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Facial artery musculomucosal (FAMM) flap

Tareck Ayad, MD, FRCSC

From the Division of Otolaryngology – Head & Neck Surgery, Centre Hospitalier de l'Université de Montréal, Centre de recherche du Centre Hospitalier de l'Université de Montréal, Montréal, Québec

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Abstract
This study presents a thorough overview of the relevant anatomy of this flap, reviews its most common indications, and introduces a step-by-step approach to a successful harvest of the FAMM flap. Knowledge of the surgical anatomy and landmarks of the FAMM flap allows a successful harvest. The superiorly and inferiorly based FAMM flaps are versatile and associated with low morbidity. The indications are numerous in Head & Neck surgery. The most common indications are defects of the floor of mouth, palate, and alveolar ridge. The advantages of this pedicled intraoral flap considerably outweigh its disadvantages. Respect of the steps described herein should allow a successful harvest of the FAMM flap despite potential pitfalls. Refinement of the indications and recent modifications in the technique to lower the revision surgery rates should allow a broader use of this flap.

Introduction

The use of microvascular free flap to reconstruct head and neck defects has been democratized in the western world. In this era of time and economic constraints, the systematic use of free flaps needs to be reassessed. Small-to-medium size defects of the head and neck can still be successfully reconstructed with pedicled flaps with limited morbidity to the donor site and optimal results. Over the last decades, use of regional flaps such as the submental flap, the supraclavicular flap, or the facial artery musculomucosal (FAMM) flap has grown in popularity. Since its first description in 1992,[1] the FAMM flap has known a continuous increasing trend in publication.[2] Subsequent publications have allowed to expand its indications,[2-5] establish its low morbidity,[6,7] and demonstrate the good functional outcomes associated with its use for specific head and neck defects.[8]

Intraoral buccal flaps have a confusing nomenclature in the literature even though a recent classification has been proposed.[9] The FAMM flap is distinct from the buccal intraoral flap described by Bozola, which is pedicled on the buccal artery, a branch of the internal maxillary artery.[10] The buccal intraoral flap is pedicled posteriorly which confers a more limited arc of rotation. It is also potentially wider but shorter in length. The FAMM flap can be pedicled inferiorly with an antegrade flow through the facial artery, or superiorly with a retrograde flow through the angular artery.

The objectives are to present a thorough overview of the relevant anatomy of this flap, review its most common indications, and introduce a step-by-step approach to a successful harvest of the FAMM flap.

Address reprint requests and correspondence: Tareck Ayad, MD, FRCSC, Division of Otolaryngology – Head & Neck Surgery, Centre Hospitalier de l'Université de Montréal, Centre de recherche du Centre Hospitalier de l'Université de Montréal, 1051 Sanguinet Street, Montréal, QC H2X 0C1, Canada.
E-mail address: tareck.ayad@umontreal.ca

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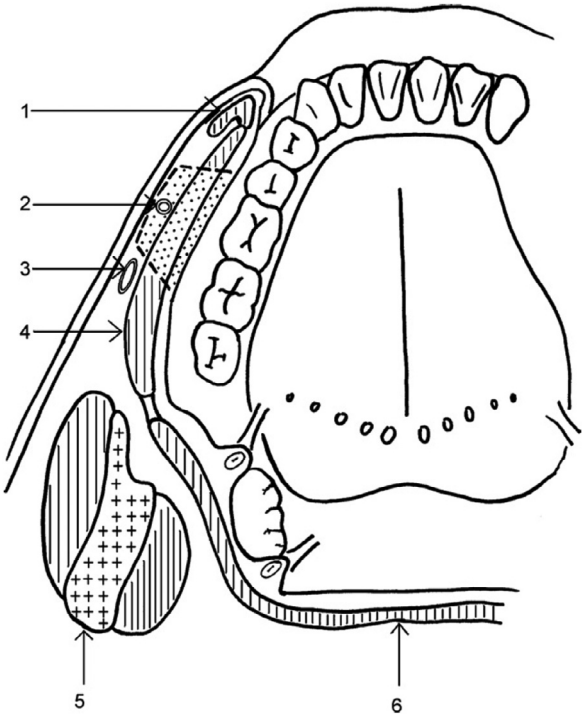

