

Midface Reconstruction With the Fibula Free Flap

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Objective: To evaluate the use, indications, and outcomes of the fibula osteocutaneous free flap when reconstructing the midface.

Design: Retrospective review of a case series.

Setting: Tertiary referral center.

Patients: We evaluated all patients requiring midface reconstruction after tumor resection between January 1, 1994, and January 1, 2000. Twenty-seven individuals who lacked sufficient retentive surfaces and/or teeth to support a conventional prosthesis were offered vascularized bony reconstruction.

Interventions: All patients underwent fibular osteocutaneous free flap reconstruction of the midface: 16 primarily, 11 secondarily.

Main Outcome Measures: Success of free tissue trans-

fer, perioperative complications, oral diet, speech, type of dental reconstruction, and cosmesis.

Results: Twenty-six of 27 flaps survived. Four patients had wound complications managed successfully with local wound care. Fourteen patients achieved a regular diet and 13 patients maintain a soft diet. Eighteen patients had osseointegrated implants placed, and 14 patients used an implant-borne prosthesis. Cosmetic results were judged to be excellent in 14 patients; good in 8; fair in 4; and poor in 1.

Conclusions: Use of the fibula osteocutaneous free flap to reconstruct the midface is highly reliable and our flap of choice for lower maxillary defects requiring bony reconstruction. However, when orbitozygomatic support is the primary objective, the utility of this flap is limited. Because of the complexity of this procedure, the choice of midface reconstruction technique should be individualized for each patient.

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MIDFACIAL DEFECTS arising from tumor extirpation or trauma may involve any portion of the central area of the face, including the palate, cheek, maxilla, orbit, and/or nose. Also, loss of these key structures has significant functional and cosmetic consequences. These may include the creation of large oronasal and oromaxillary fistulae, loss of significant tooth-bearing segments, loss of lip, cheek, and eye support, and loss of midface projection. In addition, oral alimentation and speech may be impaired.

The goals of reconstructing these defects include (1) consistently obtaining a healed wound; (2) restoring palatal competence and function (separation of the oral and sinonasal cavity); (3) supporting the orbit or filling in the orbital cavity in cases of exenteration; (4) obliterating a maxillary defect; (5) restoring facial

contours; and (6) recreating a functional dentition.¹ Obturation with maxillary prostheses has been the traditional method of rehabilitation for these patients. However, over the past 10 years, microvascular free tissue transfer techniques have greatly expanded the surgeon's ability to reconstruct this challenging area with a variety of composite tissues. Microvascular free tissue reconstruction allows for the transfer of adequate amounts of soft tissue and/or bone in a single-stage procedure without the limitations of pedicle length or flap geometry. Although many authors advocate soft tissue reconstruction of these defects,²⁻⁸ functional dental rehabilitation cannot be achieved in all cases. When there is significant loss of tooth-bearing segments, reconstruction of the defect with vascularized bone is necessary to provide a suitable substrate for osseointegrated implants and a subsequent dental prosthesis.

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PATIENTS AND METHODS

PATIENT POPULATION AND ASSESSMENT TOOLS

A retrospective review was done on patients who underwent microvascular free flap reconstruction of the midface from January 1, 1994, to January 1, 2000. All 62 patients requiring maxillary resection and/or reconstruction were evaluated preoperatively by the surgical team and maxillofacial prosthodontist. Eleven patients underwent primary maxillofacial prosthetic reconstructions; 17 underwent soft tissue free flap reconstruction with or without cranial bone; 3 patients received scapular flaps; 4 with small anterior maxillary defects underwent radial forearm osteocutaneous free flap reconstruction.

In those patients without sufficient retentive surfaces and/or teeth to support a conventional prosthesis, fibula osteocutaneous free flap reconstruction was offered. Twenty-seven patients in this category underwent fibula osteocutaneous free flap reconstruction. Preoperative plaster models were made of the maxillary and mandibular arches. The patients were evaluated for length of primary flap ischemia, perioperative complications, and adequate wound healing. Follow-up ranged from 6 months to 6 years (mean, 26 months). The patients were evaluated postoperatively for type of diet (comparison of preoperative to postoperative diet), speech intelligibility, cosmesis, and dental restoration. Cosmesis was judged individually by the patient, significant other (when applicable), and physician on a scale of 1 to 10. The results were averaged for a final score, and ratings were applied as follows: 1.0 to 3.0 indicated poor results; 3.1 to 6, fair; 6.1 to 8, good; and 8.1 to 10, excellent.

