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Reattachment of the Temporalis Muscle After Frontoorbital Advancement in Craniosynostosis Surgery

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ABSTRACT

Craniosynostosis surgery may result in temporal hollowing occasionally. Overexpansion of the normal side and undergrowth of the affected side exacerbate the problem in unilateral cases (like unicoronal synostosis). Temporalis muscle lies in the temporal fossa, and it is usually severed or detached from its origin in order to reach the lateral aspect of the fronto-orbital bar. Reattachment of the temporalis muscle is challenging especially when the orbital bar is moved forward. In this technical note, exposure of the lateral cranial vault with zigzag incision of the temporalis muscle in 35 nonsyndromic anterior plagiocephaly patients has been described in detail, and the ease of reattachment is demonstrated afterward.

KEYWORDS: Fronto-orbital advancement, Temporalis muscle, Temporal hollowing

INTRODUCTION

Temporal hollowing commonly occurs after dissection and repositioning of fronto-orbital structures. This depression typically occurs in the superolateral brow–forehead region, and the cause has been attributed to soft tissue or bony deficiencies. The area superior to the zygomatic arch and immediately posterior to the lateral orbital rim contains the temporalis muscle and associated fat pads, and includes the bone used in a frontal bandeau, and may attach to the adjacent frontal bone flap (6,10). Temporal hollowing is commonly encountered after fronto-orbital procedures. The cause of the hollowing is controversial as to whether it is a bone or soft tissue loss. The most common etiologies include tumor extirpation, posttraumatic contour deformity, temporalis muscle disinsertion/atrophy, and superficial temporal fat pad atrophy after coronal incision. The development of hollowing can be immediate or delayed depending on the etiology (8).

Temporalis muscle needs to be detached from its origin for bony exposure during craniosynostosis surgery in order to access to the frontotemporal region. Thus, resuspension of the muscle is quite challenging as it may be severed from its cranial or skin flaps during the procedure. Inadequate resuspension may contribute to the temporal hollowness, sometimes seen after craniosynostosis surgery (1). Some improvement at the temporal hollowing is observed with the advancement of the cranial bone, but bone advancement alone may not be the solution to the problem. The muscular component of the problem should also be corrected. Many techniques have been proposed for resuspension of the temporalis muscle. Barone et al. had used titanium miniplates and screws for temporalis muscle resuspension and demonstrated good results (2). Bowles had proposed a technique to preserve both the deep temporal arteries and nerves with subperiosteal dissection and resecured the bone flap with sutures through small holes (3). Remodeling for unicoronal synostosis results in temporal hollowing among other clinical features (4). Both bony and soft tissue may have affected on hollowing after cranioplasties, and malposition of the muscle may also complicate the problem (4). The delicate surgical technique and reattachment

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of the muscle plays an important role to diminish muscular contribution to the hollowing. Our technique enables easy reattachment and elongation of the muscle fibers. This study is a technical note of a surgical maneuver that can be used to alleviate temporal hollowing deformity.

MATERIAL and METHODS

Thirty-five patients with anterior plagiocephaly were operated between 2016 and 2019. All the patients underwent unilateral fronto-orbital remodeling by the same surgical craniofacial team. Twenty patients were considered as control group. In this group, after separating the temporal muscle from its origin point, a new origin point was determined for the muscle after fronto-orbital advancement and sutured to the periosteum of temporal bone. Fifteen patients had zigzag incision on temporal muscle for advancement; 11 patients were affected on the left side, and 24 patients were affected on the right side; 19 patients were operated before 1 year of age, 16 patients were operated after 1 year of age. Patients' ages were between 5 and 18 months (mean 10.5 months) in control group and between 6 and 42 months (mean 13.5 months) in temporal muscle advancement group. Follow-up period was between 5 and 24 months (mean 11.8 months) (Table I).

Ethical Approval

This work was approved by the Ethical Committee at Ministry of Health Kartal Dr. Lutfi Kirdar City Hospital. The date and number of ethical approval were 08/07/2020 and 2020/514/181/19, respectively.

Surgical Technique

The two surgeons (one neurosurgeon and the plastic surgeon) cooperated simultaneously from both sides of the patient. Access to the anterior cranial vault was gained via bicoronal incision in both cases. The temporalis muscle could be easily seen on the lateral side of the vault after the cranial vault was exposed. A transverse zigzag incision was planned on the muscle close to the origin (Figure 1). The muscle fibers were detached from each other via this incision. The surgery was carried according to the type of the synostosis and planned craniofacial remodeling. The muscle fibers were easily sutured on the newly formed cranial vault after the bony fixations. The muscle could be closed in a V–Y manner, which facilitated the muscle advancement when forward movement of the bar resisted muscle reattachment (Figure 2). Photographs were taken before and after the surgery by an independent pediatric anesthetist to assess postoperative growth. The presence and severity of temporal hollowing was checked. A score of 0 (normal), 1 (moderate), and 2 (severe) was appointed to each side of the patients (Table II) (Figures 3–8).

