ORIGINAL ARTICLE

Reconstruction of Mandible by Free Fibular Flap

Nabeela Riaz and Riaz Warraich

ABSTRACT

Objective: To determine the results of using the free vascularized fibular flap for comprehensive reconstruction of post-resection or post-traumatic mandibular defects.

Study Design: Case series.

Place and Duration of Study: Department of Oral and Maxillofacial Surgery, King Edward Medical University, Lahore, from March 2007 to June 2009.

Methodology: The study group consisted of patients who underwent reconstruction of continuity defects of the mandible using a fibular vascularized free flap. Indication for mandibular resection were squamous cell carcinoma of the floor of the mouth and alveolar ridge in 5 cases, ameloblastome of the mandible in 6 cases, odontogenic keratocyst in 3 cases, defect due to fire arm injury in 2 cases and central giant cell granuloma of the mandible in one case. The type of reconstruction performed was primary reconstruction in 11 patients and secondary in 6 patients.

Results: There were 17 patients including 14 males and 3 females with mean age of 40 years. All flaps except three survived. One patient died due to complications related to blood transfusion. Of those, 2 completely failed, one due to the unfavourable recipient bed of the patient with fire arm injury and other due to venous thrombosis. Donor site morbidity was low; there was some compromise in the ankle function but none of the patient complaint of foot drop. Simple problems with wound healing such as dehiscence and delayed wound healing developed in 5 patients, which usually required only local antiseptic treatment. After the operation patient began oral feeding and walking with some aid in fourth week and became completely ambulant in 8 weeks.

Conclusion: In this small series the free fibula flap was a versatile and reliable option for microvascular reconstruction of large mandibular defects. It provided a large quantity of bone, which could be easily shaped and passively adapt to the remaining mandible and for an implant-based prosthetic restoration.

Key words: *Fibula. Flap. Autogenous graft. Reconstruction. Mandible.*

INTRODUCTION

Tissue loss resulting from cancer ablation, debridement of infected tissues or secondary to trauma provides the surgeon with various reconstructive challenges. Although reconstruction of soft tissue defects of head and neck requires a fasciocutaneous or musculocutaneous flap, composite tissue loss that includes bone should be managed with a flap that contains vascularized bone.[1]

The goal of reconstructive surgery in tissue loss is to repair the defect at the time of surgery so that wound heals primarily, function is maintained and normal cosmesis is achieved. What is required specifically is a one stage immediate reconstruction with well-vascularized tissue and a low complication rate.[2]

Until the advent of free tissue transfer, reconstruction of the defects of mandible and midface was sub optimal.[3] Plating across the defects with or without non-vascularized bone grafts usually results in plate exposure, particularly in irradiated patients. Bulky pedicled flaps were used to cover these plates with varying degrees of success.[4,5]

The fibula free flap provides a strong long segment of bone and can include a large fasciocutaneous component as well. As such this versatile flap may be harvested as an osteocutaneous flap or a purely osseous flap. It is now the most popular method of mandibular reconstruction.[1]

The fibula flap provides a successful bone graft with an acceptably low complication rate.[2] Fibular bone allows to plan osteotomies in relation to the orientation of the bone and its vascular pedicle. Thick cortical bone readily accepts plates and screws for a secure interosseous fixation and osteointegrated implants may be placed in this bone safely.[3] Moreover, the free flaps are not expensive as compared to other methods and may provide cost saving for selected patients.[5,6] Among other alternatives like scapular and iliac crest flaps, fibular flap has many advantages for mandibular reconstruction and respresents the first choice for the head and neck surgeon.[6]

In the field of contemporary head and neck reconstructive surgery, free vascularized tissue transfer is becoming a gold standard. The current study was designed to determine the results of using the free vascularized fibular flap for comprehensive reconstruction of mandibular defects.

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METHODOLOGY

This case series was conducted at Oral and Maxillofacial Surgery Department of Mayo Hospital Lahore, over a period of more than 2 years from March 2007 to June 2009. The patients having mandibular defects or those needing mandibular resection were selected. Medically fit patients of either gender with an age range of 15-60 years were the subjects of this study. Patients, with abnormalities of the lower leg vascular anatomy i.e. having peroneous magnus or impaired circulation of the leg, with extensive leg trauma and those who were diabetic and had significant venous stasis or peripherial oedema, poor circulation or healing, or cutaneous ulcers were excluded from the study. An informed consent was obtained from them or their parents/guardians for including their data in research. The procedure, purpose with risks and benefits and treatment alternatives were discussed with them.

