and no patients who underwent levator surgery required repeat surgery. In this study, the most common complication of ptosis surgery was under correction, more so in the frontalis sling group. Researchers have associated frontal sling procedures and super maximum levator muscle resections producing a relatively atonic eyelid with a greater risk of lagophthalmos for a given postoperative fissure size than levator muscle aponeurosis advancement surgery in patients with good levator muscle function. Therefore, they argued that in patients with oculomotor nerve palsy and poor levator muscle function, discontinuing eyelid elevation entirely to cosmetic levels would be a measured course of action to reduce the risks of corneal complications by minimizing postoperative lagophthalmos. We preferred suboptimal surgical correction to prevent serious postoperative ocular complications in our patients who underwent both surgeries. In our study, the mean MRD1 and PFH values measured at 12 months point in the group 2 patients who underwent levator surgery were 2.29 and 8.43, respectively. In our study, we achieved acceptable results in patients who underwent levator resection (postoperative success was 85.7% at 1 month, 71.42% at 12 months) and we did not require revision. Therefore, we believe that levator resection surgery may be more appropriate in selected cases in which ptosis develops secondary to 3rd CN paralysis.

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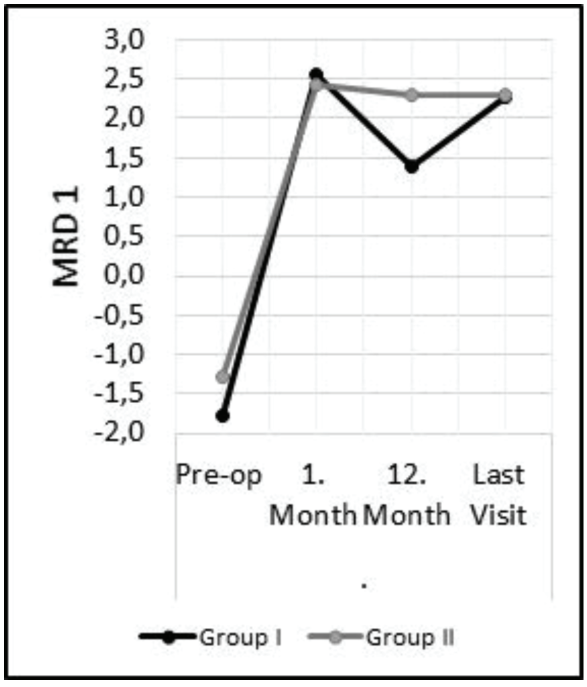

Figure 1. Graph of change in mean MRD1 value of group 1 and group 2 in preoperative, postoperative 1st month, 12th month and last control examinations
MRD1: marginal reflex distance 1

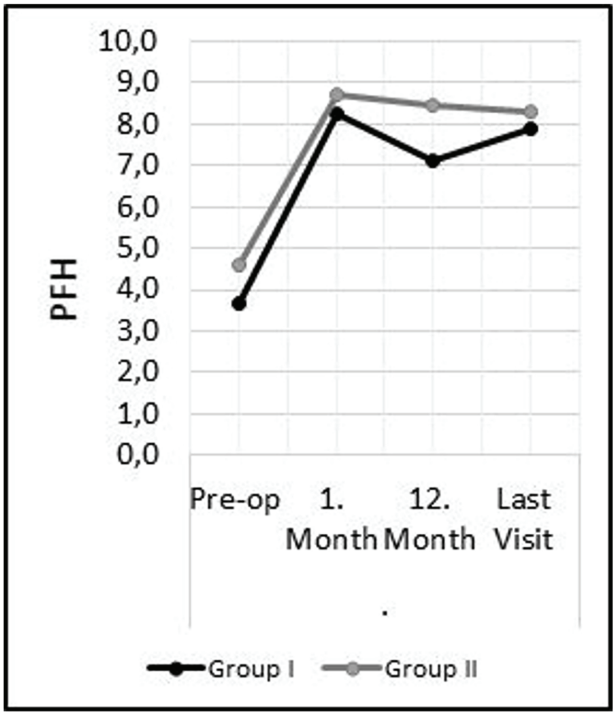

Figure 2. Graph of change in mean PFH value of group 1 and group 2 in preoperative, postoperative 1st month, 12th month and last control examinations
PFH: palpebral fissure height