Figure 1 Axial view of the cheek. The facial vein is located posteriorly to the facial artery and is rarely included in the flap. 1: orbicularis ori; 2: facial artery; 3: facial vein; 4: buccinator muscle; 5: mandibule; 6: superior pharyngeal constrictor. (Reprinted with permission.[13])

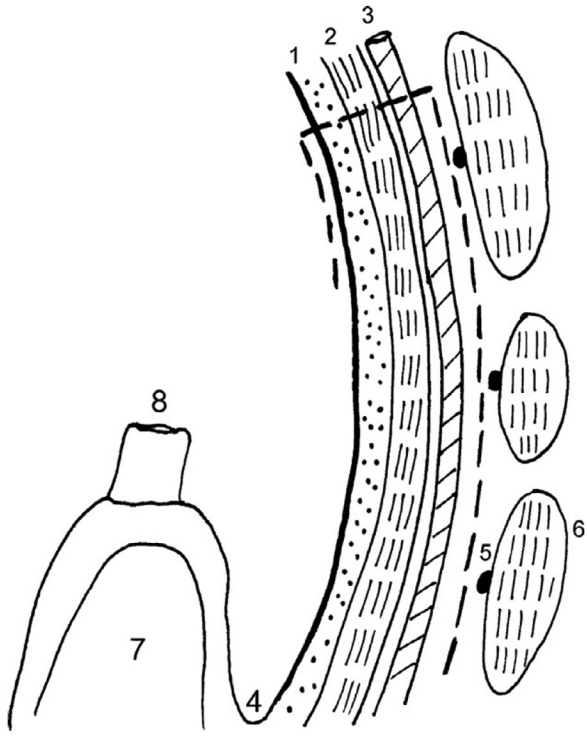

Figure 2 Coronal view of the cheek and depiction of the layers included in the FAMM flap. 1: mucosa and submucosal layer; 2: buccinator muscle; 3: facial artery; 4: gingivo-buccal sulcus; 5: facial nerve motor branches; 6: facial expression muscles; 7: mandible; 8: molar tooth. (Reprinted with permission.[13])

Anatomy

Surgical anatomy of the facial artery and vein

The facial artery follows a cervical course after branching from the external carotid artery. It lays deep to the submandibular gland and reaches the inferior border of the mandible at the anterior edge of the masseter muscle. The facial artery travels in the cheek lateral to the buccinator muscle and the *levator anguli oris*, while remaining medial to the *risorious, zygomaticus major* and the superficial layer of the *orbicularis oris* muscle. The artery has a tortuous trajectory on its way to the medial canthus to terminate as the angular artery.[11,12] Through the latter vessel, there may be retrograde flow from the ophthalmic artery, which originates from the internal carotid artery system. The facial artery is located approximately 16 mm from the labial commissure. It sends off perforators to the inner cheek area and branches to give the superior labial artery among others. The facial vein usually runs posteriorly and in close proximity to the facial artery at the level of the mandible. It progressively diverges from the artery as it reaches the nose. Doppler flow studies have shown an average distance between the 2 vessels of 13.6 mm at the oral commissure and 16.3 mm under the alar base.[11] The vein begins at the internal canthus as the angular vein and runs along the nasolabial fold to become the facial vein.

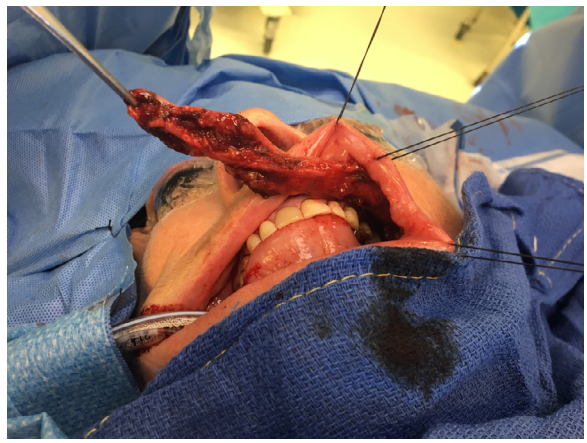

Figure 3 Superiorly based FAMM flap with facial artery attached to the muscle on the whole length of the flap.

