Original article

TEMPORALIS MYOFASCIAL FLAP IN OROFACIAL RECONSTRUCTION: A REVIEW AND EXPERIENCE OF A NORTHERN NIGERIAN HOSPITAL

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ABSRACT

Context: Temporalis Myofascial flap (TMF) has high success rates in reconstructing oro-facial defects thus overcoming many limitations of using other pedicled flaps.

Aim: To report the experience in the use of TMF for oro-facial reconstructions at the hospital.

Setting and Design: A retrospective study of patients who presented with various needs for cranio-maxillofacial soft tissue reconstruction in which TMF was used to meet those needs at a hospital in North-western Nigeria between November 2018 and July 2023.

Materials and Methods: This was a descriptive retrospective cohort study where

a self-designed proforma was used to extract information from patients' medical records.

Statistical Analysis Used: Data was analysed using *IBM Statistical Package for Social Sciences 23.*Significant association levels was set at $p \leq 0.05$.

Results: Thirty-eight cases, 20 males and 18 females between ages 6 and 60 years involving TMF use were reviewed. The TMF proved to be a versatile flap judging from its many indications for its use (Table 1). All the TMFs used were inferiorly based and were successfully utilized in 37 (97.4%) cases. An overall complication rate of 31.4% was reported in 12 patients consisting of re-ankylosis deep to TMF (n=1),transient pre-auricular swelling following ankylosis release (n=2),trismus(n=1),wound dehiscence following reconstruction of maxillectomy defects (n=1),asymmetric infra-orbital contour following orbital floor reconstruction(n=2) and 5 (13.2%) cases of acquired temporal hollowing. Development of these complications was significantly associated with the complexity of the surgical reconstructions (Fisher's exact test ($p=0.002$ Table 2.)

Conclusion: The TMF is a significant and reliable pedicled tissue for oro-facial reconstruction in its simplicity, versatility,extent, vascularity and incidence of easily manageable complications. Its outcome is comparable to other pedicled flaps and popular microvascular alternatives for oro-facial reconstruction.

Keywords: Temporalis Myofascial flap, oro-facial defect, reconstruction

INTRODUCTION

Vascularized free flaps are becoming popular for the reconstruction of oro-facial defects. However, free flaps' use for oro-facial reconstruction requires specialized surgical skills, which are presently unavailable in

many hospitals locally. This results is a consequent paucity of scientific literature on free flap use for oro-facial reconstruction in our environment Thus, using pedicled flaps remains relevant in reconstructing oro-facial defects, especially in resource-limited settings like ours.

Pedicled forehead, nasolabial, deltopectoral and pectoralis major flaps commonly used in oro-facial reconstructions may be limited in terms of their areas of coverage, size, vascularity, association with hair growth, and tissue composition when considered in the reconstruction of oro-facial defects.[1-6] Alternatively, microvascular free transfers (MFT) which is the "gold standard" in oro-facial defect reconstruction are very technique sensitive, expensive, time consuming, create distant donor site morbidity, usually involve two teams and are often associated with extensive fluid shifts.[7-10]The use of Antero-lateral Thigh(ALT) or Radial Forearm Free Flaps (RFFF) are popular options for palatal defect closure and are very reliable options in the long-term prevention of nasalance and significantly aid swallowing following palatal reconstruction.[7-11]However, the Temporalis Myofascial Flap (TMF), a relatively less frequently employed pedicled flap, to a large extent, has unavoidably overcome the limitations of the other 2 approaches and is associated with versatility, robustness and high success rates in the reconstruction of many oro-facial defects at the study center(1–6) .The circumvention of limitations of MFT in palatal defect reconstruction and flap survival is inherent in the TMF approach because of its simplicity ,exuberant vascularity, single team approach thus eliminating distant donor site morbidity and without the involvement of significant blood loss.

Previous studies have reported similar comparative reliability and good functional

outcomes using the TMF and free tissue tranfers for head and neck reconstruction.[7-11]The TMF have thus become the preferred alternative when the latter is contraindicated for reasons stated.[7,12-13]

The temporalis muscle which occupies the temporal fossa and inserts into the coronoid process and anterior border of the ramus, helps to retract and elevate the mandible[12] It is robust, pliable, and highly resilient due to its rich vascular supply. While the bulk of the muscle is supplied by the deep temporal artery, its superficial aspects and overlying fascia are supplied by the middle temporal artery. Differences in the vasculature of the muscle and its fascia make them applicable as axial flaps either separately or in combination as a single unit myofascial flap.[4]

This paper aims to report our experience in the use of temporalis muscle and fascia flaps in oro-facial reconstructions at the Aminu Kano Teaching Hospital, Kano, Nigeria (AKTH).

