RECONSTRUCTION OF FLOOR OF MOUTH DEFECTS BY THE FACIAL ARTERY MUSCULO-MUCOSAL FLAP FOLLOWING CANCER ABLATION

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Abstract: Background. The purpose of this study is to review our experience with the use of the facial artery musculo-mucosal (FAMM) flap for floor of mouth (FOM) reconstruction following cancer ablation to assess its reliability, associated complications, and functional results.

Methods. This was a retrospective analysis of 61 FAMM flaps performed for FOM reconstruction from 1997 to 2006.

Results. No total flap loss was observed. Fifteen cases of partial flap necrosis occurred, with 2 of them requiring revision surgery. We encountered 8 other complications, with 4 of them requiring revision surgery for an overall rate of revision surgery of 10% (6/61). The majority of patients resumed to a regular diet (85%), and speech was considered as functional and/or understandable by the surgeon in 93% of the patients. Dental restoration was successful for 83% (24/29) of the patients.

Conclusion. The FAMM flap is well suited for FOM reconstruction because it is reliable, has few significant complications, and allows preservation of oral function. ©2007 Wiley Periodicals, Inc. Head Neck 30: 437–445, 2008

Keywords: FAMM flap; facial artery; floor of mouth; oral cancer; reconstruction

Reconstruction of floor of mouth (FOM) defects requires special attention on maintenance of tongue mobility to ensure adequate elocution and oral phase of deglutition. Contrary to other buccal subsites, primary closure is not suitable because even minor tongue tethering can be functionally harmful. Healing by secondary intention is feasible but subsequent fibrosis and contracture lead to impairment of function. Various methods have been used for reconstruction including skin grafting, local flaps, regional flaps, and free flaps. The choice is made essentially according to the size of the defect. The general health status of the patient has also to be considered in the decision-making process. Associated medical problems compound the issue because illnesses such as chronic obstructive pulmonary disease, peripheral vascular disease, or coronary artery disease thwart complex reconstructive efforts.

The facial artery musculo-mucosal (FAMM) flap was first described in 1992 by Pribaz et al.1 This flap is a good adjunct to the available options for reconstruction of small to medium size oral cavity defects because of its versatility and reliability. However, its use for FOM reconstruction...
has been assessed in few studies, all with a limited number of patients.\textsuperscript{1,2} It is presently our favorite method of FOM reconstruction following ablation of small-sized tumors. We review herein our experience with the use of the FAMM flap for FOM reconstruction following cancer ablation. Our objectives are to assess the reliability, associated complications, and functional results of FOM reconstruction with a FAMM flap.

**MATERIALS AND METHODS**

**Data Collection.** We reviewed the charts of all patients who had a FAMM flap procedure in the Otolaryngology—Head and Neck Surgery Department at Institut Gustave Roussy (Villejuif, France) between January 1, 1997, and January 31, 2006. Follow-up data were obtained in all patients using the clinical chart notes, correspondence with the referring physician, the patient, or the patient's family. The site and stage distributions of the tumors were studied. Lesions were staged according to the American Joint Committee on Cancer (AJCC) Staging 2002 using all the information available, including the physical findings, imaging studies, and pathologic reports. Operative notes were reviewed for technical details of flap harvest and inset. Follow-up data including status of the flap, complications, dental restoration, and functional results (tongue mobility, speech, and swallowing) were collected. Functional results were subjectively assessed by the surgeons. Follow-up time was measured from the date of the surgery until the date of the last contact or death.

**Patient Characteristics.** We identified 97 patients who had a FAMM flap procedure during this period. Twenty-two patients had a FAMM flap procedure to cover areas of mandibular osteoradionecrosis, 12 for reconstruction of buccal cavity defect other than the FOM, 3 for intranasal lining defects, 2 for oropharyngeal defects, and 1 for orbital defect. After exclusion of these patients, we reviewed our experience with the 57 patients left who had a FAMM flap procedure for FOM reconstruction following cancer ablation (56 squamous cell carcinoma, 1 liposarcoma). Concomitant use of 2 FAMM flaps was done for 4 patients. The total number of FAMM flaps performed for FOM reconstruction is 61. Reconstruction was either performed primarily during the ablative surgery (45 flaps) or secondarily (16 flaps). Secondary reconstruction was indicated because of reduced tongue mobility (10 flaps) or complications such as necrosis or dehiscence following a previous reconstruction (6 flaps).