After the diagnosis, evaluation of all the patients with head and neck lesions for the extent of tumour, presence of regional and distant metastasis, bone involvement and general medical condition was done. Baseline investigations were carried out. Laboratory studies based on patient history, coagulation status were done. Chest radiography and CT scan was done to assess the presence of chronic obstructive pulmonary disease and metastasis. Pre-operative Doppler examination or angiographic imaging was done. Likewise routine examination of patients with trauma or those who required secondary reconstruction was carried out.

Ablative surgery of the tumour was done in the case of primary reconstruction, while a recipient site was prepared for secondary reconstruction. For better pedicle orientation contralateral fibula was selected as the donor tissue. When possible 2 teams simultaneously did the ablation and harvesting to reduce the operative time, but keeping in mind the dimension of the defect present or produced. A tourniquet inflated to 350 mm was used during harvesting. The lateral leg was evaluated with a Doppler examination to identify perforating vessels in the septum. These were marked and the skin flap, in the case of osteocutaneos flap, was then designed to incorporate at least one vessel. Proximally 6 cm of bone was preserved to avoid injury to the peroneal nerve. Distally, 8 cm of bone was left to support the ankle. Proximal and distal extensions allowed for bone harvest and pedicle dissection. The peroneus longus was reflected anteriorly, and the fibular bone was identified. The posterior crural septum was located and examined for perforators. Extensor hallucis longus was transected. The thick interosseouis septum was identified. Posterior dissection was performed to free the skin paddle from the soleus and gastrocnemius muscle and the septum was identified from its posterior aspect. Bone cuts were made with an oscillating saw. The bone is pulled laterally with Dingman retractors as the interosseous membrane was transected. The tibilis posterior was dissected and the pedicle underneath was identified and ligated. The flexor hallucis longus and soleus muscles were transected. Dissection was continued the the posterior tibial bifurcation. The anterior and posterior tibial pulses were palpated prior to transecting the poreneal vessels. The length of bone needed for reconstruction was measured. If the bone needed contouring, osteotomies were performed. The leg wound was closed primarily if the defect was small or no skin was harvested. A split thickness skin graft was used in the case of skin defect. A posterior leg splint was created and applied. The bone was plated and inset into the defect. The pedicle is positioned along the lingual aspect of the flap. The anastomosis was then performed with standard microvascular techniques.

Postoperatively the skin paddle was monitored frequently for signs of vascular compromise in patients with osteocutenous flaps. Good perfusion to the skin meant that the padicle was patent and providing blood to bone graft as well. For a pure osseous flap, bone viability was assessed with nuclear medicine imaging if desired.

Fluid balance and overall patient's condition were monitored as well. Prophylactic antibiotics and steroids were given. Salicylates based analgesics (e.g. aspirin) was given on the first postoperative day. The patients were allowed to ambulate in a non-weight bearing fashion on the second postoperative day. The splints were removed and the skin graft was assessed on the fifth postoperative day. The patients were then allowed to bear weight using walker or any other assistive device.

On discharge from the hospital the patient was continued on one tablet aspirin each day unless contraindicated. The first postoperative visit was generally scheduled 1-2 weeks after release from the hospital. Flap and skin graft viability were assessed. Any remaining sutures were removed. After healing of the donor site physical therapy was instituted to restore ankle function. The patients were also evaluated by a speech pathologist, physical therapist and other specialist, as required.

Adequate measures were taken to avoid complications at donor and recipient sites. Drains were used in the legs until output was sufficiently low for removal. Compartment syndrome was prevented by avoiding over tight closure of the leg, using skin grafts and drains to avoid hematomas. The posterior slab was so placed as to allow visualization of the toes and palpation of the pedal vessels. The recipient site was closely monitored for early identification of any vascular compromise. Early operative intervention was considered for flap salvage

due to venous or arterial thrombosis or if twisting of the pedicle had occurred. Operative time, hospitalization period, donor site morbidity, duration of NG tube feeding, postoperative complications such as infection dehiscence, skin necrosis were noted. A proforma containing necessary details was filled for every patient.

The collected data was analyzed by SPSS statistical version 11. The variables under study were age, sex, diagnosis, operative time, donor site morbidity, flap survival, duration of NG tube feeding and postoperative complications (infection, dehiscence, skin necrosis, delayed wound healing or fistula formation). Simple descriptive statistics were used. Numerical variables like age, operative time, duration NG tube feeding were analyzed using mean and standard deviation and for qualitative variables like diagnosis, donor site morbidity, flap survival and postoperative complications, frequency distribution tables were made for them (Figure 1, 2 and 3).