SURGICAL TECHNIQUE

Figure 1 shows a preoperative facial view and panoramic radiograph of a representative patient. The fibula flap was harvested in the standard fashion as described by Hidalgo.⁹

All bony buttresses available for contact with the fibula flap in the midface were exposed (**Figure 2A**). The upper neck vessels were isolated, and frequently the submandibular gland was removed for access. A subcutaneous tunnel was made over the mandible into the maxillary defect to a width of 2 finger breadths to allow the vascular pedicle to easily pass through. The flap was then transferred to the recipient site. The leg wound was closed primarily in 23 cases. Four patients required skin grafting to avoid tightness of the closure.

Osteotomies were then made in the fibula bone to recreate the missing tooth-bearing segment (**Figure 2B**). The maxillary model was used as a guide for placement of the osteotomies. In those cases where zygomatic reconstruction was necessary, an additional osteotomy was made to recreate the buttress and abut the bone to the residual zygoma. The osteotomies were made distally to proximally so that any excess proximal bone could be discarded, thus increasing the pedicle length. The pedicle was transferred through the subcutaneous tunnel into the neck, and 1.3-mm titanium miniplates (Synthes Maxillofacial, Paoli, Pa) were used to fix the fibula to the residual bony buttresses (**Figure 3A**). A minimum of 4 plates were placed to achieve maximum stability. If the vascular pedicle was noted not to be long enough to reach fully to the neck vessels, vein grafts were added to the peroneal vessels on a back table prior to final bony fixation. The flap was then fixed to the maxilla.

The soft tissue was contoured and then sutured in place to seal the palate and fill in soft tissue contours (**Figure 3B**). If the orbital floor has been resected, fascial or Alloderm (LifeCell Corp, Branchburg, NJ) slings were placed to support the orbit. Once this was completed, the microvascular anastomoses were performed, and final wound assessment and closure were done. Osseointegrated implants were placed 3 to 6 months after this initial procedure (**Figure 4**). They were uncovered after 3 to 4 months, and the maxillary prosthesis was completed (**Figure 5**).



Figure 1. A, A 55-year-old man 14 years after surgery and radiation therapy for maxillary alveolar carcinoma. Cosmesis score, 5.7 (mean scores for the patient, his significant other, and his physician, 5, 6, and 6, respectively). B, Panoramic radiograph of maxillary defect.

The fibula osteocutaneous free flap has enjoyed wide success in reconstructing the mandible,^{9,10} but few data are available on using this flap in reconstructing midface de-

fects. We present a series of patients who underwent fibula free flap reconstruction of the midface and evaluate the success and functional outcomes of this technique.