There were 50 male and 7 female patients. The median age at the procedure was 56 (range, 35–82) years. The median follow-up for all patients was 25 (range, 3–112) months. Twelve patients had cancer classified as T1, 32 as T2, 8 as T3, and 5 as T4a. Among the T4a patients, 3 had secondary reconstruction and 2 had primary reconstruction following ablation of a tumor invading the deep muscles of the tongue. The cancer was centered over the FOM for 53 patients, the gingiva for 2 patients, and the tongue for 2 patients. Overall and cause-specific survival is shown in Figure 1.

**Surgical Technique.** The FAMM flap was based inferiorly (antegrade flow) for all patients. The flap was designed over the facial artery trajectory with an oblique orientation, from the retromolar trigone to the level of the ipsilateral labial sulcus. The length of the flap was tailored proportionally to the size of the defect. The orifice of the Stensen's duct limits the width of the flap posteriorly which is kept under 3 cm to avoid tension at closure of the donor site. Anteriorly, the incision lies 1 cm posterior to the oral commissure. As a first step, the flap is marked on the buccal mucosa respecting the previously mentioned limits (Figure 2). The dissection starts 1 cm lateral to the oral commissure by cutting through the mucosa, submucosa, and buccinator to identify the facial artery or one of its branches. The superior labial artery is usually identified at first place, then ligated and divided (Figure 3). The flap is elevated in the layer underneath the facial artery including the overlying buccinator muscle and a small portion of orbi-
cularis or close to the oral commissure (Figure 4). The facial artery is kept attached to the overlying tissues in the entire length of the flap (Figure 5). On the superior end of the flap the facial artery is ligated and divided. The venous drainage relies on a submucosal plexus and for this reason identification and preservation of the facial vein is not mandatory. A reasonable soft tissue base is maintained to allow an adequate venous drainage (Figure 6). After elevation, the flap is rotated inferiorly and inset into the FOM defect (Figure 7). Sutures should not impair tongue mobility for optimal functional results (Figures 8A–8C). A bite block is used temporally if the pedicle crosses over molar teeth.

When used for secondary reconstruction the FAMM was expected to cover dead space after necrosis of a previously inset flap or to reverse tethering of the tongue by incision, release, and interposition of the flap. When used for primary reconstruction, the FAMM flap covered the anterior and lateral FOM in 51% (23/45) of the cases, the anterior FOM in 33% (15/45), and the lateral FOM in 15% (7/45). In 71% (32/45) of the cases, the FAMM flap covered another site in addition to FOM. Marginal mandibulectomy was performed...
on 26 of these patients, and the FAMM flap was systematically used to cover the marginal bone defect. Partial glossectomy was part of the management for 28 of these patients. The defect was covered by a FAMM flap in 6 cases, left to heal by secondary intention in 7 cases, and closed primarily in 15 cases.

All patients having secondary reconstruction had previous neck dissection, and 4 of them had sacrifice of the facial artery during that procedure. Among patients having primary reconstruction, 20 underwent ipsilateral selective neck dissection at the time of the ablative surgery, 19 patients underwent bilateral neck dissection, 4 had sentinel node biopsy, and 2 had no neck dissection. Radiation therapy was performed subsequently in 7 patients with concomitant chemotherapy in 1 patient. Previous head and neck irradiation had been performed in 10 patients including 1 patient having concomitant radiotherapy–chemotherapy. Preoperative chemotherapy was performed in 2 patients.

A Doppler was used for 4 flaps to identify the course of the facial artery on the buccal mucosa. In the 57 other cases, the flap was designed according to the expected trajectory of the facial artery. Two patients required a temporary bite block to protect the pedicle in the postoperative period. The pedicle was sectioned secondarily if the patient was dentulous or if the base of the flap caused discomfort or functional disability (Figure 9). A 2-stage procedure was required in 38 patients with division of the base of the flap after a median delay of 52 days (range, 13–189). The donor site on the cheek was closed primarily for 33 flaps and it was left to heal by secondary intention for 19 flaps. Data concerning management of the donor site were not available for 9 patients. A tracheotomy was performed on 22 patients. The median delay before tracheotomy withdrawal was 5 days (range, 3–31). A nasogastric tube was required for 44 patients. The median delay before nasogastric tube or gastrostomy tube withdrawal was 10 days (range, 2–191). The median duration of hospitalization was 12 days (range, 3–53).