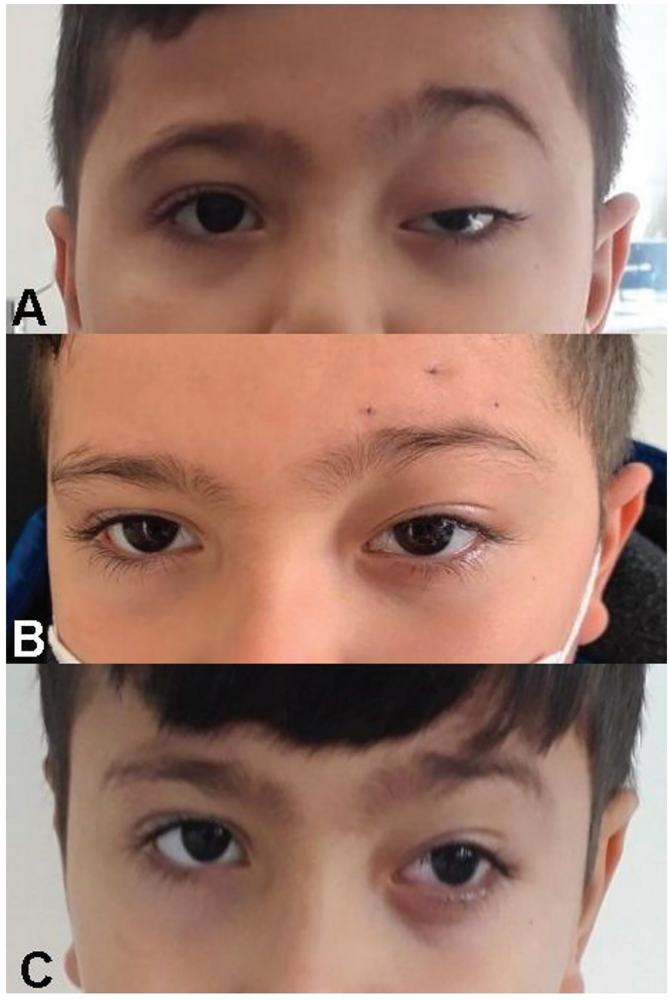

Figure 3. View of the patient who underwent frontal sling surgery due to ptosis secondary to left 3rd CN paralysis, (A) preoperative left ptosis, (B) postoperative 1st week view, (C) postoperative 6th month view
3rd CN: third cranial nerve

Bagheri et al. (16) reported the results of patients who underwent levator resection (n=5, 27.7%) and frontal sling surgery (n=13, 72.3%) due to ptosis and due to the 3rd CN paralysis. The study reported that acceptable results in patients who underwent levator resection were achieved, but the results of the first surgery were poor at a rate of 61.5% in patients who applied for frontal sling. They thought that this was due to the occurance of more severe paralysis in this group. They used silicone sling, supramide, and fascia lata as frontal sling materials in their patients. However, they did not report a comparison between suspension materials. Inadequate correction and the need for reoperation are frequent complications of sling procedures using various materials. Various studies have reported a variable recurrence rate (8-53%) in patients treated with fascia lata and various synthetic materials for the frontalis sling (14,17-20).