Surgical anatomy of the FAMM flap

The FAMM flap is an intraoral cheek flap and includes the buccal mucosa, the submucosa, the buccinator muscle, and the superficial layer of the *orbicularis oris* muscle in the area of the oral commissure (Figures 1 **and** 2). Inferiorly based FAMM flaps are pedicled on the facial artery with an antegrade flow. Superiorly based FAMM flaps are pedicled on the angular artery through a retrograde flow from the internal carotid artery system. The facial artery is preserved on the entire length of the flap and

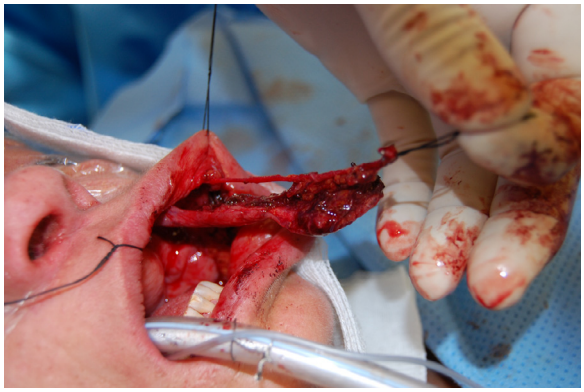

Figure 4 Superiorly based FAMM flap with facial artery partially detached from the flap, increasing the risk of necrosis.

is kept attached to the buccinator muscle (Figures 3 **and** 4). The facial vein is usually not included in the flap as venous drainage is assured by a submucosal plexus.[14] Venous drainage is also ensured by venae comitantes on the facial artery, which could be harmed during functional neck dissection of level 1. The base of the pedicle should be at least 1.5 cm to ensure adequate venous drainage through the submucosal venous plexus.

Surgical implications of anatomical variants

Several branching variations and terminal endings of the facial artery have previously been described. The classification by Lohn et al includes: type I = angular, type II = lateral nasal, type III = alar, type IV = superior labial, type V = inferior labial, and type VI = undetected.[15] Anatomical studies have described a hypoplastic or aplastic facial artery in the cheek (types V and VI) in less than 10% of the cases.[15-17] Clinical studies on the FAMM flap do not mention this occurrence and we have not encountered it in our practice. Absence of a significant facial artery should preclude the use of the FAMM flap if determined preoperatively. A posterior-based buccinator myomucosal flap (Bozola flap) could still be used or a random cheek flap if the donor site had never been radiated, if the defect is small and in the direct vicinity of the donor site.

If the facial artery terminates as the superior labial artery the perfusion of the distal end of an inferiorly based FAMM flap could be random which would be acceptable in a nonradiated patient. This situation is more problematic for superiorly based FAMM flaps as this artery is usually sectioned to increase the reach of the flap. In this instance, the superior labial artery is preserved and the flap can be raised based on this artery with perfusion emanating from the communicating branches of the contralateral superior labial artery.

Indications

The FAMM flap is indicated in reconstruction of small-to-moderate size head and neck defects. The most common indications in the literature are defects of the floor of mouth, palate, and alveolar ridge.[2] The type of flap used depends on the defect location. Table 1 details the type of FAMM flap to use according to the defect location.

Preoperative considerations

Contraindications

The use of the FAMM flap should be avoided in the presence of buccal mucosal precancerous or cancerous lesions. It should also be discouraged if the patient had any procedure that could compromise the antegrade or retrograde arterial blood flow for respectively inferiorly based and superiorly based FAMM flap. A previous neck dissection with sacrifice of the facial artery would be a contraindication for an inferiorly based FAMM flap. A patient with a history of Caldwell-Luc approach or Weber-Ferguson approach probably has an interruption of the angular artery or lateral nasal artery which precludes the use of a superiorly based FAMM flap. The use of a Doppler to assess the antegrade or retrograde arterial flow is not reliable in these situations. A positive arterial pulse could still be coming from collateral contributions of the contralateral mental, inferior labial, and/or superior labial arteries. During the dissection, these collateral ves-

Table 1 Type of FAMM flap recommended according to site or subsite defect

Inferior FAMM flap	Superior FAMM flap
Inferior oral cavity defects: -Retromolar trigone -Inferior alveolar crest -Inferior lip -Mobile tongue -Floor of mouth	Superior oral cavity defects: -Hard palate -Superior alveolar crest -Superior lip
Oropharynx (tongue base, lateral pharyngeal wall, soft palate)	Intranasal lining Maxillary antrum Orbit Skull base