RESULTS

This study was carried out on 17 patients who underwent reconstruction with fibula free flap for mandibular defects. Among these, 14 patients were males (82.4%) and 3 were females (17.6%) with the male female ratio was 4.6:1.

The age of the patients presented with some lesion or defect ranged between 27-55 years with the mean age of 40.6±9.2 years.

There were 6 patients with ameloblastoma (35.3%), 5 patients with squamous cell carcinoma, 3 patients with odontogenic keratocyst (17.6%), 2 patients with mandibular defect due to FAI (11.8%) and one patient with central giant cell lesion (5.9%, Table I).

Secondary reconstruction was done in 6 patients (35.26%) and resection followed by reconstruction was done in 11 patients (64.7%). Out of the 6 patients who were secondarily reconstructed 2 had fire arm injury, one had odontogenic keratocyst, and another had central giant cell granuloma, and 2 had squamous cell carcinoma of the alveolar ridge and floor of the mouth.

The range of operation time was 6.45-9.30 hours with average time of 5.5 ± 1.3 hours. The range of hospital stay was 14-28 days and average stay was 18.4 ± 4.5 days. The range of duration of NG tube was 14-35 days and average duration was 21.6 ± 7.3 days.

Donor site morbidity included wound scarring in 5 patients (29.4%). All patients were ambulated within 5 weeks. Major donor site complications were uncommon. Skin grafts, when used, were survived well. Range of motion of the foot was a little limited due to scarring and muscle resection but none of the patients complained of ankle instability. Prolonged pain was rare at donor site.

Recipient site complications included vascular complication in 2 flaps (11.76%). There were postoperatively

Figure 1: Pre-operative illustration of the patient central giant granuloma.

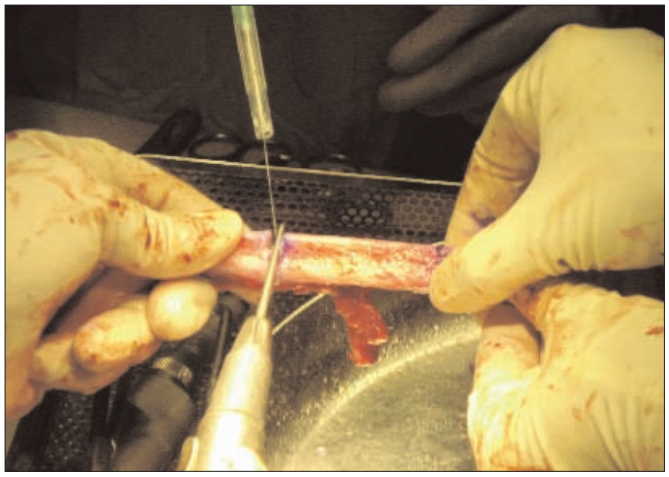

Figure 2: Osteotomy of the fibula to fit into the mandibular defect.

Figure 3: Postoperative illustration of the patient.

Table I: Relative frequencies of the reasons for mandibular defects (n:17).

Diagnosis	Number of patients	Percentage
Ameloblastoma	6	35.3%
Central giant cell granuloma	1	5.9%
Squamous cell carcinoma	5	29.4%
Fire arm injury	2	11.8%
Odontogenic keratocyst	3	17.6%
Total	17	100%

salvaged following venous thrombosis by an urgent operative intervention. Thrombectomy and revision of the thrombosed vessels were performed. Wound infection occured in 6 patients (35.2%, Table II), which were managed by local antiseptic measures. Dehiscence of the wound occurred in 3 patients (17.6%) and was resutured after the control of infection. Afterwards healing was uneventful. However, one patient developed skin and later osseous graft necrosis (5.8%) that requires debridement. This patient was later on reconstructed with pectoralis major pedicle flap. There was some delayed wound healing in 6 patients (35.2%). One patient with fire arm injury had fistula formation (5.8%). Due to the unfavourable condition of the recipient bed of this patient and the formation of the fistula, the free flap failed in this patient. One patient died in the early postoperative period due to complications related to blood transfusion.

Table II: Relative frequencies postoperative complication at the recipient sites (n:17).