MATERIALS AND METHODS

The paper is a retrospective review of TMF utilization in oro-facial reconstructions at AKTH from November 2018 to July 2023. Ethical clearance for the study was granted by the AKTH Research and Ethics Committee (AKTH/MAC/SUB/12A/P-3/V1/3788). All cases involving TMF utilization during the period under review were identified from Maxillofacial clinic registers. The case files were retrieved for the collection of data including the bio-data, pre-operative diagnosis, indication for TMF utilization, surgical access to the TMF, pattern/mode of TMF utilization (split use – anterior, middle, or posterior segment or full muscle use), recipient site, technique of flap mobilization about prominent bone(s) in the path towards recipient site, follow-up time, and complications related to the TMF. Post -

operative care included early supervised jaw exercises under the influence of suitable analgesic and using an acrylic screw for the arthroplasty group.The defect augmentation group had regular daily dressing with warm saline lavage in those with intraoral wounds. All patients had routine post-operative analgesia and antibiotics with appropriate dosing and frequency for 5 days. Timelines for post-operative review were;1 week ,1 month,3months, 6 months, 1year and 2 years. Cases whose files were not retrievable or with incomplete data were excluded from the study. The data collected was directly entered into an Excel sheet on which descriptive and inferential statistics was done using IBM Statistical Package for Social Studies (SPSS version 23)

RESULTS

Thirty-nine cases involving the use of TMF during the review period were identified. One case of TMJ ankylosis whose case file was not retrievable was excluded from the study. Therefore, 38 cases involving 20 Males and 18 Females between the ages of 6 and 60 years were reviewed. The commonest pre-operative diagnosis warranting TMF use in cases reviewed was TMJ ankylosis *n*=32(84.2%), other diagnoses were squamous cell carcinoma of the Maxilla, Orbito-Maxillary Ossifying fibroma, post-osteomyelitis maxillary and orbital wall defects associated with globe damage and infra-orbital skin defect. The different pre-operative diagnoses of the cases and their frequencies are presented in Table 1.

Surgical access to the TMF (Fig.1) was via the Al-Kayat Bramley [8]approach in 31(81.6%) cases and the Endaural approach in 7(18.4%) cases.

The commonest indication for TMF use was as inter-positional/disc replacement material in TMJ ankylosis release *n*=30(79.0%), other indications for TMF use in the review include

use during post-maxillectomy and orbital wall/floor reconstructions. The indications for the use of the TMF in the study and their frequencies are highlighted in Table 1.

Of all the 38 cases, the purpose of use of the TMF was achieved in 37 (97.4%) cases. Only 1 case had TMJ reankylosis when TMF was used as an inter-positional/disc replacement material.

The TMFs used were inferiorly based split harvests in 33(86.8%) cases and full/whole muscle flap in 5(13.2%) cases (Fig.2). As a split flap, the middle-third segment of the TMF was used in 32(84.2%) cases (Fig. 1). An anterior half split TMF was used for orbital floor reconstruction in 1(2.6%) case following ablation of orbito-maxillary ossifying fibroma. In this case, the posterior half of the TMF was moved anteriorly to prevent an obvious temporal hollowing. No case of posterior TMF segment use was identified among the cases reviewed.

In cases of TMJ ankylosis release, the split TMF used was passed under the zygomatic arch (sub-zygomatic) to reach the arthroplasty gap created in 28(73.7%) cases while it was passed over the arch (supra-zygomatic) in 3(7.9%) cases. In 1(2.6%) case of extra-articular TMJ ankylosis, the zygomatic arch was ostectomized to allow mobilization of the TMF into the buccal region to fill a buccal defect after excision of fibrous adhesions that impaired mouth opening. In all the post-maxillectomy reconstructions, the full muscle was passed sub-zygomatic to reach the defect sites.