Table 2 Advantages and potential drawbacks of the FAMM flap

Advantages	Drawbacks
-No external scar	-Limited width
-Good axis of rotation	-Use of a bite block after surgery or tooth extraction to avoid trauma to the pedicle in dentate patients
-Thin and pliable	-Two-stage procedure required to section the pedicle in dentate patients (unless modified FAMM flap used[20,21])
-Hairless	-Bulky flap that may hinder use of dental prosthesis if used in vestibular reconstruction
-Easy to harvest	
-Reliable	
-Withstands postoperative radiation therapy	
-Low complication rate	
-Length can be tailored to defects	
-Primary closure of donor site if width under 3 cm	
-Flap harvest and tumor ablation in the same operating field	

sels are ligated or cauterized to increase mobility of the flap.

Previous radiation therapy in the surgical field is not an absolute contraindication. However, retrospective series have shown higher rates of complications (trismus, dehiscence, and necrosis) for FAMM flaps harvested in a previously radiated area.[2,18]

Pearls and pitfalls in planning of the surgery

Assessment of the extent of the defect is usually straightforward in reconstruction of congenital or chronic defects (ie, palatine fistula, septal perforation). Preoperative assessment of defects expected in an oncologic setting can be challenging when clinical assessment is limited by pain or trismus in patients with oral cavity cancers. Moreover, ill-defined lesions and field cancerization can lead to defects larger than expected that are not suitable to reconstruction with a FAMM flap. In these instances, it is mandatory for the surgeon and patient to be prepared for alternative reconstructive options such as the radial forearm free flap or the submental flap.

Potential sacrifice of the facial artery during neck dissection needs to be part of the decision process. Level 1 node metastases might hinder preservation of the facial artery and hence preclude the use of a FAMM flap.

Inferiorly based FAMM Flap

General preoperative considerations

We recommend administration of antimicrobial prophylaxis directed against oral cavity flora. After oral intubation, the endotracheal tube is positioned contralateral to the surgical bed. It can be held in place by transbuccal or intraoral dental sutures. Tracheotomy is performed according to the location and extent of the defect. Neuromuscular blockage will facilitate exposure of the oral cavity throughout the procedure. We do not recommend local infiltration of the flap outline with an epinephrine solution since it can provoke a spasm of the facial artery that may hinder its dissection.

Size and reach of the flap

The usual length of the flap is 9 cm. It can be longer if extended higher in the gingivolabial sulcus. The flap can reach the contralateral anterior alveolar crest, floor of mouth, or lip. The maximal width of the flap is usually approximates 2.5-3 cm. We recommend using another kind of flap if more than 3 cm of flap width is required to fill the defect.

Design of the flap

The buccal mucosa is exposed using 2 or 3 traction sutures in the upper and lower lips and a Weider's tongue retractor (heart-shaped). Alternatively, Senn's retractors or Gillies skin hooks can be used instead of traction sutures.

As a first step, the flap is marked on the buccal mucosa respecting predefined limits (Figure 5). Anteriorly, the flap is drawn 1 cm posterior to the oral commissure. The orifice of the Stensen's duct limits the posterior extension of the flap. Inferiorly, the base of the flap is centered over the area of the second and third molar teeth with a 2 cm base. The flap is designed over the facial artery trajectory with an oblique orientation from the region of the second molar to the ipsilateral gingivolabial sulcus. The length of the flap is tailored proportionally to the size of the defect. The Doppler can be used but it is not mandatory as the facial artery will invariably be found within the previously described limits. Also, the Doppler-driven marking of the facial artery trajectory becomes unreliable as soon as a significant incision is performed, the mucosa having a tendency to retract.

Identification of the facial artery

The first step of the surgery requires identification of the facial artery. It can be done with either one of the methods described herein.