FIGURE 5. Inferiorly based facial artery musculo-mucosal flap with the facial artery (arrows) running underneath the buccinator. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

FIGURE 6. Patient with a clinical and radiological T2N0 lesion of the floor of mouth treated by a left pelviglossectomy and sentinel lymph node biopsy. The dorsum of the tongue was preserved. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

FIGURE 7. The facial artery musculo-mucosal flap was used to cover the floor of mouth defect. The tongue defect was left to heal by secondary intention. The donor site on the inner surface of the cheek is closed primarily. The base of the pedicle bridges over the edentulous inferior gingiva and will require section on a secondary procedure to allow dental rehabilitation and optimal tongue range of motion. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]
RESULTS

Flap Survival. No total flap loss was observed in our series of 61 FAMM flaps. Partial necrosis of the FAMM flap occurred in 15 patients, the tip of the flap being affected in 14 cases and the base in 1 case after section of the pedicle in the second-stage procedure. Two patients required revision surgery because of partial necrosis. Partial flap necrosis was seen in 37.5% (6/16) of the flaps performed as a secondary reconstruction procedure and in 20% (9/45) of the flaps used for primary reconstruction. Reconstruction following ablation of a high-stage primary tumor is associated with a higher partial necrosis rate; T1–T2: 18% (8/45); T3–T4: 44% (7/16). Prior neck dissection, radiation therapy and localization of the FOM defect (anterior, lateral, or mixed) did not affect flap survival.

Complications. The overall rate of complications is 36% including partial necrosis (22/61). We encountered 23 complications in 22 flaps. Table 1 shows the detailed description of these complications. The rate of complications requiring a revision surgery is 10% (6/61). Indications for revision surgery were drainage of a submental abscess,

![FIGURE 8. (A–C) Results of the floor of mouth reconstruction 3 weeks postoperatively. Tongue mobility is preserved. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]](image1)

![FIGURE 9. Tongue protraction 5 months after section of the pedicle and 1 month after completion of radiation therapy. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]](image2)

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<th>Table 1. Complications of the FAMM flap.</th>
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<td>Types of complications</td>
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<td>Partial necrosis</td>
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Abbreviation: n, number of flaps affected by the complication.
drainage of a cheek hematoma, surgical release of tongue tethering, surgical release and skin graft for a scar in the cheek, cleaning of necrotic tissues in 2 patients. The remaining complications settled with conservative management. Of note, there was only 1 case of scar contracture in the cheek which needed a surgical intervention. No other case of scar contracture causing trismus was reported at the donor site.

**Functional Results.** Tongue mobility was judged “satisfying” by the surgeon for 87% (34/39) of the patients, with this data recorded in the files. The majority of patients resumed to a regular diet (85%; 39/46), 11% (5/46) to a soft diet, and 4% (2/46) were gastrotomy tube–dependant. For 45 patients, a limited subjective assessment of speech quality was reported. Speech was considered as functional and/or understandable by the surgeon in 93% (42/45) of the patients. Speech was considered of little or no use in 7% (3/45) of the patients. Dental restoration was indicated for 29 patients and was successful for 83% (24/29) of them. Dental prosthesis was used for 18 patients and dental implants for 6 patients. Causes of dental restoration failures are dental implants extrusion (1 patient), mandibular osteoradionecrosis (1 patient), and surgical complications in such as loss of gingivobuccal sulcus and mucosa thinning over the mandible for 3 patients. Beside missing data in some files, functional results are not reported for all patients because 1 died in the postoperative period, 1 had a concomitant partial laryngeal surgery complicated by chronic aspiration (tracheotomy and gastrostomy dependant), 1 had an early cancer relapse, and 3 had a follow-up too short to assess function.