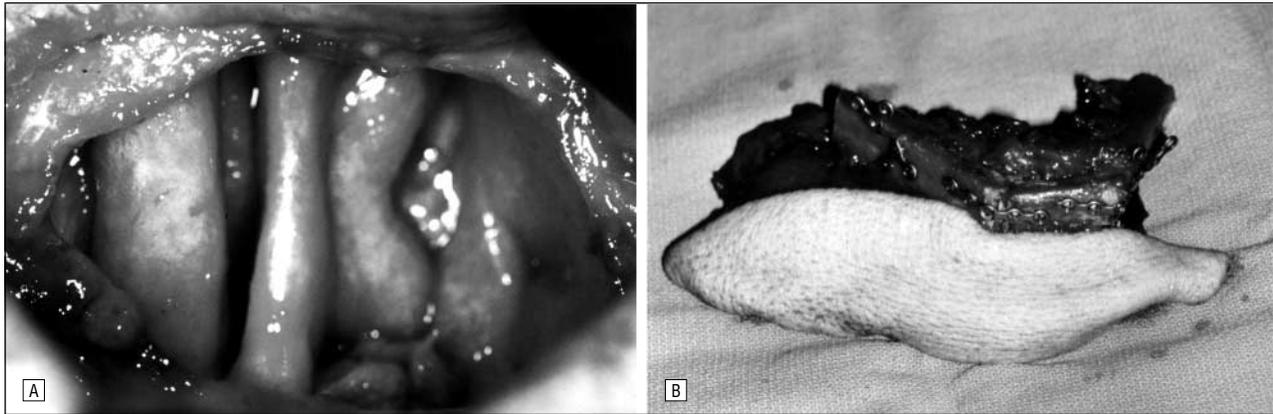


Figure 2. A, All bony buttresses available for contact with the fibula flap in the midface were exposed. B, Osteotomies are made to shape the fibula into the maxillary alveolar shape.

RESULTS

Twenty-seven patients underwent fibula osteocutaneous free flap reconstruction of maxillary defects. Sixteen were done primarily at the time of tumor extirpation. Eleven were performed secondarily. The tabulation below lists the patient characteristics:

Characteristic	Finding
No. of patients	27
Age, y	14-74 (mean, 59)
Sex	20 Male, 7 female
No. of primary reconstructions	16
No. of secondary reconstructions	11
No. of inferior maxillary defects	20
Unilateral	12
Bilateral	8
No. of maxillectomy defects	7
Follow-up	6 mo to 5½ y (mean, 26 mo)

All patients were missing at least 50% of the maxillary tooth-bearing segment. Seven patients also had loss of the zygoma and infraorbital rim and floor. The primary flap ischemia time ranged from 2½ to 5 hours (mean, 3 hours 45 minutes). All flaps were noted to be viable at the completion of the surgical procedure. Nine patients required vein grafts to lengthen the vascular pedicle.

The following tabulation lists the perioperative complications:

Complication	No.
Flap failure	1
Return to operating room	14-74 (mean, 59)
Venous obstruction	2
Arterial obstruction	1
Wound dehiscence	4
Additional flap procedures	1
Additional eyelid procedures	3

There was 1 patient with total flap failure. This patient was noted to have arterial insufficiency 24 hours after the procedure. Reexploration in the neck revealed patency in both the arterial and venous anastomoses; however, the flap was clearly not viable. This patient had vein grafts placed during the primary procedure, and it was ultimately noted that the patient had occlusion at the anastomosis between the peroneal artery and vein graft. This

anastomosis was buried under the cheek, and attempts at salvage were unsuccessful. This patient went on to have reconstruction with a maxillary obturator.

Two patients developed venous occlusion within 36 hours of procedure completion. A hematoma was evacuated in 1 patient resulting in resolution of the venous occlusion. The second patient had kinking of the vein. This was realigned, and the flap was salvaged successfully. Four patients developed partial wound dehiscence in the early postoperative period, and these all resolved within 21 days with local wound care. One patient underwent additional soft tissue reconstruction with a rectus abdominus free flap to improve soft tissue contour in the infraorbital and zygomatic area. Three patients developed lower lid ectropion and required secondary local procedures for correction.

The following tabulation summarizes functional rehabilitation results:

Function	Result
Diet	14 Regular; 13 soft
Speech	All intelligible over the telephone
No. of patients with	
Implants placed	18
Implant-borne prostheses	14
Upcoming implant procedures	8
Maxillary obturation	8
Cosmesis, No. of patients	
Excellent	14
Good	8
Fair	4
Poor	1

All osseointegrated implants were placed secondarily. Eleven patients can eat all food consistencies, similar to their preoperative diet. Three patients actually improved from a preoperative soft diet to a postoperative regular diet. Of the 13 patients who tolerated a soft diet, 8 ate all food consistencies preoperatively, while 5 had maintained a soft diet. Although formal speech evaluations were not performed, all patients were intelligible on the telephone. In those patients who had inferior maxillary defects with preservation of most of the zygomatic prominence, cosmesis was judged to be excellent. In those patients with loss of most of the zygomatic prominence and/or infraorbital rim and floor, cos-