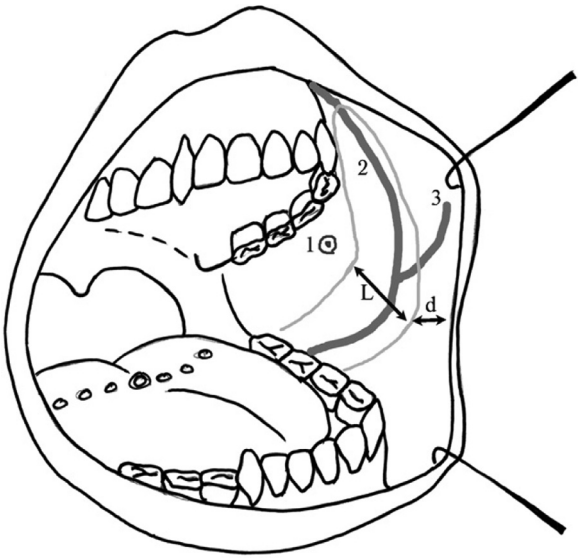

Figure 5 Landmarks for design of the inferiorly based FAMM flap. d: distance of 1 cm from the labial commissure deliminates the anterior edge of the flap. L: largest width possible determined by the position of the orifice of Stensen's duct. Inferiorly the base of the flap is centered over the area of the second and third molar teeth with a 2 cm base. 1: orifice of Stensen's duct; 2: facial artery; 3: superior labial artery. (Reprinted with permission.[13])

- Distal identification of the facial artery: The distal part of the flap is incised through the mucosa, submucosa, and buccinator muscle. The facial artery lies deeper to the buccinator muscle. It is clipped and incised distally.
- Anterior identification of the facial artery: The dissection starts 1 cm lateral to the oral commissure by cutting through the mucosa, submucosa, and buccinator muscle to identify the superior labial artery. This artery is then followed in a retrograde fashion to identify the facial artery. The superior labial artery can be ligated and cut at this point.

Harvest of the flap

The flap is elevated in the layer underneath the facial artery including the overlying buccinator muscle (Figures 1 **and** 2). In the area of the labial commissure fibers of the orbicularis ori and buccinator muscle intermingle and are both included. The facial artery is kept attached to the overlying tissues in the entire length of the flap. The venous drainage relies on a submucosal plexus and for this reason identification and inclusion of the facial vein is not necessary. A 2 cm soft tissue base is maintained to allow an adequate venous drainage.

Inset of the flap

After elevation, the flap is rotated inferiorly and inset into the defect with interrupted mattress sutures. If the pedicle crosses over a molar tooth this can be removed or a bite block can inserted contralaterally for 10 days to avoid injury to the pedicle. A single FAMM flap is

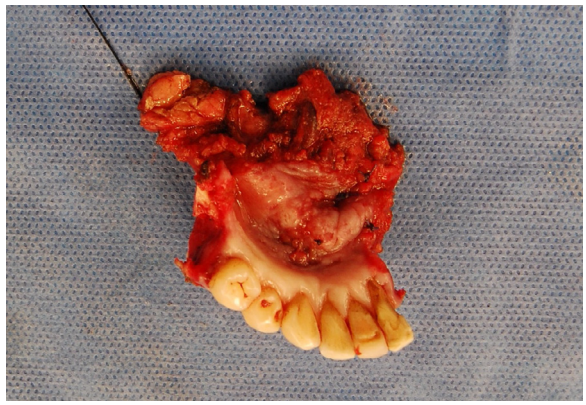

Figure 6 Resection specimen of a T2 squamous cell carcinoma of the right flor of mouth, including the inferior alveolar crest, floor of mouth, and ventral part of the mobile tongue.

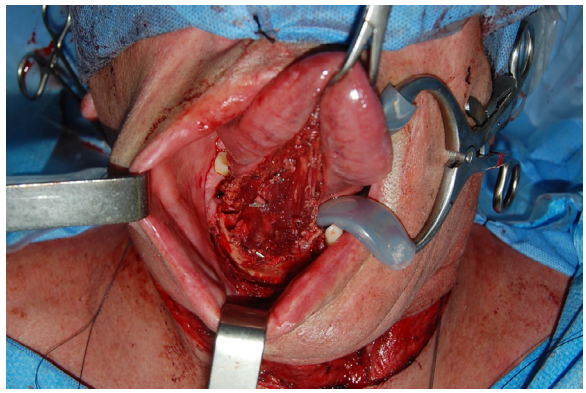

Figure 7 Medium size defect of the oral cavity encompassing the inferior alveolar crest, floor of mouth, and ventral part of the mobile tongue. The defect extends contralaterally to the planned FAMM flap.