In 1(2.6%) case of orbital floor reconstruction, the TMF was teased off its insertion on the coronoid and passed over the lateral orbital wall (supraorbital approach) to reach the orbital region (Fig. 3) while in 2(5.3%) other cases of orbital floor reconstruction, the lateral walls were partially destroyed and the TMFs were

directly rotated into the orbital region through the defective parts of the lateral wall (trans-orbitectomy approach).

Split thickness skin graft was placed over the TMF in 2 cases - in 1 case of post osteomyelitic orbital wall defect to repair an associated infra-orbital full-thickness skin defect (Fig. 4) and in 1 case of composite Maxillectomy defect that involved full-thickness buccal skin excision. Intra-orally, in all 3 cases of maxillectomies, there was significant epithelization over the TMF used for palatal reconstructions at 4 weeks post-operatively.

The follow-up time ranged from 3 months to 1 year and the complications seen include facial asymmetry from excessive zygomatic prominence in 2 (5.2%)cases each of TMJ ankylosis and orbital floor repairs. The excess contour in the TMJ cases was temporary and was not clinically obvious 1 month post-operatively. One (2.6%) case of bony re-ankylosis deep to the inter-positional TMF was recorded among the TMJ ankylosis releases. In the post-maxillectomy reconstructions, 1(2.6%) case of minor palatal dehiscence and 1(2.6%) case of limitation of mouth opening occurred. Two cases (5.2%) of prominent infra-orbital contour occurred following orbital floor reconstruction with full TMF while there were 5 cases (13.2%) of temporal hollowing post -maxillectomy and orbital reconstruction using full TMF. There was no documentation of flap necrosis or loss among the cases reviewed. Fisher's exact analysis(Table 2) revealed that the development of complications was significantly associated with complexity of the surgical reconstruction (*p=0.002).*

Table 1: Frequency distribution of the presurgical diagnoses, indication for and pattern of use of TMF.

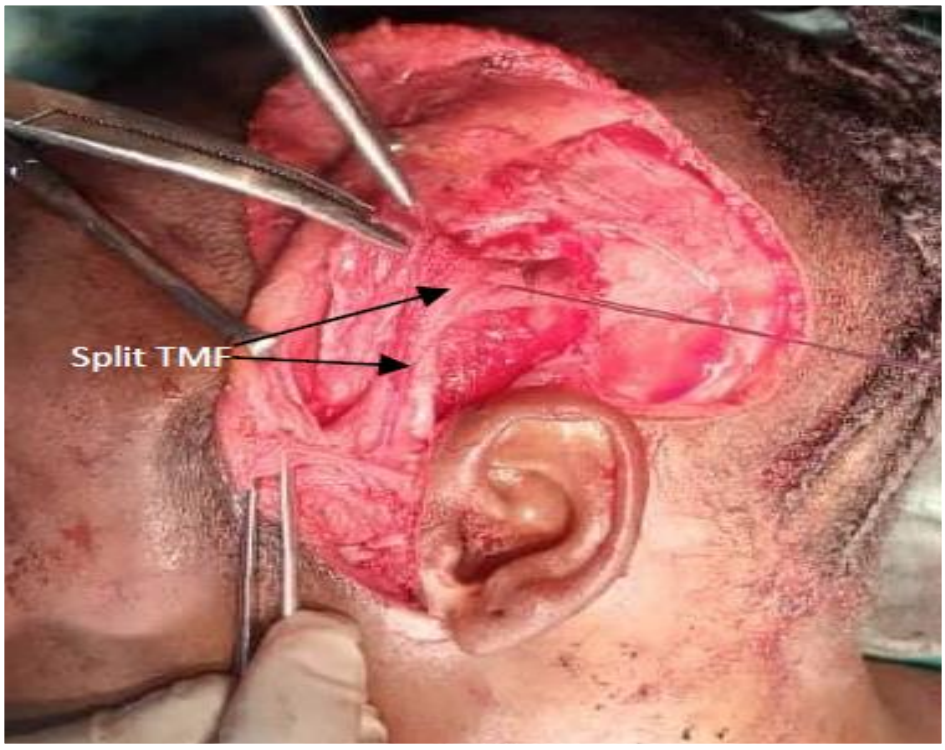
Presurgical diagnosis			Indication for use of TMF	Pattern of TMF use	N(%)	Complications
Temporomandibular joint ankylosis	Intra-articular		Interpositional arthroplasty material	Split muscle use – middle portion	30(78.9%)	i) Reankylosis deep to the interposional TMF (n=1) ii) Transient Preauricular post-operative swelling (n=2)
	Extra-articular	from extensive Post Cancrum Oris buccal fibrosis and intermaxillary bony fusion.	Resurfacing of buccal mucosal defect after fibrous tissue excision	Spilt muscle use – middle portion	1(2.6%)	--
		from Bucco-masseteric myositis ossificans	Resurfacing of buccal mucosal defect after segmental excision of ossified muscles to eliminate trismus	Split fascia use	1(2.6%)	--
Right Orbito-Maxillary Ossifying Fibroma			Orbital floor reconstruction to support orbital contents	Split muscle use – anterior portion	1(2.6%)	