**DISCUSSION**

The FAMM flap combines the principles of the nasolabial flap and buccal mucosal flaps. The different layers of the FAMM flap are the cheek mucosa and submucosa, the underlying layer of the buccinator muscle, a portion of the orbicularis oris close to the labial commissure, and the facial artery. The facial artery enters the face on the anterior edge of the masseter muscle after hooking around the inferior border of the mandible. Its course is tortuous and follows an oblique direction along the cheek. It lies approximately at 16 mm from the labial commissure. Inclusion of the facial vein in the flap is not mandatory because the venous return relies on the submucosal venousplexus. The facial vein is found posteriorly to the facial artery and tends to move away from it along its course in the cheek.

In our institute, we have used the FAMM flap to cover surgical defects of various sites (oral cavity, oropharynx, intranasal lining, and orbit) and also as an adjunctive treatment for mandibular osteoradionecrosis (resection of necrotic bone followed by transposition of the FAMM flap on the resulting defect). The later group of patients presents a different treatment challenge than the one discussed here. In cases of osteoradionecrosis, the goal is to counteract the effects of radiotherapy by bringing healthy tissue to a region highly compromised by hypoxia. In the present study, the goal is to preserve oral function for patients with a surgical defect that encompass the FOM as a result of cancer resection. There are 9 studies/case reports published to date in the literature about the FAMM flap. The largest series comes from Ashtiani et al, with 22 FAMM flaps performed for closure of palatal fistulas. Among all these series, the results of 90 flaps are reported. There are 3 cases of complete necrosis, 6 partial necrosis of the tip of the flap, and few other complications. In our study, the rate of complications is higher. However, only 6 of them required a revision surgery. We initially found our higher rate of complications surprising and wondered whether our rare use of the Doppler to locate the facial artery could be an explanation. However, the facial artery was identified in 56 of the 57 FAMM flaps harvested without use of the Doppler. In the remaining case, the flap suffered a partial necrosis of the flap tip without significant consequences. This patient might have had a hypoplastic facial artery as found in 2% to 9% of the population. There are more probable explanations to our higher rate of complications. Compared to other reports, the patients in our series are older, have a higher rate of reconstruction following locally advanced tumor resections, and have had multimodality treatments more often. Moreover, many of the patients in our series had the reconstruction performed secondarily after failure of a previous reconstruction (16 flaps). Insetting of the flap on these unfavorable grounds is more tedious and more prone to complications. No complete flap necrosis occurred. Partial flap failures were more frequent when the flaps were used for secondary reconstruction or after T3–T4 cancers ablation. Medium to large size defects should not be managed by FAMM flap reconstruction if microvascular...
lar surgery is available and not contraindicated by the general status of the patient.

Park et al. showed in an anatomical study that facial arteries anastomose together through inferior labial arteries and a horizontal mental artery. If facial artery ligation was done proximally to the aforementioned anastomoses in a previous surgery, a FAMM flap can still be theoretically harvested on the same side based on these anastomoses. In our series, 4 patients had a FAMM flap harvested on the same side the facial artery was ligated and incised on a previous surgery. All flaps survived with 1 experiencing distal necrosis without subsequent revision surgery. As a first step during flap harvest, the facial artery was tested by incision of its distal end and observation of the arterial bleeding. Even though our results were good in these patients, we generally favor use of an alternative method of reconstruction of the FOM in this setting.

The FAMM flap is our favorite method of reconstruction for limited-sized defects of the FOM. The retrospective nature of this study prevents a thorough functional assessment such as detailed assessment of speech and swallowing. However, our results seem to indicate that preservation of function is successful in the majority of our patients. Dental restoration is an important issue in FOM reconstruction because it allows the patient to return to a regular diet. The FAMM flap offers a supple ground on which dental prosthesis can be abutted (Figure 10) and an elastic cushion against prosthetic loading, but one must be aware that its relative bulkiness can decrease the depth of the sulcus. In these situations, anchorage of osseointegrated implants for fixed dentures is preferred.