Statistical Analysis

Statistical Package for The Social Science (SPSS) 15.0 statistical program was used for all statistical analysis. The variables were accepted as categoric according to the evaluation method. Correlations of photographic scores of the affected and nonaffected sides, the pre- and post-operative photographic scores were determined by Mann–Whitney U test. p-value of < 0.05 was accepted for statistical significance.

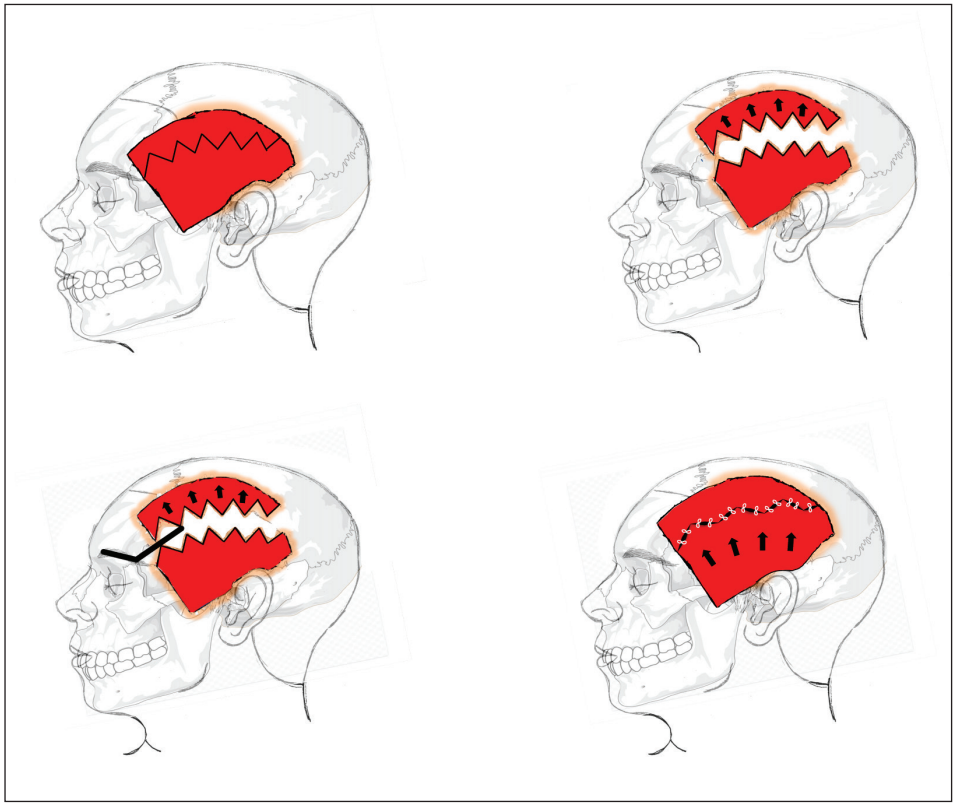

Figure 1: Illustration of transverse zigzag incision on the muscle close to the origin.

Table I: Demographic Data of the Patients

Patient	Sex	Age at the operation (months)	Laterality	Temporal Zig Zag incision	Follow-up period (months)
Patient no:1	M	11	R	none	108
Patient no:2	F	18	L	none	101
Patient no:3	M	6	L	none	84
Patient no:4	F	8	R	none	78
Patient no:5	M	7	L	none	72
Patient no:6	F	10	R	none	73
Patient no:7	F	9	R	none	72
Patient no:8	M	8	R	none	72
Patient no:9	F	11	R	none	76
Patient no:10	F	12	R	none	74
Patient no:11	F	21	R	none	60
Patient no:12	F	11	R	none	59
Patient no:13	M	8.5	R	none	57
Patient no:14	F	13	R	none	52
Patient no:15	F	15	L	none	43
Patient no:16	F	12	L	none	41
Patient no:17	M	5	L	none	30
Patient no:18	F	8	R	none	29
Patient no:19	M	5	L	none	24
Patient no:20	M	12	L	none	22
Patient no:21	F	6.5	R	Zigzag incision	24
Patient no:22	F	9	L	Zigzag incision	21
Patient no:23	M	14	R	Zigzag incision	21
Patient no:24	F	6	R	Zigzag incision	19
Patient no:25	M	14	L	Zigzag incision	18
Patient no:26	M	7	R	Zigzag incision	17
Patient no:27	F	14	R	Zigzag incision	16
Patient no:28	F	6	R	Zigzag incision	16
Patient no:29	M	13	R	Zigzag incision	14
Patient no:30	M	42	R	Zigzag incision	9
Patient no:31	F	24	R	Zigzag incision	9
Patient no:32	F	15	R	Zigzag incision	7
Patient no:33	M	8	R	Zigzag incision	6
Patient no:34	M	12	L	Zigzag incision	2
Patient no:35	F	12	R	Zigzag incision	2

