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ORIGINAL ARTICLE

Dysfunction of the Temporalis Muscle Following Pterional Craniotomy: Analysis of 20 Cases

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ABSTRACT

Background & Objectives: *Temporalis muscle dysfunction following pterional approach for skull base approaches is commonly encountered which is very discomforting for patients however, literature regarding its management is insufficient. This study presents 20 cases over the course of 4 years and discuss the pitfalls in the management of temporalis muscle dysfunction following pterional craniotomy for various lesions.*

Materials and Methods: *Sixty patients were operated using the pterional craniotomy, out of which 20 patients were included in the study. In these cases we used three methods of temporalis muscle dissection namely, the submuscular, subfascial & interfascial. Postoperatively, patients were followed for a median of 8 months. Detailed description of the follow-up findings and their statistical associations is presented.*

Results: *Twenty patients with 12 (60%) males & 8 (40%) females with mean age of 43.8 ± 10.9 years were operated. Twelve (60%) patients were operated using the submuscular approach, 6 (30%) by the subfascial method and 2 (10%) by interfascial technique of temporalis muscle dissection. Of the 20 patients, 8 (40%) reported trismus, 10 (50%) had temporal region and jaw pain and 14 (70%) complained of difficulty chewing. For these patients, we employed local heat therapy (n = 14, 70%), chewing exercises (n = 12, 60%) and oral range-of-motion exercises (n = 9, 45%). 78.5% of patients responded with resolution of pain after local heat therapy, 80% with jaw range-of-motion exercises. The temporal hollowing was assessed by plastic surgeon, but none of the patient pursued plastic surgery intervention.*

Conclusion: *Temporalis muscle dysfunction following pterional craniotomy occurs in about one-third of patients. It is a cause of significant patient concern. Physiotherapy and oral analgesics can alleviate the common symptoms. Patients must be informed about this complication to avoid undue psychological distress. Early diagnosis & management leads to better patient response.*

Keywords: *Temporalis muscle dysfunction, pterional craniotomy, postoperative complications.*

INTRODUCTION

Pterional craniotomy is the workhorse approach for skull-base lesions such as pituitary adenomas, Craniopharyngioma, sphenoid wing tumors and aneurysms involving the anterior, middle and even the posterior circulation.[1,2] This approach involves dissection of the temporalis muscle because the bone flap that has to be elevated involves the junctional region of frontal, temporal, zygomatic and part of sphenoid bone.[3,4] The pterional area is covered by temporalis muscle and various methods have evolved for elevation.

Bone flap **submuscular**, it include initial elevation of the temporalis muscle from the bone.

Incision of the muscle and elevation of the bone with muscle (subfascial & interfascial).[5,6,7]

All methods, however, involve invasive handling of the temporalis muscle. This commonly led to

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muscle atrophy due to either ischemic injury and fibrosis, denervation or disuse by the patient due to pain.[8,9] The muscle atrophy lead to problems in mastication and patient discomfort as well as dysfunction of the temporomandibular joint and abnormality in the opening of the jaw.[1,10]

We aim to present our data regarding incidence and management of temporalis muscle dysfunction following pterional craniotomy because although there are widespread views about how to prevent this complication there is deficiency about its management. We would also like to emphasize the importance of multidisciplinary approach regarding management of temporalis muscle dysfunction. This will eventually improve patient outcomes and reduce chronic complications of a successful cranial surgery.

MATERIALS AND METHODS

Study Design

This study represented a retrospective overview of prospectively collected data between January 2015 & January 2019 of patients undergoing pterional craniotomies for various diagnoses. The institutional review board granted ethical approval for this study. All patients included in the study provided an informed consent.

Inclusion Criteria

We included patients between 15 and 65 years of age who underwent pterional craniotomy for various skull base lesions.

Exclusion Criteria

Patients with incomplete data and those with death in the early postoperative period were excluded.

Data Collection Procedure

All follow-up patients were examined in detail and particular attention was paid to the presence of temporalis muscle dysfunction, which may either present as trismus (restriction of jaw movements), temporal swelling, temporal pain & tenderness as well as temporal hollowing due to temporalis muscle atrophy. Data was collected about diagnosis, surgical technique used, follow-up duration, presenting complaints regarding temporalis muscle dysfunction, management strategies, time to resolution & final-outcome.