Unilateral Maxillary antral carcinoma	Post ablative palatal reconstruction and maxillary defect obturation	Full muscle use	1(2.6%)	i) Temporal hollowing ii) Mild TMF-recipient tissue junction dehiscence
Unilateral (composite tissue) maxillary antral squamous cell carcinoma with cheek involvement	Post ablative Palatal and cheek reconstruction	Full muscle use with skin grafting over TMF in cheek defect area	1(2.6%)	i.) Temporal hollowing ii) Limitation of mouth opening
Bilateral palatal squamous cell carcinoma	Post ablative palatal reconstruction and maxillary defect fill	Full muscle use	1(2.6%)	Temporal Hallowing
Post osteomyelitic maxillary and orbital wall/floor defects	Orbital floor/lateral wall reconstruction for orbital prosthetic placement	Full muscle use with skin grafting over TMF in infraorbital skin defect in 1 case	2(5.3%)	i) Temporal Hollowing ii) Excessive Zygomatic and infraorbi

tal contour (n=2)

Table 2: Fisher's exact test of association between complexity of TMF use and development of complications

		Development of Complications		Total	p-value
		Yes	No		
Complexity of surgical use	Arthroplasty	2	28	30	.002
	Post ablative Reconstruction	5	3	8	
Total		7	31	38	



- Fig 1: Mid/central split TMF developed after exposure using Alkayat-Bramley approach

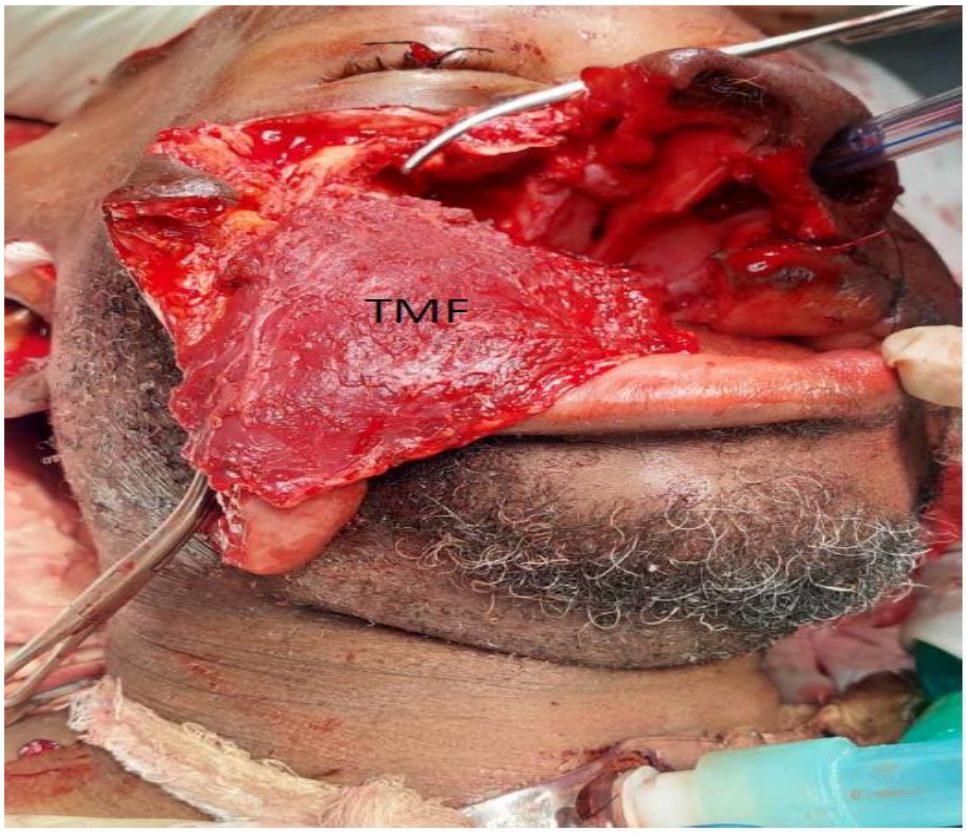


Fig 2: showing the whole TMF flap rotated into the oral cavity for maxillary defect