Table II: The Presence and Severity of Temporal Hollowing

	Cranioplasty with Muscle Incision (n)		Cranioplasty without Muscle Incision (n)	
Preoperative	No Hollowing - 0	0	No Hollowing - 0	0
	Mild Hollowing - 1	9	Mild Hollowing - 1	13
	Severe Hollowing - 2	6	Severe Hollowing - 2	7
Postoperative	No Hollowing - 0	9	No Hollowing - 0	4
	Mild Hollowing - 1	5	Mild Hollowing - 1	11
	Severe Hollowing - 2	1	Severe Hollowing - 2	5

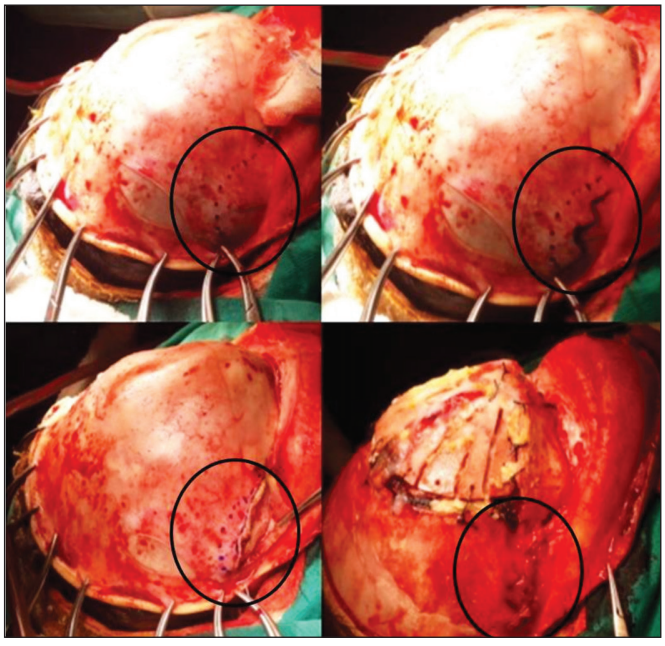

Figure 2: Intraoperative photograph of the closed muscle in V–Y advancement.

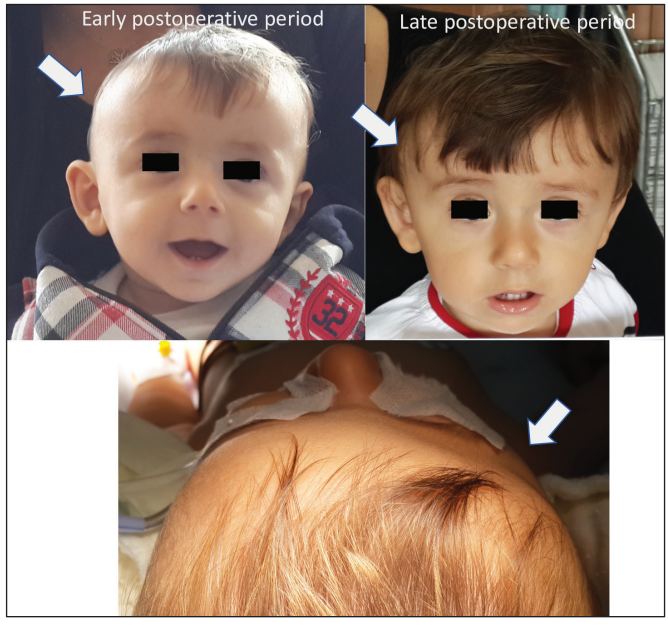

Figure 3: Photograph of a patient whose muscle had elongated in zigzag maneuver at the right side.