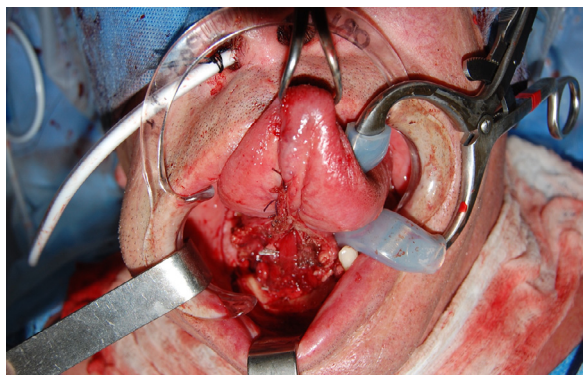

Figure 8 The mobile tongue is closed primarily with interrupted mattress sutures as it involves less than one-third of the mobile tongue.

wide enough to reconstruct contiguous subunits of the oral cavity such as the inferior mucosal lip and the inferior alveolar crest or the inferior alveolar crest and the floor of mouth (Figures 6-9). Reconstruction of floor of mouth defects with the FAMM flap will allow free mobility of the tongue while acting as a barrier to any communication between the oral cavity and the neck. It will provide ro-

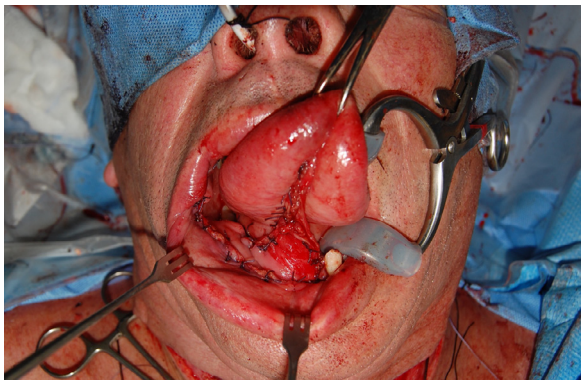

Figure 9 The FAMM flap is used to cover the inferior alveolar crest and floor of mouth defects, reaching easily the contralateral side. The last right inferior molar tooth has been extracted to avoid trauma to the flap pedicle.

Figure 10 Closure of the donor site with interrupted mattress sutures.

bust tissue for bone coverage in the instance of a marginal mandibulectomy[8] (Figure 9).

Closure of the donor site

The donor site is closed primarily with interrupted mattress sutures and no drain is left in the cavity (Figure 10). The buccal fat pad can be used for the closure of the donor site when large FAMM flaps are harvested and excessive tension is observed after closure of the donor site.

Superiorly based FAMM flap

Raising a superiorly based FAMM flap is similar in most aspects to inferiorly based FAMM flaps. We will highlight the differences in the following section.

Design of the flap

The main difference lies in the position of the base of the flap (Figure 11). The pivot point is in the vicinity of the maxillary tuberosity or in the gingivolabial sulcus. A distance of 0.5-1.0 cm is preserved between the posterior

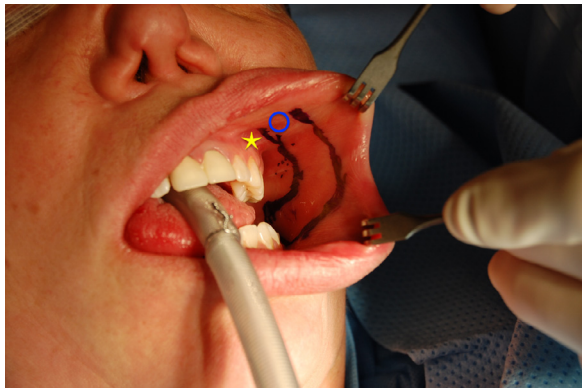

Figure 11 Design of a superiorly based FAMM flap. The landmarks are identical to the inferiorly based FAMM flap excluding the base of the flap which is located in the vicinity of the maxillary tuberosity or in the gingivolabial sulcus (blue circle). A distance of 0.5-1.0 cm is preserved between the posterior margin of the flap and the gingiva (yellow star) to facilitate wound closure. The distal end of the flap is designed according to the size and shape of the defect. (Color version of figure is available online.)