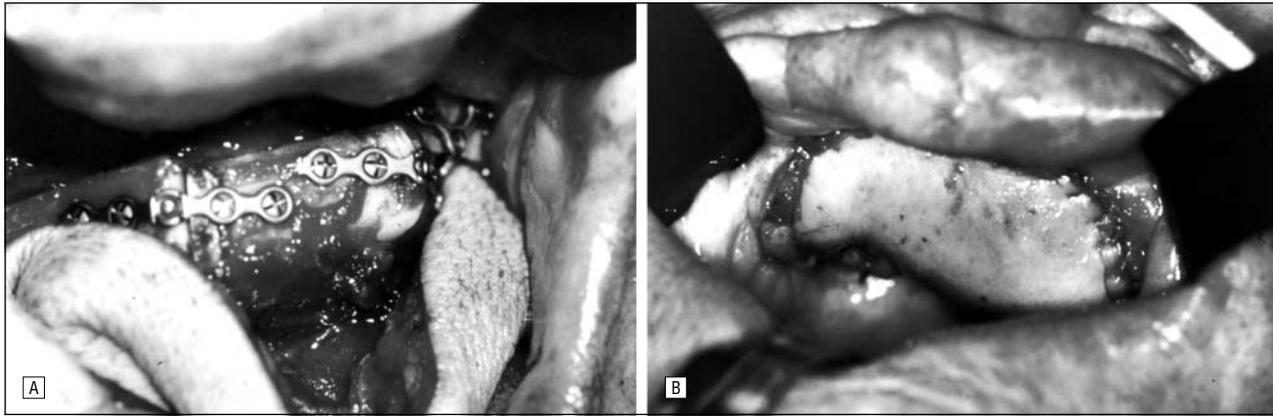


Figure 3. A, Fibula fixed to residual zygoma and maxillary buttress with 1.3-mm titanium plates. B, Soft tissue flap inset.

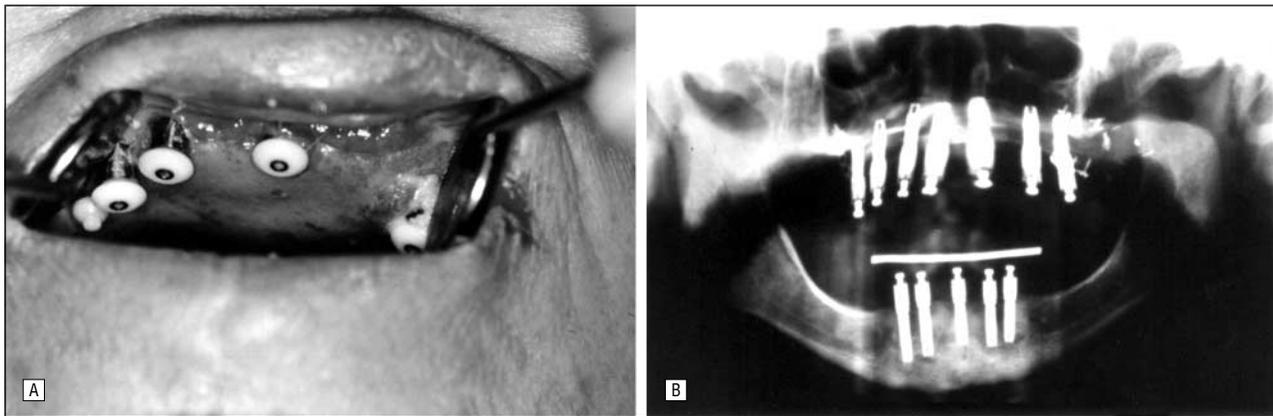


Figure 4. A, Osseointegrated implants in place 5 months after primary procedure. B, Panoramic radiograph after implant placement.

mesis was noted to be fair, mainly owing to flattening in this area. In the patient who ultimately required a maxillary obturator, cosmesis was judged to be poor.