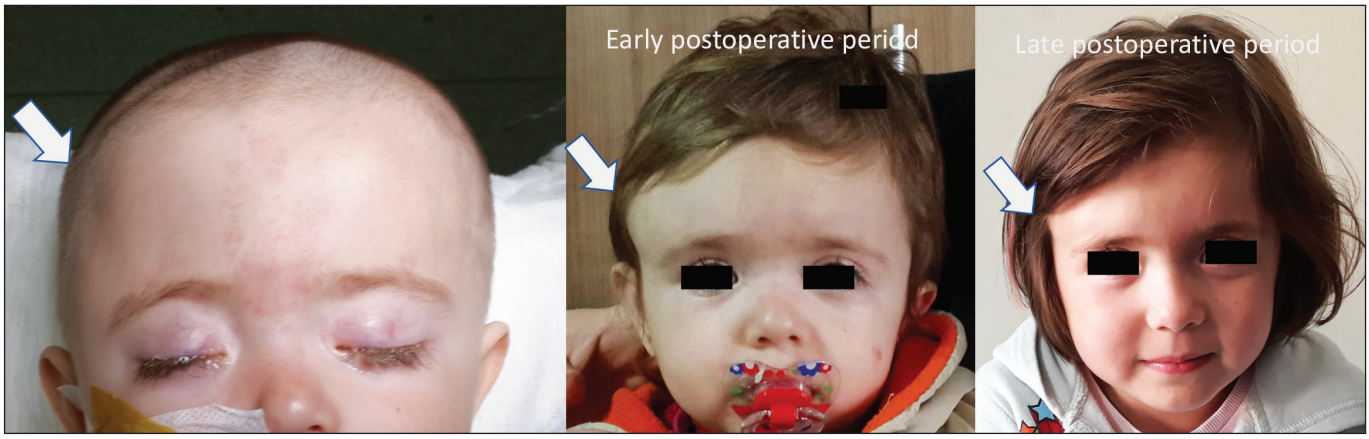

Figure 4: Photograph of a patient whose muscle had elongated in zigzag maneuver at the right side.

Figure 5: Photograph of a patient whose muscle had elongated in zigzag maneuver at the left side.

Figure 6: Photograph of a patient whose muscle had not elongated in zigzag maneuver. The temporal hollowing deformity is prominent at the left side.

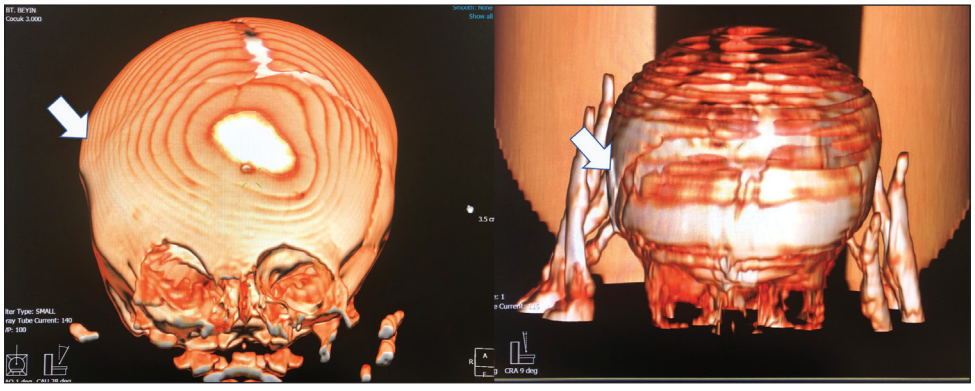

Figure 7: 3D CT scan image of a patient who underwent zigzag temporal muscle incision at the right side. Temporal hollowing deformity is less prominent. Left-sided image is the figure of preoperative period and right-sided is of postoperative period.

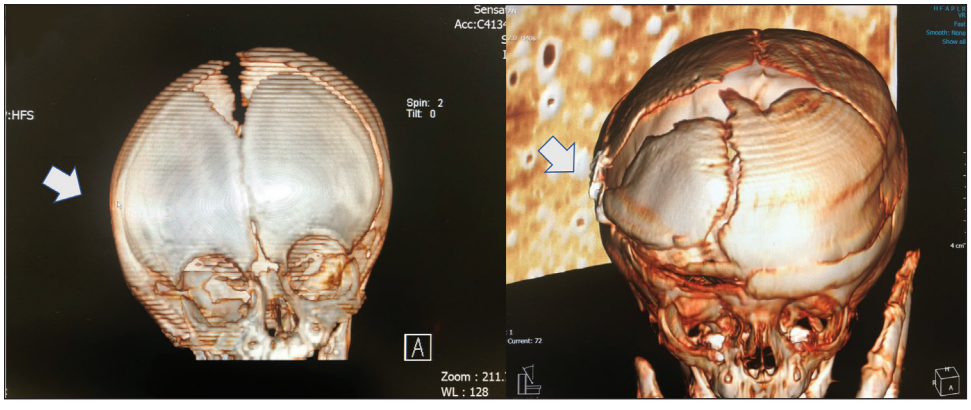

Figure 8: 3D CT scan image of a patient who underwent linear muscle incision (not zigzag incision) at the right side. Temporal hollowing deformity is prominent. Left-sided image is the figure of preoperative period and right-sided is of postoperative period.