In our study, the success of the surgical procedure performed in group 1 patients who underwent frontal sling was 88.8% during

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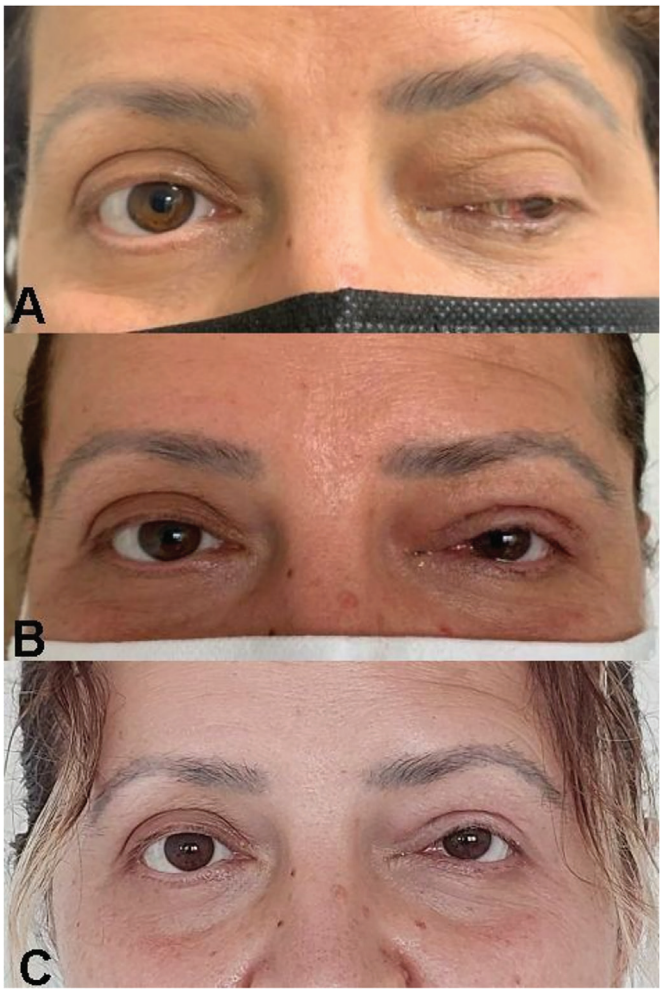

Figure 4. View of the patient who underwent levator resection for ptosis secondary to left 3rd CN paralysis, (A) preoperative left ptosis, (B) postoperative 1st week view, (C) postoperative 6th month view
3rd CN: third cranial nerve

the 1st month examination, whereas it decreased to 55.5% during the 12th month examination, similar to the results of studies in the literature. We believe that the decrease in the success rate in group 1 over time may be due to the lower initial levator muscle function and the silicone material used in the patients in this group. During the follow-up period, revision was performed once in 2 (22.2%) patients and twice in 1 (11.1%) patient in group 1, resulting in a total of 3 patients (33.3%). Because of the surgeries performed, all our patients had an open visual axis during the last examination.

Study Limitations

3rd CN paralysis and related ptosis is a disease that is very rare and difficult to manage. Therefore, our study was designed retrospectively because designing a prospective study involves various difficulties. Another limitation of our study is the small number of cases included. To overcome this limitation, multicenter studies should be designed in which data from ptosis cases due to 3rd CN paralysis can be optimized.

CONCLUSION

In light of all the information, although the surgical management of functional and cosmetic problems experienced by patients with ptosis due to 3rd CN paralysis is difficult and complex to treat, a safe and effective treatment along with the appropriate surgical technique can be provided to the suitable patient.

Ethics Committee Approval: An approval statement was obtained from the Clinical Research Ethics Committee of University of Health Sciences Turkey, Başakşehir Çam and Sakura City Hospital (decision no: 348, date: 26.10.2022).

Informed Consent: Signed informed consent was obtained from all participants, including the parents or guardians of the children, for the research and publication of the images.

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Author Contributions: Surgical and Medical Practices - F.S.; Concept - F.S.; Design - F.S.; Data Collection and/or Processing - F.S., M.U.; Analysis and/or Interpretation - F.S., M.U.; Literature Search - F.S., M.U.; Writing - F.S.

Conflict of Interest: The authors have no conflict of interest to declare.

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