International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V14I2.292 ISSN:1308-5581 Vol 14, Issue 02, 2022

EVALUATION OF THE FACTORS ASSOCIATED WITH TEMPORAL HOLLOWING AFTER PTERIONAL CRANIOTOMY – AN ORIGINAL RESEARCH

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ABSTRACT

Aim

The purpose of the present research was to assess various factors which affect temporal hollowing after pterional craniotomy procedure.

Methodology

A retrospective study of patients who underwent pterional craniotomy was conducted. Inclusion criteria included older than 18 years, having undergone unilateral pterional craniotomy, and with no craniofacial anomaly or temporal defect. Volumes of bone, temporalis muscle, and extratemporalis layer were calculated.

Results

A total of 51 patients were included. Bone volumes of surgical and nonsurgical sites were 219.12 + 23.02 cm3, and 228.39 + 22.76 cm3, respectively ($p = 0.04$). Difference of bony volume was 9.10 cm3 (3.99%). Volumes of temporalis muscle in surgical and nonsurgical sites were 12.86 + 3.95 cm3, and 18.10 + 6.08 cm3, respectively ($p < 0.005$). Difference of muscle volume was 5.08 cm3 (28.32%). Volume of extratemporalis soft tissue in surgical and nonsurgical sites were 11.99 + 5.70 cm3, and 17.31 + 7.76 cm3, respectively ($p < 0.005$). Difference of soft tissue volume was 5.56 cm3 (31.68%).

Conclusion

Hollowing after pterional craniotomy is an unavoidable result. Bone, temporalis muscle, and soft tissues are combined etiologies. Volume of temporal area reduction was 19.74 cm3. Immediate reconstruction is recommended and volume of reconstruction is calculated from preoperative imaging.

Keywords pterional craniotomy, temporal hollowing, aetiology, bone volume

INTRODUCTION

Temporal hollowing deformity (THD) is a contour irregularity in the frontotemporal region, which is a common complication following surgical dissection of the temporal region or use of the coronal approach for neurosurgery.[1-4] THD is characterized by a concave contour within the pterional region, along the temporal fossa and posterior to the lateral orbital rim, which results in facial asymmetry in the frontal view.[2-6]Although most cases of THD remain unreported, THD is a highly prevalent complication of craniotomy/ craniectomy.[7] The reported incidence is surprisingly high, approaching up to 52%; thus, THD is likely to occur in one of every two patients undergoing craniotomy/ craniectomy. Furthermore, THD is permanent even after cranioplasty, which aims only to restore bony continuity without consideration of soft tissue loss during the procedure.Although the surgical outcome may be functionally successful, THD may cause significant deformity, which can be a source of serious concern and distress to patients due to social stigma.[3-5] With increased concerns regarding quality of life, there is greater demand for correction of THD. Various techniques and materials have been developed, from bone continuity restoration to soft tissue volume augmentation.

Autologous fat graft, injection of fillers, autologous tissue transfer, and synthetic alloplastic implants have all been used. Among them, vascularized free tissue transfer has the advantages of deformity correction and maintenance of the soft tissue volume, despite a somewhat unfavorable surgical field.[1-10]Pterional craniotomy, first described by Yasargil in 1975, is one of the most commonly used techniques in vascular neurosurgery.[3] Although this approach enables easy access to a variety of lesions in the anterior and middle cranial fossae, superior aspect of the posterior cranial fossa, sellar and parasellar regions, superior orbital fissure, and cavernous sinus, it has several limitations, such as temporalis muscle atrophy and facial nerve damage, which are matters of great concern to patients even with successful postoperative outcome.[4]Several techniques have been proposed to address this problem, depending on the authors' hypotheses, such as split myofascial bone flap, interfascial pterional craniotomy, or avoidance of dissection beneath the superficial layer of deep temporal fascia or through the temporal fat pad. However, no gold standard has yet been identified with respect to the optimal surgical technique for preventing temporal hollowing after pterional craniotomy, because the actual etiologies of hollowing are still debated and inconclusive. This study's objective is to determine the etiology and predictive factors of temporal hollowing after pterional craniotomy.

AIM OF THE PRESENT STUDY

The purpose of the present research was to assess various factors which affect temporal hollowing after pterional craniotomy procedure.

METHODOLOGY

A retrospective study of patients who underwent pterional craniotomy between January 2016 and December 2018 was conducted. Inclusion criteria included age of over 18 years; experience of having undergone unilateral pterional craniotomy; absence of previous craniofacial anomaly, trauma, or surgery; and absence of previous temporal area defect or injury.Exclusion criteria were experience of emergency surgery, advanced tumor with bony resection. Pterional craniotomy was performed. MRI and CT scans were performed before the operation,immediately postoperation, and 6 months postoperation.The volume of bone was calculated using IPLAN CRANIAL 3.0.6 BRAIN LABORATORY based on the CT scans of both the left and right Sites. In group 1, part of the muscle was elevated, leaving a cuff of temporalis muscle comprising at least 1 cm at the superior temporal line, and the temporal muscle was resutured upon completion of the procedure. In group 2, the entire temporalis muscle was elevated without leaving a cuff, dissected from the temporal bone at its origin, and reattached to the temporal bone by drilling the bone and fixing the muscle with nonabsorbable suture to the bone.The volumes of bone, temporalis muscle, and extratemporalis soft tissues were calculated, including the preoperative surgical site and postoperative surgical and nonsurgical sites. The univariate analysis of the independent variables was accomplished using the chi-square test and independent *t*-test. A *p*-value of <0.05 was considered statistically significant.