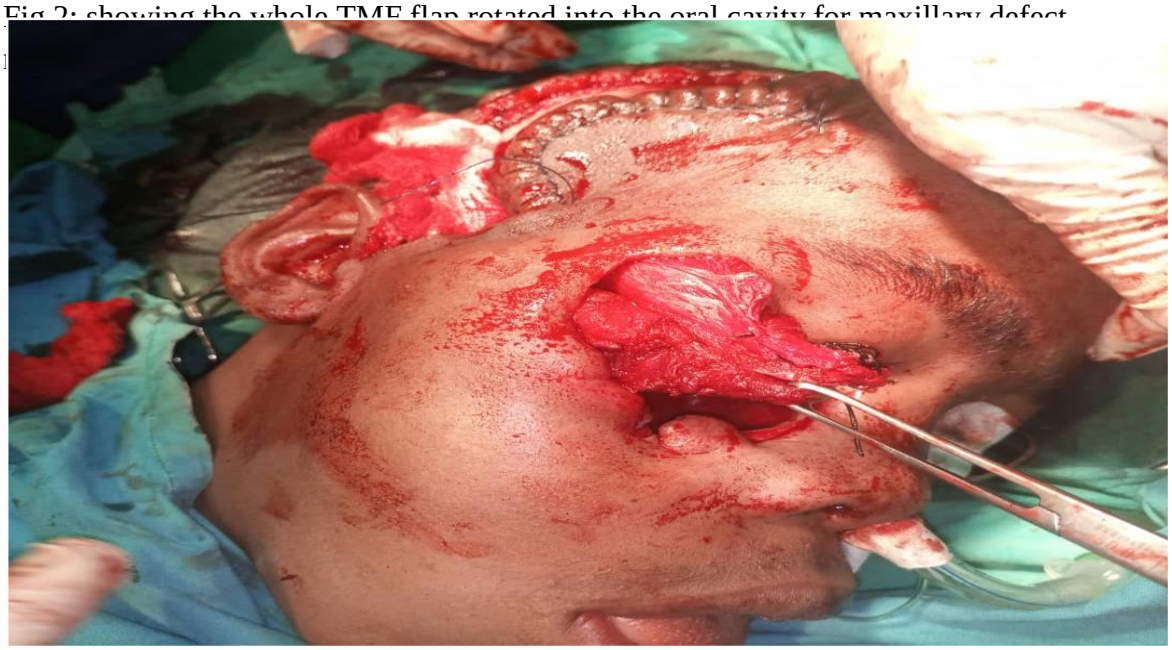


Fig. 3: showing TMF mobilization into the orbital region for the repair of orbital floor defect

