CLINICAL STUDY

Versatility of Fibula Free Flap in Reconstruction of Facial Defects: A Center Study

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Abstract

Purpose To study a series of cases where vascularised fibula flap was used in various combinations of bone with muscle and skin along with its modifications for reconstruction of simple and composite defects of the facial region.

Patients and Methods The investigators designed a retrospective study composed of patients with any pathology or defect who underwent reconstruction of maxilla or mandible with vascularised fibula free flap from 2009 to 2013. All patients were evaluated for age, gender, location and type of defect, incorporation of adjoining skin paddle and muscle, number of fibula osteotomies, ischaemia time, anticoagulant regimen, length of hospital stay, flap failure rate, dental implant rehabilitation. All patients with a minimum follow-up of 3 months post-operatively, were included in this study.

Results The study sample composed of 30 patients with average age of 39.5 years. Immediate reconstruction was done in 86.66 % of patients. 93.1 % were mandibular reconstructions. In 40 % of patients, the fibula was double barrelled. Skin island was included with the fibula in 20 % of patients. 10 % patients underwent dental rehabilitation using implants with 6.66 % requiring distraction osteogenesis of the fibula which was not required with double barrel reconstructions. Hematoma at the recipient site was the commonest post-operative complication, although its

frequency was low. A significant donor site morbidity of around 3.33 % was seen. Average stay in hospital was about 7 days. Post-operatively all patients ambulated normally and none used assisted devices. A reconstruction plate was used to achieve the ideal contour of the jaw in most cases. Aesthetic results were usually good, especially in young patients. The overall success rate was 93.33 %.

Conclusion The fibula has many assets which make it the ideal choice for bony reconstruction of facial skeleton and adjoining soft tissue with predictable results.

Keywords Retrospective · Reconstruction · Fibula free flap · Maxilla and mandible · Double-barrelled · Distraction osteogenesis · Donor site morbidity

Introduction

Partial or complete resection of maxilla and mandible can be unaesthetic and at the same time cause functional difficulties. Large defects involving the maxillomandibular region due to destruction of bony segments and soft tissues have long been the consequences of extensive surgical ablations.

Immediate reconstruction of maxilla, mandible and adjoining soft tissues has been performed using fibula tissue transfer from past 3 to 4 decades and has proved to be a reliable morphofunctional reconstruction technique. Fibula free flap was first described by Taylor and colleagues in 1975 [1], and then Hidalgo [2] introduced it for mandibular reconstruction in 1989.

Fibula free flap (FFF) provides several advantages over other donor sites. These include ample bone length, ease of flap dissection and shaping with less blood loss, a possibility of 2 team approach, long pedicles with large calibre

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vessels and minimal donor site morbidity. Its vascular supply is recipient independent, making it favourable for reconstruction in irradiated or poorly vascularized tissues. The fibula is nourished by its periosteal blood supply. Hence, multiple osteotomies of the fibula to conform to the maxilla and mandible are feasible without devascularising individual segments. Moreover FFF offers tremendous bicortical bone stock for dental implant placement and a versatile cutaneous unit for concomitant soft tissue reconstruction [2–9]. Also FFF based on separate septocutaneous perforators is of benefit to extensive substitution to externally cutaneous and internally oral linings [10].

The aim of this study is to report a case series with our experience in using vascularized fibula flap in various combinations of bone, muscle and skin for reconstruction of maxilla and mandible.

Patients and Methods

A retrospective analysis of 30 patients who had undergone reconstruction for maxillary and mandibular defects operated on between 2009 and 2013 in Department of

Maxillofacial Surgery, Bhagwan Mahaveer Jain Hospital, Bangalore, India was done. This study was granted exemption from the IRB. Also, an informed consent was obtained from all the patients involved in this study.

Inclusion criteria included patients with any pathology or defect demanding reconstruction, with a minimum follow-up of 3 months. Exclusion criteria included only unwilling patients.

All patients underwent fibula free flap transfer via a midlateral incision over the fibula with a modification if skin paddle was included. Pre-operatively the extent of defect was determined using panoramic radiograph and/or computed tomography (CT). Jewer et al.'s [11] HCL classification (Fig. 1) for mandible and Brown's [16] classification (Fig. 2) for maxillary defects, was used in this study. Hand Doppler and Duplex coloured Doppler [12], was performed to detect any anatomical variation or pathology of the peroneal circulation, patency of the anterior and posterior tibial vessels and identification of skin perforators. No arteriograms were used. Allen's test of arterial occlusion of the foot was also done routinely for all patients.

A lateral approach [13] under tourniquet was used for flap harvesting. Proximal and distal ends of at least 6 cm of

Fig. 1 HCL classification of mandibular defects. *C* central segment, *L* lateral segment excluding condyle, *H* lateral segment including condyle

Fig. 2 Brown's classification of maxillectomy defects. Class I = without oroantral fistula, class II = low level excluding floor of orbit, class III = high level including orbital contents, class IV = radical maxillectomy including orbital extenteration

fibula were left in situ to maintain ankle and knee joint stability. The skin island was centred at the middle and/or lower thirds of the leg. Recipient needs dictated the size of the fibula and its cutaneous paddle.

A two-team approach was used in all patients. The cephalic team prepared the recipient site and neck vessels, while the other team harvested the flap and reconstructed the defect.