Surgical Approaches

All patients were operated by consultant neurosurgeons under general anesthesia. Postoperatively, the patients were kept in the surgical ICU and were shifted to the ward after overnight observation.

Interfascial Method

Yasargil in 1980s popularized Interfascial method and still practiced today. In this technique, approximately 4 cm above the lateral orbital rim, an incision is made in the superficial layer of the temporalis fascia starting from the **anterior limb of the inferior temporal line** extending it to the **root of the zygoma**. This incised superficial layer is retracted with fishhooks anteriorly, which exposes the **superficial fat pad**, which lies between the superficial and **deep** layers of the temporalis fascia. This elevates the facial nerve **frontalis branches** anteriorly as these branches lie on the surface of the superficial layer. The deep layer is incised down the temporalis parallel along the line of incision. **Another incision** is made along the **superior temporal line**, leaving a cuff of the temporalis fascia for later repair. The muscle is then dissected from the bone with periosteal elevator and retracted anteroinferiorly.

Subfacial Method

In the subfascial method, an incision is made in the **superficial and deep layers of temporalis** muscles and they are reflected **anteriorly** along with the scalp fold. The subfascial dissection is taken down to the **zygoma**. Incision in the muscle is taken down to the bone with stripping of the muscle from the bone in a retrograde fashion. The upper border of the temporalis muscle is incised along the **superior temporal** line, leaving a cuff of muscle and fascia.

Submuscular Technique

In Submuscular technique the incision in the temporal muscle is taken down to the bone and **muscle is dissected off from the bone elevating** the temporalis fat pad along with the temporalis fascia and TM in a single block. The muscle is also dissected along the superior temporal line and muscle is dissected off the bone with periosteal elevators. The muscle is retracted anteroinferiorly with fishhooks. **Free bone flaps** is raised.

Statistical Analysis

Data was recorded in an excel chart and was analyzed using SPSS version 25.0. Continuous data is presented in mean ± standard deviation and categorical variables are presented in frequencies and percentages. Statistical significance was kept at 0.05.

RESULTS

Twenty-five patients developed temporalis muscle dysfunction out of which five patients were excluded from the study due to inadequate clinical data. There were 12 (60%) males and 8 (40%) females. The mean age was 43.8 ± 10.9 years (range: 20 – 60).

Table 1 shows the primary histopathological diagnoses for which a pterional craniotomy was performed along summary of the clinical findings & demographics. There were 30% (n = 6) cases who were hypertensive, 20% (n = 4) were diabetic, 10% (n = 2) ischemic heart disease and 5% (n = 1) asthmatics. All of these patients were on long-term (>30 days) oral steroids after surgery. No association of the comorbidities with temporalis muscle dysfunction were noted (Fischer p = 0.18) (**Fig. *1***).

Twelve (60%) patients were operated using the submuscular approach, six (30%) by the subfascial method and two (10%) by interfascial technique. The mean operative time was 2.8 ± 2.1 hours while the median number of transfusions per procedure was 2 (range: 0 – 3).

The most common method of temporalis muscle dissection was submuscular (n = 11, 55%), followed

Table 1: *Summary of the study patients: their demographics, operative & clinical findings.*

					Postoperative Clinical Findings			
S. No.	**Age**	**Gender**	**Diagnosis**	**Dissection Method**	**Pain**	**Trismus**	**Chewing Difficulty**	**Temporal Hollowing**
1.	50	Male	Sphenoid Wing Meningioma	Submuscular	+	+	-	-
2.	45	Female	Pituitary Adenoma	Submuscular	+	+	-	+
3.	48	Male	Craniopharyngioma	Interfascial	-	-	+	-
4.	55	Female	Sphenoid Wing Meningioma	Interfascial	-	-	+	+
5.	60	Male	Pituitary Adenoma	Subfascial	+	-	+	-
6.	34	Male	Craniopharyngioma	Interfascial	+	+	-	-
7.	32	Female	Pituitary Adenoma	Submuscular	-	-	+	+
8.	47	Male	Glioma	Submuscular	-	+	+	-
9.	37	Male	Sphenoid Wing Meningioma	Submuscular	+	-	-	-
10.	45	Female	Glioma	Submuscular	+	-	+	+
11.	56	Female	Sphenoid Wing Meningioma	Interfascial	-	+	+	+
12.	58	Male	Pituitary Adenoma	Submuscular	-	-	+	-
13.	53	Male	Pituitary Adenoma	Submuscular	-	+	+	-
14.	46	Female	Pituitary Adenoma	Interfascial	+	-	-	+
15.	49	Male	Glioma	Subfascial	+	-	+	-
16.	36	Male	Tuberculum Meningioma	Submuscular	-	+	+	-
17.	25	Female	Tuberculoma	Interfascial	-	-	+	-