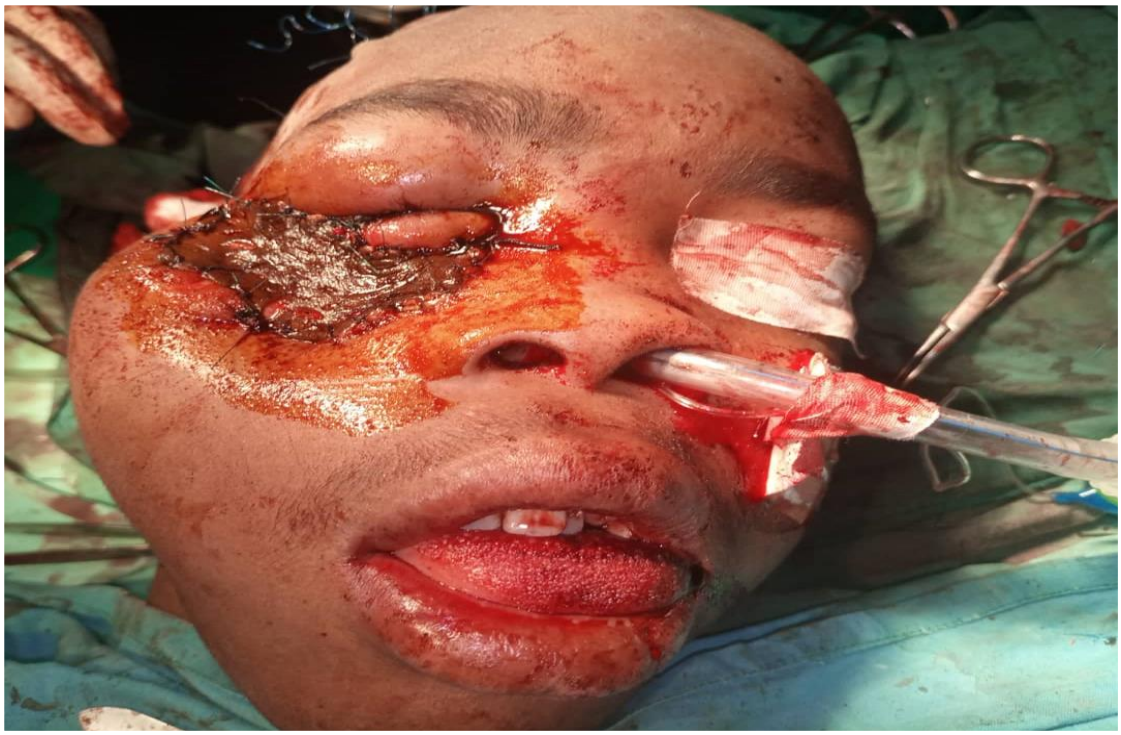


Fig 4: showing the immediate post-operative view of the orbital floor and infraorbital skin defect reconstruction with full TMF and skin grafting over the TMF; the excessive zygomatic contour prominence can be appreciated.

Fig. 5: Post-operative view of epithelized TMF on the palatal aspect following reconstruction of left Maxillectomy defect.

DISCUSSION

The experience with the TMF started in November 2018 when we first harvested and applied it as an inter-positional material in the treatment of TMJ ankylosis. Increased familiarity with the technicalities of harvesting the TMF for TMJ arthroplasty stimulated considerations of TMF for other surgical reconstructive purposes.

In the cases, TMF was successfully used either as a fascia only, split (i.e. segmental) or full/whole myofascial pedicled flap for reconstructions of both soft and hard tissue surgical defects (Table 1). The different indications for successful use of the TMF in this report exemplify its versatility in oro-facial reconstructions. This may be attributed to its rich vascular supply, large size covering up to 20cm^2, proximity to the face and wide arc of rotation of 135 degrees. [2,5,14]

Al-Kayat Bramley's[15] approach was frequently used to expose the TMF (Fig 1). This permitted its full or partial harvest without damaging the temporal branch of the facial nerve in cases reviewed. The endaural approach was also used in a few cases to improve the cosmesis of the access scar by hiding it behind the tragus[16] in patients concerned about post-operative show of a preauricular scar.

The commonest indication for TMF use was as inter-positional/joint disc replacement material between the surfaces of the cut ramus and glenoid fossa after excision of ankylotic bone in the treatment of intra-articular TMJ ankylosis. The interposed TMF prevents re-ankylosis and fills the gap, thus maintaining the ramus height and preventing premature occlusal gag and open bite.[17] The TMF, a well-vascularized flap has an innate characteristic of "tropism" suggestive of its potential to increase its bulk making it

suitable for interposition considering the rigours of joint movement during mastication.[14] In a case of extra-articular TMJ ankylosis due to myositis ossificans in our cases, the temporalis fascia-only flap was used to line/re-surface a mucosal defect after concomitant excision of cicatricial contracture of affected buccal mucosa which contributed to limitation of mouth opening in the patient. The subsequent post-operative epithelization of the fascia prevented both contracture recurrence and re-ossification of tissues in the region. The successful use of the fascia-only flap is probably due to its axial pattern vascularity from the middle temporal artery.