Morbidity	Number of cases	Percentage
Infection	6	35.2%
Dehiscence	3	17.6%
Skin necrosis	1	5.8%
Delayed wound healing	6	35.2%
Fistula formation	1	5.8%
Total	17	100%

Out of 17 patients, 14 patients (82.3%) had successful flap survival. Nine patients came for follow-up till 2 months after surgery. None of the patients had plate exposure or extrusion. Seven patients complained of trismus which might be due to surgical manipulation and/or resection of the masticatory muscles and disturbance in mandibular integrity. Patients were counseled regarding jaw opening exercises to minimize the impact of this complication. Patients were also referred for the prosthodontic rehabilitation or for the radiation therapy if indicated.

DISCUSSION

Mandibular reconstruction represents a challenge to the oral and maxillofacial surgeon and has been revolutionized by the modern microvascular techniques. The use of free bone flaps for mandibular reconstruction has the obvious advantage of being a well-vascularized tissue that can withstand the hostile environment of the oral cavity. The donor site complication is a serious problem when planning a free tissue transfer. In this study the fibula free flap harvest appears to be associated with acceptable donor site morbidity and preservation of good foot and ankle function in most individuals. Radiographic analyses of donor and contralateral ankles showed no difference in the syndesmotic space or medial clear space.[7-17] Only one patient in the study by Garrett *et al.* had increased talar tilt compared with the contralateral side but there was preservation of the ankle stability.[18] One study reported development of compartment syndrome at the donor site.[19] These results regarding donor site morbidity are in accordance to the published studies, which also claim less donor site morbidity with free fibular graft.[17,18] However, Daniel *et al*. emphasized that vascularized fibular bone graft has minimal impact on the overall patient health, but there is significant deleterious effect on foot and ankle function.[7]

The average operative time was 6 hours and 45 minutes. It also depends upon that whether the defect was primarily reconstructed or it was done as a second stage procedure. This is consistent with those in larger series.[6] The advantages of revascularized free flap are achieved at the cost of the procedure that is longer than other conventional reconstructive procedures.[9] Foster and Anthony also concluded that additional operative time is required for a free flap reconstruction.[10] Average hospital stay was 14-28 days with an average of 18.37 $\pm$ 4.52 days. This time was a little longer than those, which are mentioned, in recent patient series.[5,6]

The range of NG tube dependencies was 14-36 days with an average of 21.6 $\pm$ 7.31 days. This wide range was due to the fact that those patients who had failure of their grafts had extended period of NG tube dependency. However, in recently published studies the NG tube dependency is less in patients who underwent revascularized free tissue transfer as compared to the pedicle flaps.[2]

Tosoco *et al.* evaluated 18 patients of free fibular flap reconstruction of the mandible which were resected for central giant cell granuloma. In this study they also prosthodontically rehabilitated the patients via implants. They had best functional and esthetic results.[20]

Peled reconstructed 13 patients (9 males, 4 females) of discontinuity defects of the mandible with free fibular flap. Wound healing disturbance at the donor site occured in 4 cases.[1] Two flaps were lost with the success rate of 84%. In this study we have success rate of 82%. In another study 21 cases (13 males, 8 females) of mandibular reconstruction with fibula free flap were evaluated.[3] They performed 7 free osseous fibula flaps and 14 osteocutaneous fibula flaps.[3] All flaps except one survived and they confirmed the viability by scintigraphy. In 3 cases there were donor site skin healing problem which were managed by split-thickness regrafting. Two patients had temporary foot drop which recovered in an average 3 months. At recipient site 2 patient had orocutaneous fistula without flap loss.

In this study there were two complete graft failures, one due to unfavourable recipient bed of the patient with fire arm injury and other due to venous thrombosis. Another patient died in early postoperative period due to complication regarding blood transfusion. There was an overall success rate of 82.6%, which is a little low than the previously published studies. However, complications and functional results are comparable to those studies.

Literature favours fibula donor site as the first choice for most cases of mandibular reconstruction particularly those with anterior or large bony defects requiring multiple osteotomies.[11] Large bony defects should be reconstructed with vascularized bony flaps; non-vascularized bone grafts are effective for short bone defects in non-irradiated tissue and/or in patients determined to be too medically compromised to tolerate the additional operative time required for a free flap reconstuction.[10]

CONCLUSION

In this series the free fibula flap was a versatile and reliable option for microvascular reconstruction of large mandibular defects. It provided a large quantity of bone, which could easily be shaped and passively adapt to the remaining mandible. The bone height was suitable for an implant-based prosthetic restoration. Surgical experience with this flap favours it as the first choice for the majority of mandibular reconstruction cases.

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