18.	20	Male	Glioma	Interfascial	-	-	+	-
19.	45	Female	Sphenoid Wing Meningioma	Submuscular	+	-	-	+
20.	35	Male	Pituitary Adenoma	Submuscular	+	+	+	-

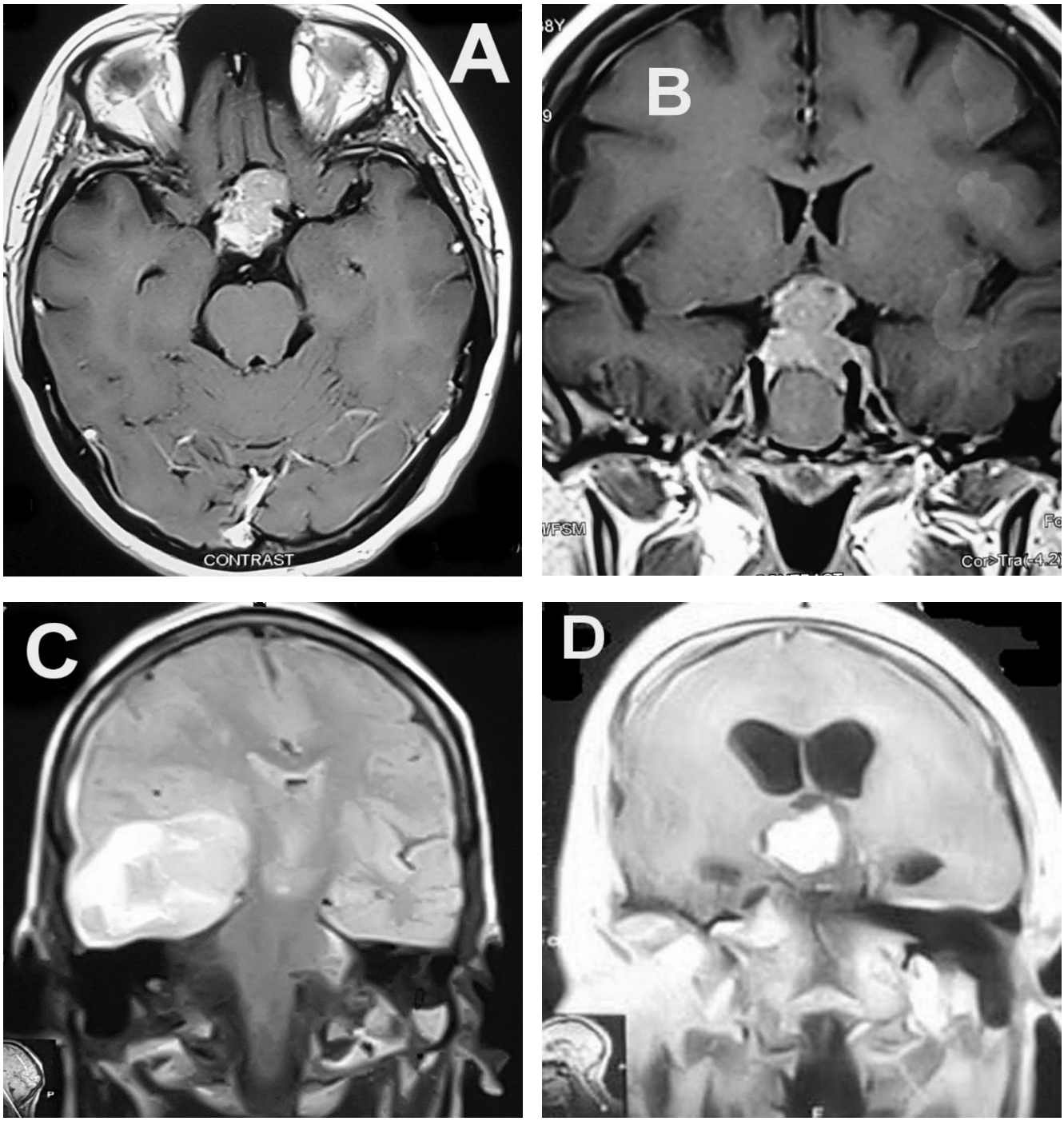

Fig. 1: *Some case examples; A & B, Pituitary Macro-adenoma, C, Glioma involving the temporal tip, D, Craniopharyngioma in a 35 year adult.*