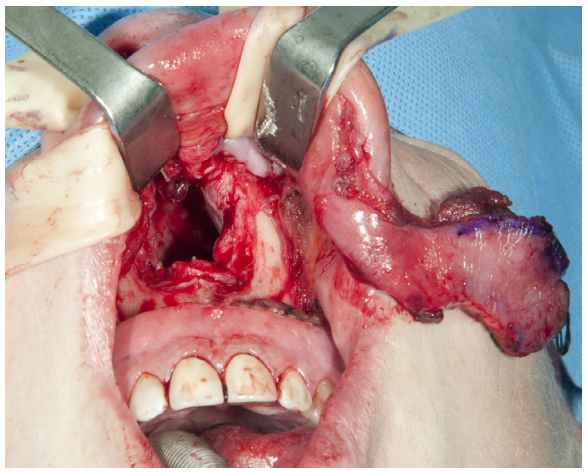

Figure 12 Superiorly based FAMM flap ready to be tunneled into the nasal cavity though an incision into the nasal floor mucosa to access the pyriform aperture.

margin of the flap and the gingiva to facilitate wound closure. The distal end of the flap is designed according to the size and shape of the defect (Figure 12). Measurement of the defect and use of a template is valuable in reconstruction of cartilaginous or bony defects of sites such as the hard palate or septum for an optimal flap outline. We recommend adding 2 mm of tissue circumferentially to obtain tension-free closure of the defect.

Facial artery identification

The facial artery can be identified by locating the superior labial artery first with an incision in the area of the labial commissure as detailed above. It can also be located with careful blunt dissection at the distal end of the flap and then traced back superiorly.

Flap harvest

The mucosal incisions are completed according to the previously drawn outline and extend through the mucosa, the submucosa, and the buccinator muscle. The facial artery is dissected in a retrograde manner, from proximal to distal. Hence, the facial artery will become smaller as dissection will progress superiorly toward the base of the flap. This warrants meticulous dissection as the artery is tortuous.

Distal flap preparation

The FAMM flap is fully dissected up to its base, at the junction of the gingivolabial sulcus and first molar. The distal end of the flap has a mucosal side and a muscular side (buccinator muscle). The muscular side can be covered with a full thickness skin graft if required by the defect (ie, septal perforation).

Flap inset

Intraoral inset is straightforward though maintaining a tension-free closure is essential. Intranasal inset requires extension of the posterior incision to the area of the ipsilateral canine in order to deliver the flap into the nasal cavity. The dissection is deepened up to the inferior border of the pyriform aperture where a tunnel is created to the floor of the nasal cavity. The flap is then tunneled into the nasal cavity through an incision on the nasal floor mucosa (Figure 12). These steps are not required when the FAMM flap is used for reconstruction of defects other than septonasal defects.

Postoperative pedicle management

Once the flap is dissected up to the level of the alveolar crest, it is transposed over the gingiva and inset in the defect, creating a bridge over the gingiva. The pedicle can be safely sectioned 3 weeks after the initial surgery if needed. Up to 37% of inferiorly based FAMM flaps require this second step surgery.[8] This is usually required if the base of the flap crossing the alveolar crest hinders dental rehabilitation or limits tongue mobility.

Modifications have been introduced to perform this flap in a single-stage surgery. In the modified inferiorly based FAMM flap described by Duranceau et al, the anterior incision of the flap is extended into the alveolar crest to reach the defect.[19] The base of the flap is then dissected in a subperiosteal plane over the alveolar crest up to the floor of mouth defect. The flap, now in continuity with the defect, can be rotated in place with no intervening bridge. Another modification for a one-step surgery was described where the FAMM flap is harvested as an island flap including the facial artery and vein.[20,21] This technique requires blunt dissection of the facial vessels in the cheek to tunnel the flap into the neck at first followed by another tunnelization from the neck into the oral cavity or oropharynx. In this technique, the dissection of the pedicle and marginal nerve might be tedious but it obviates the need to extract teeth in dentulous patients.

Conclusions

The FAMM flap is a robust and versatile reconstructive option for small- and medium-sized defects of the oral cavity, oropharynx, intranasal mucosa or/and septum, and some other less common sites. The advantages of this pedicled intraoral flap considerably outweigh its disadvantages. Respect of the steps described herein should allow a successful harvest of the FAMM flap despite potential pitfalls. Refinement of the indications and recent modifications in the technique to lower revision surgery rates should allow a broader use of this flap.

Disclosures

The authors reported no proprietary or commercial interest in any product mentioned or concept discussed in this article.

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