Midfacial Reconstruction and Radiation: Case Report and Review of the Literature

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ABSTRACT

Midfacial radiation-induced defects usually involve the bony structures and require composite reconstruction. A 36-year-old male patient with a midfacial defect due to radiation and failure of local flaps was referred to us and treated successfully with a microvascular flap. This case is reported in correspondence with a literature review of the classification of midfacial defects, choice of treatments, and outcomes of different reconstructive options. The deleterious effects of radiation on tissue healing and the functional and aesthetic outcome of reconstruction are discussed. Midfacial defects that are refractory to treatment with local flaps are best treated with microvascular free tissue transfer.

KEYWORDS: Neuroblastoma, midface, reconstruction, radiation, composite flap

Complex midfacial defects are challenging because of the need for three-dimensional reconstruction involving soft and bony tissues. Reconstruction of the bony regions of the midface, unlike the lower face, which includes the mandible, does not generally require preservation of mastication and movement. However, the presence of the sinuses and oronasal passages requires the isolation of adjacent vital organs to prevent contamination and infection. Furthermore, maintaining the structural integrity of the midface is important for preserving facial aesthetics as well as function. Many methods of midfacial reconstruction are available, involving the use of local, regional, or microvascular free flaps. However, when dealing with a defect in an irradiated field, the choices are fairly limited due to the need for highly vascularized tissue.¹⁻⁵ We present a patient with an orbitomaxillary defect in an irradiated field that was treated successfully using a composite radial forearm flap.

CASE REPORT

A 36-year-old man with a history of an olfactory esthesioneuroblastoma involving the orbital cavity underwent a bifrontal craniotomy and resection of the superomedial wall of the right maxillary sinus and the inferior orbital wall and partial ethmoidectomy and turbinectomy. This was followed by proton and external beam radiation therapy, revision of the craniotomy, and cement cranioplasty. The patient then underwent several reconstructive procedures over a 6-month period including a subperiosteal midface elevation, reconstruction of the midface with a titanium plate, reconstruction of the right lower eyelid, as well as right conjunctival dacryocystorhinostomy.

The patient was referred to our department soon after secondary reconstruction with symptoms of dizziness, headache, double vision, depression, anxiety, and an exposed infraorbital plate (Fig. 1). The patient further demonstrated extensive facial deformities and a chronic open wound of the right maxillary sinus. A computed

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Craniomaxillofac Trauma Reconstruction 2010;3:137-140.

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Received: April 5, 2010. Accepted: May 16, 2010. Published online: July 26, 2010.

DOI: <http://dx.doi.org/10.1055/s-0030-1262956>.

ISSN 1943-3875.

Figure 1 Preoperative evaluation of infraorbital exposed plate.

Figure 3 One-year follow-up after free flap reconstruction.

tomography scan confirmed the clinical findings and indicated that there was not enough orbital bone to reanchor the plate (Fig. 2).

To reconstruct the facial defect, a microvascular radial forearm osteocutaneous flap was used. The skin flap (10 × 6 cm) covered the defect, and the bone graft was internally fixed to augment the maxilla. The facial artery and vein were dissected and anastomosed with the radial artery and cephalic vein. The radius was plated with a locking plate (LCS, Synthes, Oberdorf, Switzerland). A split-thickness skin graft harvested from the right thigh was then used to cover the forearm defect. The postoperative course was uneventful, and the patient was discharged on postoperative day 6.

The follow-up in our outpatient clinic showed a well-healed flap with good cosmetic results. One year after surgery, the patient complained of slight spasms in the right side of the face and fullness of the midface flap with a color mismatch (Fig. 3). The patient had full range of motion of his fingers and wrist in his left hand. Surgery was planned to correct the fullness of the radial

forearm flap but was postponed indefinitely due to insurance matters.

DISCUSSION

The modern treatment of midfacial deformities dates back to the treatment of injured soldiers in World War I.⁶ Later, with the growing acceptance of maxillary resection in cancer patients, Hoopes and Edgerton outlined the goals of midface reconstruction in 1966.⁷ These included supporting the orbital contents, restoring the palate and facial contour, and repairing the maxillary defect. Cordeiro and Santamaria later proposed a system of classifying maxillary defects based on the extent of the maxillary bone resection.⁸ This classification system was established to facilitate the selection of an appropriate surgical procedure, addressing first the bony defect followed by the soft tissue requirements, and the critical functional structures of the midface such as the nasal airway and the palate. In 2005, Archibald et al developed a method of classification, dividing the maxilla into three subunits—upper, middle, and lower—and using this as the basis for outlining the method of reconstruction.¹ These classification systems provide a good guideline for selecting the proper flap for a particular defect. Complex midfacial defects have been reconstructed with skin grafts, local flaps, pedicled flaps, regional myocutaneous flaps, and free tissue transfer.^{2–5,9} Free tissue transfers are mainly used for large defects that cannot be covered with local and regional flaps or that require complex three-dimensional contouring.