by interfascial (n = 7, 35%) and subfascial (n = 2,10%). No association was noted between dissection method and temporalis muscle dysfunction.

All our patients reported within the first postoperative month with 90% patients reporting complaints of temporalis muscle dysfunction at the two-week follow-up after surgery. Of the 20 patients, 8 (40%) reported trismus, 10 (50%) had temporal region and jaw pain and 14 (70%) complained of difficulty chewing.

Management

For these patients, we employed local heat therapy (n = 14, 70%), chewing exercises (n = 12, 60%) and oral range-of-motion exercises (n = 9, 45%).

Local heat therapy was effective in reducing pain & swelling in 78.5% (n = 11/14) which usually occur during early postoperative period. Similarly, patients with trismus were advised chewing exercises as well as range of motion exercises, which included the forceful opening of the jaw with index and thumb fingers of both hands in opposite direction. In the majority of patients, the limitation in range of motion resulted from prolonged disuse.

Outcome

Mere encouragement to chew normally and provision of oral analgesics lead to reduction in intensity of the clinical problem in 80% (n = 16) of patients.

50% (n = 10) patients had resolution of their problem within 3 follow-up visits while in the remaining 50%, 3 (15%) patients were ultimately referred to maxillofacial surgeons. One patient required long-term physiotherapy for pain & trismus and only achieved partial recovery at 10-month follow-up.

We tested our data of different dissection methods for association with temporalis muscle dysfunction. However, there was no significant association between the dissection method and postoperative temporalis muscle dysfunction. There were 30% (n = 6) cases of trismus in submuscular dissection group, 10% (n = 2) in the interfascial and none in the subfascial dissection group (p = 0.261). Pain complaint was reported by 30% (n = 6) for the submuscular group, and 10% (n = 2) each for interfascial & subfascial methods (p = 0.185). Chewing difficulty was noted in 35% (n = 7) for submuscular group, 10% (n = 2) for subfascial and 25% (n = 5) for interfascial group (p = 0.584).

However, we noted that in 7 (35%) cases where there was prolonged surgical retraction (> 4 hours), irrespective of the dissection method, developed postoperative atrophy of the temporalis muscle with temporal hollowing (p < 0.001). All patients were females and they presented within 8 weeks of surgery with the temporal depression in the anterior part of the temporalis fossa. These patients were assessed by a consultant plastic surgeon who advised surgical reconstruction. However, none of the patients opted to undergo surgical intervention.

DISCUSSION

Skull base lesions are commonly encountered in neurosurgical practice and those in the anterior and middle cranial fossa are approached through the pterional craniotomy or its modifications.[5,11] Temporalis muscle mobilisation is the cornerstone of this approach. Literature suggests that **pain, chewing difficulty & trismus** are some of the common problem.[6,12] Temporalis muscle **atrophy** with temporal **depression** is aesthetically a significant complication.[12,13] Various **aetiologies** leading to **degeneration** of the temporalis muscle **fat pad** are presented in the literature.[14] Multiple studies have reported a complication rate of 50% - 70% following surgical approach through the temporalis region.[15-16,17] Over the course of time however, various researchers have suggested several techniques of temporalis muscle dissection & its separation from bone as well as preservation techniques for the **vascular supply** as well as the **facial nerve branches** which courses across the anterior one-third of the temporalis region.[1,18,19] Additionally, another cohort of researchers have focussed on the management issues in restoration of the temporalis muscle **function** as well as its **aesthetic** restoration. Despite the ongoing research, data is insufficient about the management of these complications.[17]