An inferiorly based TMF rotated to the joint site either sub-zygomatic, supra-zygomatic, or through a zygomatic arch ostectomy gap was used in the TMJ arthroplasties. The TMF was subsequently inserted into the arthroplasty gap before being sutured to peri-articular soft tissues to prevent its displacement. In contrast to our method, Rowe[18] and Toller[19] used an anteriorly and a posteriorly based split TMF passed sub-zygomatic and supra-zygomatic respectively. According to Pogrel and Kaban[4], partial arch ostectomy permits rotation of the flap without causing excessive contour. In 1 of our cases of TMF use in extra-articular ankylosis following healing of Cancrum Oris (Table 1), there was a specific need to do partial arch ostectomy to gain access to the medial aspect of the arch for excision of abnormal fibrous and bony deposits which contributed to the ankylosis. Subsequently, the ostectomy facilitated the transition of the flap into the mouth to re-surface buccal defect following the excision of fibrous tissues causing ankylosis. The arch ostectomy also prevented unaesthetic post-operative contour over the region. This experience is in agreement with Pogrel and

Kaban[4] who stated that though the use of partial arch ostectomy is the preference of the individual surgeon, it must satisfy specific needs in the transition of the flap without compromising its vascularity. Pogrel and Kaban[4] also noted that none of the techniques described for the TMF transition to the arthroplasty gap including the inferiorly based TMF passed either sub-zygomatic, supra-zygomatic or via zygomatic arch ostectomy site compromises the TMF's vascularity. Our experiences support this notion as there was no TMF necrosis documented following its use as TMJ inter-positional/disc replacement material in our cases.

Concerning the portion of the TMF used as a split flap for TMJ arthroplasty, Zubillaga Rodríguez *et al.*[2] reported the use of the central or mid part of the TMF for inter-positional material in TMJ ankylosis. The mid aspect of the TMF has more height and is directly over the TMJ site, its use in our centre reduced the events of inadequate flap length to reach the depths of the arthroplasty gap which may occur especially when the TMF is being passed to the arthroplasty site in a supra-zygomatic pattern.

Complications arising from TMF use in this study are highlighted in Table 1. One case of TMJ re-ankylosis observed with TMF use as inter-positional/disc replacement material occurred medial to the flap and was thought to be caused by a combination of inadequate ostectomy, poor volume extension of the TMF into the depths of the bony gap and the patient's non-compliance with post-operative physiotherapy instructions This non-compliance with post operative physiotherapy can be explained by the fact that the paediatric age group constituted a large population of our TMJ ankylosis cohort and some could not comply with long-term painful mouth opening exercises. The 2 cases

of mild post-operative excess zygomatic prominence were due to the supra-zygomatic transit of the flap and associated surgical site oedema when TMF was initially being used. This complication was, however, temporary in both cases as the excessive prominence became clinically non-evident at 1 month post-operatively. The recurrence of this specific complication ceased when sub-zygomatic TMF transit was adopted during subsequent treatments.

The creation of support for the placement of prosthetic eyes and repair of infra-orbital skin defects to improve cosmesis prompted our orbital reconstructions. However, in our cases of post-osteomyelitic orbital defects reconstructions, we observed excessive postoperative prominence in the lateral orbital regions causing facial asymmetry possibly due to the use of the full TMF bulk coupled with its supra-orbital transit (over the lateral orbital rim) into the orbit. To avoid excessive contour over the lateral orbital region we recommend the utilization of the split TMF. Bhattacharjee *et al* [3] suggested 3 methods of mobilization of the split TMF into the orbit: supra-orbitally over the lateral orbital rim, trans-orbitally through a surgical window made by drilling the lateral orbital wall or via a trans-orbitectomy approach in which the lateral orbital wall is partially resected and the muscle passed through the resection gap. As was done in one of our cases of orbital floor reconstructions, detaching the muscle from its coronoid insertion point increases the mobility of TMF when desired. In our cases, the supra-orbital and trans-orbitectomy approaches were used. While the supra-orbital approach in our cases was intentional, the trans-orbitectomy approaches used were due to the absence of the lateral walls from ablation of orbito-maxillary Ossifying fibroma and osteomyelitic damage respectively.