Various methods have been used for management of FOM defects. Healing by secondary intention leads to progressive contracture with restrained tongue mobility and impaired function. Split- or full-thickness skin grafting is effective in reconstruction of small FOM defects. To prevent graft failure, it systematically requires anchorage by a bolster with tie over nonabsorbable sutures or by a stent with through-and-through sutures in the FOM. Even if results are good initially, progressive contraction can lead to reduced tongue mobility especially after postoperative radiotherapy. Coverage of alveolar crest defects is feasible when a marginal mandibulectomy is required, but in the long run, patients suffer from denture sores because of the thinness of mandible coverage. Skin graft should be avoided for deep defects because the resulting concavity will lead to saliva and food particles accumulation making oral hygiene problematic.

Compared to conventional pedicled skin flaps, the FAMM flap does not require any external incisions. It has the advantage to replace the missing mucosa with tissue of the same quality. Moreover, this flap does not cause any cheek distortion or ectropion and avoids the risks of intraoral hair growth and inclusion cysts formation as seen with the nasolabial flap.

The FAMM flap is preferred over random mucosal flaps because of its greater mobility and better tolerance for a high length/width ratio (5:1) being an arterialized flap. The buccinator musculomucosal flap as described by Bozola et al. has a different blood supply and arc of orientation. The flap is pedicled posteriorly on the buccal artery. It has the advantage of being wider (mean width, 3.5 cm) than the FAMM flap, but it is more limited in length (mean, 7 cm) and less flexible in its arc of rotation. It can be used for lateral FOM defects only.

The tongue appears well suited for anterior FOM reconstruction because of its rich vascular supply and proximity to the defect. Several designs of the tongue flap have been proposed, but many of them restrict tongue mobility. When the primary tumor approaches the pelvilingual sulcus, a partial glossectomy is needed and the use of a tongue flap is compromised.

Because of its thinness and pliability, the musculocutaneous platysmal flap is well suited for FOM reconstruction. However, its reliability has

![FIGURE 10. Dental restoration by prosthesis 5 months after section of the pedicle and 1 month after completion of radiation therapy. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]](https://www.interscience.wiley.com)
been questioned, particularly if ipsilateral neck dissection is performed, which is usually the case for FOM cancers.\(^{18,19}\) Platysmal flaps have unpredictable results unless the blood supply of at least 1 region is preserved.\(^{20}\) Previous irradiation and neck surgery are relative contraindications to platysma flap transfer.

The submental flap is an island musculocutaneous flap supplied by the mental artery and is considered more reliable than the platysmal flap. The scar is hidden under the mandible, and a large skin paddle can be raised. Use of this flap is not encouraged when neck dissection is planned in the submental and submandibular areas. Isolation of the pedicle with a thick surrounding fibrofatty tissue may compromise the completeness of neck dissection.\(^{21}\)

The infrahyoid flap is also considered more reliable than the platysmal flap. It is very suitable for FOM reconstruction because it is not bulky and the skin is supple.\(^{19}\) Some drawbacks include the presence of hair-bearing skin in males and the difficulty to harvest this flap without compromising on the quality of neck dissection, which is not the case with FAMM flap raising. Survival of the flap is at risk if the neck dissection includes sacrifice of the ipsilateral external and internal jugular veins.\(^{19–22}\)

Regional flaps such as the pectoralis major or latissimus dorsi are not adapted for intraoral reconstruction because of their bulkiness. Thin free flaps such as the radial forearm flap or the thinned anterolateral thigh flap are preferred. For medium-sized soft tissue defects, reconstruction with a free flap is an adequate option. If the patient has too many comorbidities and the main defect is central, we prefer to use a double FAMM flap reconstruction. This technique obviates the need of a lengthier, more complex procedure and intensive postoperative monitoring. It can be particularly valuable in hospitals in which microvascular expertise is not available.

**CONCLUSION**

The FAMM flap is presently our preferred method of reconstruction for small to medium-sized defects of the FOM following cancer ablation despite some minor complications and disadvantages such as the frequent need for a second-stage procedure and, rarely, for a bite block. The advantages of the FAMM flap are its versatility, reliability, ease of harvest, proximity to the defect and similar mucosal lining, absence of external scar, and low rate of significant complications. Moreover, the FAMM flap does not require any modification in the planning of the neck dissection other than preservation of the facial artery. It is well suited for coverage of bone defects when marginal mandibulectomy has been performed. We expect to study prospectively function maintenance following FAMM flap reconstruction.

**REFERENCES**