RESULTS

A total of 51 patients were included in the study. Thirty-five patients were female (68.6%). The patients' mean age was 52.1 years (range 20–77 years). Sixteen patients had experienced operative times of more than 8 hours. The average area of craniotomy was 153.85 cm2 Bone volumes of the preoperative and postoperative surgical and nonsurgical sites were 228.22 ± 23.38 cm3, 219.12 ± 23.02 cm3, and 228.39 ± 22.76 cm3, respectively. (Table1)The difference in the volume of bony tissue between surgical and nonsurgical sites was 9.10 cm3 (3.99%). The volumes of the temporalis muscle in preoperative surgical, postoperative surgical, and nonsurgical sites were 17.94 ± 7.01 cm3, 12.86 ± 3.95 cm3, and 18.10 ± 6.08 cm3, respectively. Statistically significant differences in muscle volume were observed between postoperative surgical and nonsurgical sites. The difference in bony tissue volume in cases with operative times of less than 8 hours was 9.10 ± 5.34 cm3 and in cases with operative times of more than eight hours it was 8.65 ± 4.12 cm3.The volumes of temporalis muscle in cases in which part of the muscle was elevated, leaving a cuff of temporalis muscle group for both postoperative surgical and nonsurgical sites were 13.62 ± 4.30 cm3 and 18.36 ± 6.55 cm3, respectively. Statistical significance was observed between postoperative surgical and nonsurgical sites in cases in which part of the muscle was elevated, leaving a cuff of temporalis muscle group. (Table 2)

Table 1- Volume of temporalis muscle in postoperative pterional craniotomy between leave and nonleave cuff muscle

	Part of muscle elevated leaving a cuff of temporalis muscle (*n* = 37)		**Entire temporalis elevated without leaving a cuff (*n* = 14)**		**Surgical site**	
	Surgical site	Nonsurgical site	Surgical site	Nonsurgical site	Part of muscle	Entire temporalis

					elevated leaving a cuff of temporalis muscle (n = 37)	elevated without leaving a cuff (n = 14)
Volume of temporalis muscle (cm3) (mean ± standard deviation)	13.62 ± 4.30	18.36 ± 6.55	10.37 ± 1.75	16.96 ± 4.62	13.62 ± 4.30	10.37 ± 1.75
p-Value	<0.001		0.005		0.001	

***A p-value of <0.05 was considered statistically significant.*

Table 2-Bony volume in different sites of postoperative pterional craniotomy between surgical and nonsurgical sites

Bone site	**Surgical site (cm3) (mean ± standard deviation)**	**Nonsurgical site (cm3) (mean ± standard deviation)**	***p*-Value**
Frontal	52.70 ± 7.74	55.57 ± 8.85	0.06
Parietal	116.98 ± 13.29	120.56 ± 13.05	0.11
Temporal	42.45 ± 5.71	44.79 ± 4.88	0.02
Zygoma	6.76 ± 2.55	7.47 ± 2.42	0.10
Total	219.12 ± 23.02	228.39 ± 22.76	0.04

DISCUSSION

The incidence of hollowing after temporal craniotomy is reportedly 87 to 100%.[11] All patients in our study showed temporal hollowing after pterional craniotomy. The patients reported feeling that this is a hallmark of neurosurgery aimed at treating neurological disorders and that it can cause psychosocial problems. Many methods have been developed to rectify this outcome, including both prophylactic and therapeutic modalities. Controversy has arisen regarding whether the cause of hollowing originates in soft tissue or bony tissue.[12]Temporal hollowing is a contour irregularity in the frontotemporal area, which commonly develops following surgical dissection in the temporal region, including via the intracranial access procedure.[13] Temporal hollowing can cause significant craniomaxillofacial asymmetry, esthetic deformity, and serious cosmetic concern in patients, even when there is an excellent postoperative functional outcome. The proposed mechanisms of temporal hollowing include devascularization, denervation, or disruption of the fat pads or temporalis muscle.In pterional craniotomy using the "interfascial temporalis flap" technique, the intermediate temporal fat pad is split vertically to create two separate composite flaps. The anteriorly reflected flap includes skin, superficial temporal fascia, partial superficial layer of the deep temporal fascia, partial intermediate temporal fat pad, and partial deep layer of the deep temporal fascia. The posteroinferiorly reflected flap includes the temporalis muscle, deep temporal fat pad, partial deep layer of the deep temporal fascia, and partial intermediate fat pad. Use of the myocutaneous flap technique has been reported to avoid fat pad dissection. De Andrade et al. reported that a myocutaneous flap group showed significantly lower levels of temporal hollowing compared to an interfascial temporalis group. However, this technique limits exposure of the anteroinferior temporal fossa.[7]Our study showed that the decrease in the volume of temporalis muscle after surgery was statistically significant and that the average volume reduction was 5.08 cm3 (28.32%). However, the volume of temporalis muscle reduction in cases in which part of the muscle was elevated, leaving a cuff of temporalis muscle, was lower than that in cases in which the entire temporalis was elevated without leaving a cuff. At present, no gold standard for surgical technique has been developed to prevent temporal hollowing after pterional craniotomy. Both immediate and late reconstructions of the temporal area have been reported, with many materials, including autogenous and nonbiologic materials, used.14,17-24 No definitive implants have demonstrably yielded the best results.

CONCLUSION

Temporal hollowing is an inevitable outcome following pterional craniotomy. No predictive factors, such as age, sex, causes of disease, time of operation, postoperative radiation, or surgical technique, have been identified.

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