COMMENT

Maxillary defects resulting from tumor extirpation or trauma represent a challenging dilemma for reconstructive surgeons. The choice of reconstruction depends on the extent and anatomic locations of bony and soft tissue loss, which varies from patient to patient. Common reconstructive goals, however, include consistently obtaining a healed wound, sealing the palate and separating the oral and sinonasal cavities, obliterating the defect, supporting the orbit, and restoring facial contours.¹ Restoration of functional maxillary dentition can optimize speech, swallowing, and cosmesis.¹¹⁻¹³

No single reconstructive technique has been described to achieve all of these goals. Though traditionally these defects were obturated by a maxillary prosthesis,^{14,15} recent advances in microvascular free tissue transfer allow the potential for single-stage autologous tissue maxillary reconstruction.^{1-3,5,6,16}

Initially, soft tissue flaps provided adequate bulk and a long vascular pedicle to reach recipient vessels in the neck. Shestak et al^{4,5} found the latissimus dorsi free flap to be very versatile. In all patients reported, the palates were sealed and aesthetic recontouring of the face and

cheek soft tissues was achieved. The rectus abdominus flap demonstrates similar attributes and postoperative results.⁶⁻⁸ These soft tissue reconstructions, however, do not address the maxillary bony skeleton, particularly the orbit, zygoma, and alveolus.

The scapula osteocutaneous free flap offers the potential to address these needs.¹⁷⁻²⁰ This flap is advantageous because the soft tissue component can be rotated around the bone stock with greater freedom than with other composite flaps. It is particularly useful in defects when both the orbital floor/zygoma and palate must be reconstructed. If the angular branch of the thoracodorsal vessel is included in the flap harvest, both the tip and lateral border of the scapula can be harvested.

When appropriate osteotomies are made, the palate and infraorbital regions can be restored.²¹ Uglesic et al²² have described an osteomyocutaneous free flap based on the subscapular system of flaps for reconstruction of the total maxillectomy defect with orbital exenteration. This type of flap has good bone stock that can be used for the infraorbital area and palate, a muscle component (latissimus dorsi) for cavity obliteration, and a skin component fulfilling soft tissue deficits of the face, cheek, and palate. The scapula, however, may not always be suitable for placement of osseointegrated implants.^{23,24} Further disadvantages include inability to harvest the flap simultaneously with the extirpative procedure; difficulty in orienting the bone to provide orbit, zygoma, and

alveolar reconstruction; and the relatively short pedicle length.

When only the soft tissue of the palate is reconstructed, conventional dentures provide functional dentition if adequate teeth and/or retentive surfaces are available to provide stability.¹³ In many cases, soft tissue reconstruction alone results in a flatter surface of the maxillary arch than in the native condition. Blunted neoalveolar contours are created, and loss of depth occurs in the gingivsulcus and palatal arch. This results in a “trampoline-like” surface so that the reconstructed maxilla functions poorly to retain the denture. Osseointegrated implants can provide superior retentive areas to allow the achievement of a functional dentition.^{13,25}

The fibula osteocutaneous free flap has provided these attributes in reconstruction in the oromandibular complex.^{9,10} Multiple case reports have described the use of this flap to reconstruct a variety of maxillary defects.^{1,11,12,26-33} These reports describe the ease with which the flap can be harvested and the excellent bone stock and soft pliable skin paddle that can be used for either intraoral or cutaneous reconstruction. In addition, the vascular pedicle may be lengthened to avoid the need for vein grafts by removing the excess proximal bone.

In the largest series, Foster et al¹² used the fibula free flap in 5 patients. It was principally used when the amount of bone loss exceeded the hemipalate, but it could also be contoured to additionally reconstruct the orbital rim. Our experience has shown this flap to be extremely versatile as well. The principal determination in the choice of this flap was the extent of the palatal defect. After consultation with the maxillofacial prosthodontist, if the residual palate and/or dentition was insufficient to support a conventional prosthesis, the fibula was selected so that osseointegrated implants could be placed. In the 20 of 27 patients whose defects were limited to the inferior maxilla, excellent results were obtained for speech, swallowing, and cosmesis. The bone provided bulk and skeletal support, while the soft tissue was easily rotated to resurface the palate and lower malar areas when necessary.

We also found, however, that as the need for reconstruction of the zygomatic complex, infraorbital rim, and floor increased, this flap was limited in its ability to restore the entire maxillary form. The technical difficulties increased as well. It is difficult to osteotomize and orient the bone to both restore the palate and fill the infraorbital area. Even with the harvest of additional soleus to provide soft tissue bulk, there is somewhat limited rotation of the skin paddle to resurface the palate as well as provide zygomatic and infraorbital contour. This resulted in cheek flattening and ectropion in 4 of the 7 patients with this type of defect.