Our study presents an overview of the prospectively collected data. During the study period, 60 cases of pterional craniotomy were recorded, in which 25 **(41.7%)** cases presented with significant complaints needing clinical intervention. Out of the 25 patients we selected data of **20 patients**. This data as presented above is indicative of the fact that almost one-third to half of patients who undergo pterional craniotomy are at risk of developing temporal muscle **dysfunction**. The reasons might be several folds. One of the most common reasons is the **trauma** of the

dissection itself, which renders the muscle at risk of degeneration. Some authors have suggested the **line of muscle incision** as the factor determining risk of temporal muscle dysfunction & degeneration of the temporal fat pad.[18] **Coronal incision** with the **splitting** of the muscle fibers rather than incising at the anterior one-third followed by **subperiosteal dissection** is suggested to be the one method for **preserving function & bulk** of the temporalis muscle. Matic et al[20] have suggested that a **suprafascial dissection plan** preserves muscle function & bulk. Similarly, Bowles et al[21] have presented a technique of **subperiosteal dissection** and **fixation** of the muscle with making small **burr-holes** with a 1-2 mm drill bit and **fixating** the muscle according to the orientation of its fibres. They reported no cases of temporalis muscle dysfunction or hollowing in a sample of 100 cases. Zager et al[19] reported use of **micro-screws** along the superior temporal line to which the temporalis muscle is anchored. We used the method described by **Yasargil**[2] in which the temporalis muscle and its fascia is incised along the **superior temporal line**, leaving a cuff of muscle and fascia to which the temporalis muscle is **anchored** at the end of the procedure.

Matic et al[20] in their randomized controlled study has recommended the use of **suprafascial dissection** and to reduce patient weight loss in order to prevent temporal hollowing. Similarly, Vaca et al[18] in a systematic review of techniques to prevent temporal hollowing has classified evidence in the following order; **avoidance** of **dissection** below the **superficial temporal fascia** or through the intermediate fat pad (Level I and II). Similarly, there is level II evidence that the **origin** of **temporalis muscle** must be preserved. There is level I evidence that dissection through the temporal fat pad will increase the chances of temporal atrophy and **denervation**.[18]

All our patients reported within 30 days with 90% reporting about their problem in the first **two weeks** after surgery. Studies by Abdulazim et al,[17] and Kawaguchi et al[22] reported that patients with temporalis muscle complaints reported **within 3 months**. It is important to follow patients closely and to monitor therapy for restoration of temporal muscle function, since **early** institution of **physiotherapy** can prevent **atrophy** due to **disuse** as well as help in restoration of jaw range of motion. Although most authors have focussed on the methodology of craniotomy and dissection methods of the temporalis muscle, it is important to note that postoperative screening with institution of **physiotherapy** can be helpful and majority of patients **respond** to these conservative measures. However, it is also noteworthy, that temporalis muscle dissection should also be taken into consideration and factors such as **avoiding aggressive dissection** use of **diathermy** and careless retraction should be **avoided**.[12,13,23] Though, we did not measure objectively, the symptoms of temporalis muscle dysfunction produce significant psychological concern and can easily hamper recovery after the index surgery. It is important that this complication be discussed with the patient/relatives during the informed consent procedure.

The limitations of our study are the **small number** of patients and the **retrospective** nature of the study due to which no final conclusions can be made. The smaller sample size may also be an explanation for failure to show a statistical **significance** for a particular dissection method.

CONCLUSION

It is important to note that temporalis muscle dysfunction present in the form of atrophy, swelling, pain and restriction of jaw movements. This complication occurs in almost one-third to half of patients and patients should be closely followed for timely treatment. A majority of patients respond to local physiotherapy techniques, however the temporal hollowing is troublesome and eventually needs plastic surgery intervention. It is also important to consider discussing about this complication before the index surgery during the informed consent procedure, since it leads to significant concern in patients who are not completely informed about this complication.

ROLE OF AUTHORS

Dr. Muhammad Mukhtar Khan and Dr. Muhammad Idrees Khan: Treatment and Literature Review.
Dr. Khial Jalal and Dr. Faiqa Filza Khan: Paper Writing.
Dr. Muhammad Nawaz: Paper Editing and Results Writing.
Dr. Irfan Jan: Data Collection.
Dr. Tariq Khan: Study Design and Overall Supervision.

Additional Information

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Authors report no conflict of interest.

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In compliance with the ICMJE uniform disclosure form, all authors declare the following:

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