Radiation therapy has acute and chronic side effects including tissue breakdown, delayed wound healing, and osteoradionecrosis.¹⁰ Radiation treatment of the midface causes loss of structural support and alterations in three-dimensional facial contour and symmetry. In addition, oronasal and sinusal nasal barriers are disrupted, increasing the chances of infection. The

Figure 2 Radiographic findings of midfacial bony deficiency.

principal treatment of osteoradionecrosis involves sequestrectomy and soft tissue debridement of all devitalized tissue followed by reconstruction with well-vascularized tissue.¹¹ Local flaps, such as the lateral cheek and inferiorly based rotation flaps, can be used in conjunction with a vascularized bone graft to cover the skin defect.^{12,13} Local skin flaps are preferable for resurfacing the face because they provide the best texture and color match.¹⁴ However, in irradiated areas, they would provide less than ideal vascularity for healing. Therefore, free tissue transfer from a nonirradiated area is the most effective reconstructive option as it provides an adequate source of tissue to fill the defect and an independent blood supply for improved healing.¹ There are several flaps that can be used to reconstruct midface radiation defects depending on the size of the defect and the need for bony reconstruction.

The radial forearm flap, anterolateral thigh flap, scapular flap, and iliac crest flap are generally used for combined soft and bony tissue reconstruction in the midfacial region. The latissimus dorsi and the rectus abdominus myocutaneous flaps are routinely used by plastic surgeons and have several advantages when used for defects requiring only soft tissue repair.¹⁵⁻¹⁹ The rectus abdominus flap provides large-diameter vessels and a large volume of soft tissue fill that can be contoured for different defect volumes and skin surface requirements.⁸ Likewise, the latissimus dorsi flap supplies a bulk of available tissue for complex defects; however, repositioning in the lateral decubitus appears to be necessary.²⁰

Composite microvascular flaps such as scapula and fibula flaps have been advocated for maxillary repair.²¹ The composite fibula flap is a popular flap for maxillofacial reconstruction as it has a fairly long pedicle; however, its skin is much less robust and tolerant for multiple paddles.¹ Schliephake reports using osteocutaneous scapula flaps to repair complex midfacial defects in oncologic patients.²² These flaps have plentiful skin that can be raised with good bone; however, they usually cannot be harvested while the resection is in progress and often require secondary procedures to provide enough bone in the position required.^{1,23} The iliac crest flap can provide a large flat segment of bone that can be contoured for complex midfacial defects. However, an iliac crest bone graft has several limitations such as a shorter vascular pedicle, bulky soft tissue, and donor site morbidity.^{1,24} The osseocutaneous radial forearm free flap appears to be a reasonable choice for maxillary repair of limited bony defects. It contains large vessels that can be anastomosed at some distance from the defect and pliable skin that allows for three-dimensional surface contouring.^{15,24}

We have used the composite radial forearm flap in our patient who had a mid- and upper-maxillary defect following previous tumor surgeries and radiation therapy. In addition to the maxillary defect, the patient had

an isolated orbital defect, which was repaired with the same flap. Based on Cordeiro and Santamaria's classification system, this defect would be classified as type I defect or limited maxillary defect.⁸ Cordeiro and Santamaria recommend the use of the radial forearm flap for this type of defect as it provides good external skin coverage and minimal bulk.⁸ According to Archibald et al, the defect would be located in the middle/upper maxillary subunit; be responsible for the bony width, height, and anterior projection of the face; separate the sinonasal cavities; and support the orbital contents.¹ Archibald et al also suggests the use of the radial forearm flap as long as the bony defect is not large.¹ Larger defects usually involve bilateral maxillary bone loss. Donor site morbidity associated with radial forearm flaps includes tendon exposure, fracture of the radius, poor cosmesis, and decreased hand mobility, strength, and sensation.²⁵ Of these, the radial fracture is the most serious complication that can be prevented by plating the radius at the time of surgery.²⁶

In our patient, the reconstructive options were limited to vascularized free tissue because of the radiation damage. We chose the radial osseocutaneous forearm free flap because the soft tissue defect did not require any bulk and the bony defect was not too extensive. The thin pliable skin of the radial forearm is suited for internal and external lining of the defect. The radius was plated with a locking plate to prevent fracture of the bone.

One year after surgery, our patient had a good aesthetic and functional outcome. We were able to restore the contour of the maxillary bone with the radial bone graft and cover the soft tissue defect with the radial skin flap. Evaluation at that time showed a minimal contour deformity consisting of fullness in the flap covering the medial cheek with a slight color mismatch. A local skin flap would have provided a better color match; however, local tissue was not used for external covering because of radiation damage to the cheek. A secondary procedure was planned to debulk the flap; however, the surgery was postponed due to insurance matters.

The patient presented minor donor site morbidity related to slight numbness to the dorsum of his left hand. Lutz et al, in a prospective study of 95 cases, reported of numbness distal to the donor site after suprafascial elevation of a radial forearm flap in 54% of the patients. These cases were attributed to swelling and surgical manipulation of the nerves, postoperative edema, and perineural scarring.²⁷ The numbness is usually temporary as it was in our patient. The patient also displayed good extension and flexion of his wrist and digits and had a normal range of motion.

CONCLUSIONS

The success of maxillofacial reconstruction is judged by the functional and aesthetic outcomes of the particular

flap used. The appropriate microvascular flap should be chosen based on the size of the bony defect and the volume of soft tissue loss. Functional success involves reestablishing the midfacial barriers to prevent future infection and supporting the vital structures. The aesthetic outcome is determined by the patient's facial contour, symmetry, and skin color match. The case presented here demonstrated several local attempts to reconstruct a midfacial defect in an irradiated field prior to definite free flap coverage. We conclude that a free flap containing an independent blood supply should not be considered the least option for these patients undergoing radiation therapy.

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