Secondary lower lid procedures were necessary in 3 patients owing to persistent ectropion. These patients did, however, have the same excellent speech and swallowing function as those with more inferior defects. Five of these 7 patients required vein grafts for the pedicle to reach the neck recipient vessels. The 1 flap failure was due to kinking of the peroneal artery and anastomosis with the vein graft caused by acute angulation at the level of the zygoma. This anastomosis was buried under the subcutaneous tunnel and could not be salvaged.

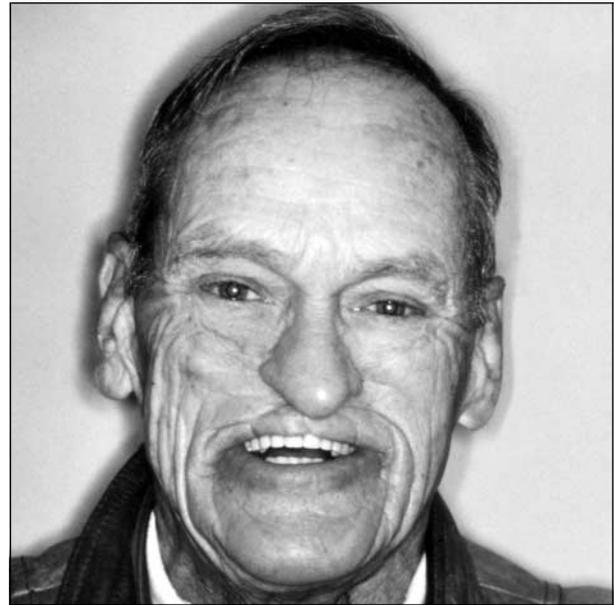


Figure 5. One-year postoperative result. Postoperative cosmesis score, 8.7 (mean scores for the patient, his significant other, and his physician, 8, 9, and 9, respectively).

To provide maximum bone to reconstruct these maxillary defects, the iliac crest myo-osseous flap provides an excellent source of tissue. Brown³⁴ and Brown et al³⁵ presented 3 cases of reconstruction using this flap and had favorable functional results. The disadvantages of using this flap and the maxilla are its potentially excessive bulk, limited soft tissue mobility in relationship to the bone, and short pedicle length. Freije et al³⁶ advocated the use of dual free flaps to reconstruct the face. Although success has been reported in a small series of patients, the advantages of 2 separate free flaps have not been demonstrated. Despite the increased complexity and amount of time involved in this procedure, it has not proven more beneficial than the use of a properly designed single free flap, which provides excellent bone stock and pliable soft tissue.

Most recently, Cordeiro et al² and Cordeiro and Santamaria³ have elegantly described the use of soft tissue free flaps with nonvascularized (rib, calvarium) and vascularized (radius) bone to reconstruct a variety of maxillary defects. In these series, particular attention was paid to osseous reconstruction of the orbit and zygoma, and excellent cosmetic results were achieved. The palate, however, was sealed with soft tissue only, although 43 of 46 patients tolerated an unrestricted or soft diet. Thirty-nine of 46 patients had nearly normal or normal speech, while 6 more had intelligible speech. Only 15 of 46 had a useable prosthesis, but the authors stated that this was not considered a requisite to assist chewing function.

Our experience has shown that the ability to recreate a functional dentition led to improved swallowing and cosmesis in all cases. In those patients who have yet to receive a maxillary prosthesis, attainment of a soft diet was the rule, and limited data suggest lack of upper teeth leaves some patients self-conscious about their appearance.

It is clear from the literature and our series that no single flap or technique is sufficient to reconstruct com-

plex maxillary defects in all cases. The fibula osteocutaneous free flap has excellent utility for primarily alveolar and palatal defects and when the need for implant-borne prostheses is paramount. When orbitozygomatic support is the primary objective, the utility of the fibula free flap is limited, and other techniques described may be more appropriate. Future directions in maxillary reconstruction will be to combine these techniques in each individual defect to achieve the optimum result for the patient. The complexity of the techniques should always be matched to the desired goals of the patient as well as the needs of the defect.

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