The temporalis muscle has a mean size of 8cm (anteroposteriorly) by 6cm (cranio-caudally) with a thickness of about 0.5cm increasing to 1.5cm towards the zygomatic arch.[2] The full/whole TMF is sufficiently bulky to fill maxillectomy defects, thus aiding the restoration of facial contour and partitioning of the oral and nasal cavities simultaneously as was done in three of our cases. The TMFs were easily rotated via a sub-zygomatic transit into the defect area (Fig.2) due to the absence of the maxilla following resection. Subsequently, the flap was sutured to the soft tissue edges of the palatal defect with its fascial surface turned orally to avoid displacement and aid healing with surrounding tissues of the recipient site. Such immediate reconstruction of the palate obviated the need for prosthetic obturators and aided the fast recovery of the patients. Though a complication of mild dehiscence of the reconstructed palate was seen in one case, the reconstruction with TMF satisfactorily provided good oral seal in 2 other cases. However, especially for cases of malignancies, this approach has the potential demerit of eliminating clinicians' ability to monitor the ablation site for signs of tumor recurrence as the defect is no longer accessible for visual clinical inspection.

Long time post -operative outcome of the TMF is known to be better than that by other pedicled flaps with respect to velopharyngeal function and swallowing irrespective of the reconstructed palatal anatomic zone. This study did not carry out an objective assessment of nasalance and swallowing but literature compares result using TMF in restoration of palatal defects with excellent outcomes comparable with the use of microvascular free transfers ,like ALT and RFFF.[10,11]

When the TMF is used for the reconstruction of extra-oral defects as done in two of our

cases (Table 1) it should be skin grafted.[20] The placement of split-thickness skin grafts on the TMF (Fig. 4) in 2 of our cases aided rapid coverage of the TMF beneath the skin defect and prevented skin contractures that could arise following secondary healing. However, reconstruction of the intra-oral tissue defects with TMF does not require skin grafting as complete epithelization occurs within 4-6 weeks over the oral surface of the TMF[20] .In our cases, significant epithelization was observed as early as 4 weeks post-operatively (Fig. 5). Another advantage of the TMF for intraoral reconstruction is that it is non-hair bearing, therefore, we had no concerns about hair growth from the flap post-operatively.

The acquired temporal hollowing, a complication of TMF harvest (Table 1) can be reconstructed using alloplastic material augmentation such as pre-fabricated Poly-ethylene implants[21], however due to financial constraints and unavailability of local supplies of such alloplasts, the donor site defects were not reconstructed. Post-operative temporal hollowing among patients was masked with females' hair and the use of the female head veil and male traditional hats. When split TMFs are used like in our cases of TMJ ankylosis treatments, the use of the mid-segment of the TMF where the donor defect is bordered anteriorly and posteriorly by the residual Temporalis myofascial tissues prevents temporal hollowing. Also, rotating the residual posterior segment of the TMF into the anterior portion of the temporal fossa when its anterior half split was used as in 1 of our cases of orbital reconstructions can prevent temporal hollowing.[12] As with the use of its mid-segment, harvesting the posterior segment of the TMF can also help to prevent visible temporal hollowing.[5,16]Outside all the stated camouflage, modification and augmentation

techniques, a cranioplasty as a secondary outpatient procedure is a major consideration in providing a clinical solution to post-operative acquired temporal hollowing as opined by several authors.[10].

Concerning the maximum follow-up period of 1 year in this report, a longer follow-up was impossible in most cases because the patients could barely afford the transportation fare from their residences to our hospital after making out-of-pocket payments for surgeries. This reduced their frequency of attendance for post-operative reviews, thus delaying timely observation and management of complications such as TMJ re-ankylosis and limitation of mouth opening after TMF reconstruction of a maxillectomy defect. This may have been simply prevented by prescription of continuous or early mouth exercises respectively as necessary. Surgical reconstructive procedures are financially demanding on patients; therefore, it is recommended that health insurance payment schemes be developed to ease the burden of receiving such care on patients and their relatives. The retrospective nature of this study and the lack of long term post - operative follow-up constitute a limitation. The role of the TMF in oro-facial reconstruction could not objectively assess outcome in relation to palatal defect size ,anatomical location of the defect, assessment of post-operative swallowing and effect on nasalance .This can only be assessed using a prospective cohort. Most of the TMF in this study were used as interpositional TMJ material to ensure satisfactory functional inter-incisal gap and could have returned if their clinical situation was not acceptable to them.

Of the many demerits of a small sample size similar to this study, we conclude that the TMF is a versatile and reliable pedicled flap for the reconstruction of various Oral and

Maxillofacial tissue defects. The consideration and use of Temporalis Myofascial flap in oro-facial reconstructions especially in situations where there is limited expertise or resources for microsurgical free tissue reconstruction is recommended.

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