RESULTS

Effect of Muscle Incision at Temporal Hollowing (Age-Independent)

The mean change in the muscle incision group (–0.97) was smaller than the non-muscle incision group (–0.23); the difference between these two values was considered statistically significant ($p<0.0001$).

Effect of Muscle Incision at Temporal Hollowing Before 12 Months

Although the mean change in the muscle incision group (–0.4167) was smaller than the group without muscle incision (–0.1923), yet no statistically significant difference was found between these two values ($p=0.1$).

Effect of Muscle Incision at Temporal Hollowing After 12 Months

The mean change in the muscle incision group (–1.33) was smaller than the non-muscle incision group (–0.2857); the difference between these two values was statistically significant ($p<0.0001$).

Effect of Age at Temporal Hollowing Without Muscle Incision

The mean change (–0.2857) in the group that was operated after 1 year but not muscle advancement was found to be smaller (–0.1923) than the group that was operated before 1 year and without muscle advancement. However, there was no statistically significant difference between these two values ($p=0.2983$).

Effect of Age at Temporal Hollowing with Muscle Incision

The mean change (–1.33) in patients who were operated after the age of 1 year was smaller when compared with the group operated before 1 year (–0.4167); the difference between these two values was statistically significant ($p=0.0003$).

DISCUSSION

Fronto-orbital advancement in unilateral coronal synostosis (plagiocephaly) appears to decrease the risk of intracranial pressure; however, aesthetic shortcomings do occur (10). Temporal hollowing commonly occurs after cranial vault remodeling (12). The etiology of temporal hollowing is of bony origin in trigonocephaly (13), and temporal hollowing can be persistent after surgery (1).

Temporal hollowing after surgical correction of anterior plagiocephaly may be caused by either bony or soft tissue deficiency, and sometimes both at the same time. Rodriguez-Florez et al. had demonstrated aberrant temporalis replacement following fronto-orbital remodeling for metopic synostosis that contributed to late deformity (9). Engel et al. had proposed that temporal hollowing was a combination of both bony and soft tissue origin and the surgical technique as well (5). The surgical procedure creates an area with deficient bony and soft tissue because of the advanced orbital bar. Careful dissection and elaborate surgical technique are required for good bony tissue regrowth at the cut edges of the bone. The problem at the temporal area is further progressed when inadequate resuspension of the temporal muscle is processed. Martini et al. had studied the functional measurement of temporalis muscle after fronto-orbital advancement and demonstrated no measurable dysfunction following surgery (7). The hollowing, whether bony or soft tissue origin, seems to worsen by time (7,13) and may be independent from the muscle function. Steinbacher et al. had demonstrated that temporal hollowing takes its source from bony tissue; however, they had also mentioned that the decreased temporalis muscle thickness may contribute the hollowing (11). Reconstruction of the temporalis muscle is essential in craniosynostosis surgery whatever may be the surgical technique. The zigzag incision of the temporalis muscle enables both V–Y closure, when necessary, and reattachment of the muscle easily. No detachment of the temporalis muscle is performed from the bony insertion or the point of origin when this technique is used. The rapid reattachment of the muscle fibers decreases the operative time and reconstitutes the muscle integrity. Although the temporal muscle is not separated from its insertion or origin, it is aimed to make the incision as distal as possible in our technique since denervation may occur by cutting and resuspending the muscle. Thus, we have hoped to avoid neurogenic denervation. Although cranial synostosis surgery is recommended before 1 year of age, it was observed that muscle advancement had caused temporal hollowing in the post-1-year-old group; this can be explained by the fact that post-1-year-old muscle growth was accelerated compared to the preoperative period, and therefore it can contribute more to temporal fullness. The number of patients eligible for this study was limited to 35 after our inclusion and exclusion criteria. All the patients were analyzed by a blind medical doctor and categorized according to their demographic data. This technique is proved beneficial for temporal fullness regardless of age.

CONCLUSION

Fronto-orbital advancement alone was unable to restore normal contour in temporal region, therefore, it is necessary to advance the temporal muscle along with cranial bone advancement to solve this problem. In our technique, zigzag incision allows the advancement of the muscle with the V–Y pattern as is known from basic plastic surgery practice. Thus, we believe that our technique will also contribute to muscle elongation.

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