Data collected through the chart reviews included age at reconstruction, gender, diagnosis, defect location and size, flap ischaemia time, fibula bone length, skin paddle, use of soleus and/or flexor hallucis muscle, number of fibula osteotomies, anticoagulant regimen, length of hospital stay, duration of follow-up, esthetic satisfaction, post-operative complications (flap problems, fistula formation, bone exposure, miniplate complications, infection, donor site disabilities), dental rehabilitation and additional procedures done to achieve the same was done.

Results

Thirty consecutive patients with various etiologies, underwent reconstruction of maxilla and mandible with FFF (Table 1). There were 23 males and 7 females, with a mean age of 39.5 years (range 11–68 years). Immediate reconstruction was done in 86.66 %, of which 93.3 % underwent mandibular reconstruction and the remaining maxillary.

According to the classification proposed by Jewer et al., for mandibular defects, 30 % patients were of H-category, 10 % L-category, 7 % LC-category, 1 % LCL-category and 1 % of C-category (Fig. 3) and according to Brown's classification, for maxillary defects, 3.33 % patients were of class II and 3.33 % were of class III category (Fig. 4).

A Weber–Ferguson incision with a skin crease incision in the neck was used for maxillary reconstruction and a visor incision or lip-split incision with skin crease extension in the neck was used for mandibular reconstruction (Fig. 5). Anastomosis to the facial vessels was commonly done for maxillary and to the facial or lingual or superior thyroid branch of ECA and a branch/trunk of IJV was done for mandibular reconstructions.

Skin paddles were harvested in 40 % patients, with all the cutaneous units placed as intraoral linings except one patient where it was used to reconstruct the corner of mouth (Fig. 6). Donor sites were closed primarily in 50 % patients with harvested skin paddles and the remaining required a split thickness skin graft (Fig. 7). A suction drainage was inserted before wound closure, and an elastic bandage was used as dressing.

Table 1 Patient characteristics

Number of patients	30
Age	11–68 (mean: 39.5)
Gender	
Male	23
Female	7
Reconstruction	
Maxillary	6.7 %
Mandibular	93.3 %
Defect characteristics	
Mandibular	
H	30 %
C	1 %
L	10 %
LC	7 %
LCL	1 %
Maxillary	
Class IIa	3.33 %
Class IIIb	3.33 %
Single barrel	40 %
Double barrel	60 %
Ischaemia time	120–180 min (mean: 150)
Flap failure rate	6.66 %

The mean number of osteotomies of the fibula to recreate the mandibular shape was two (range 0–3) (Fig. 8), depending on the location and extent of the defect. A reconstruction plate was prebent intraoperatively (Fig. 9) to be symmetrical with the contralateral jaw and was used to attach the fibula segments to it. 60 % of patients were reconstructed with a 'double-barrel' technique (Fig. 10). Titanium miniplates and screws were used to fix the osteotomy segments in the double-barrel technique.

The flap artery and vein were anastomosed to the recipient vessels. No autogenous vein graft was used. All the donor and recipient vessels were topically irrigated with heparinized saline solution before microanastomosis. Return of flap circulation was judged by bleeding of periosteum, bone and skin paddle. The total ischaemic time was 150 min on average (range 120–180 min).

Post-operatively pharmacologic regime was a low-molecular weight heparin during the first few days for thrombosis prophylaxis. All patients were ambulated within 3–5 days and none of them used any assisted devices. Hospital stay was approximately 1 week in all cases, except one wherein, the patient went into hypotension induced acute renal failure which warranted extended stay in the hospital.

6.66 % patients had a flap failure, wherein the flap had to be removed within 10 days after primary reconstruction.

Fig. 3 **a** C-category, **b** LC-category mandibular defects

Fig. 4 **a** Class II, **b** class III maxillectomy defects

Fig. 5 **a** Weber Ferguson incision. **b** Midline lip-split with skin crease extension in neck. **c** Visor incision

Venous stasis was the cause of failure in both patients. Following this, 2 veins were anastomosed for all our FFF patients as a protocol. A significant donor site morbidity was seen in 3.33 % of our patients but none had any permanent disability.

Fig. 6 Skin paddle used for **a** intra-oral lining, **b** corner of mouth

10 % patients reported back for dental implant rehabilitation of which 6.66 % underwent vertical distraction osteogenesis (Fig. 11) to facilitate the same but this was not required once we started performing double-barrel reconstructions.

An overall success rate of 93.33 % was reported with our study.

Fig. 7 Donor site: **a** without skin paddle, **b** with skin paddle

Fig. 8 Number of osteotomies: **a** one, **b** two

Discussion

The vascularized fibula flap in combination with skin and muscle has become a flap of choice for maxillary and mandibular reconstruction. Thirty consecutive patients were evaluated with a minimum follow-up of 3 months following reconstruction. Irrespective of the etiology of the defect, FFF was preferred for reconstruction. The ease of harvesting, use of two-team approach, availability of good bone length, feasibility of obtaining a skin paddle, muscle or both, perform multiple osteotomies, ability to double barrel the flap,

Fig. 9 Prebending of reconstruction plate

Fig. 10 **a** Single barrel fibula. **b** Double barrel fibula

presence of good caliber vessels including two veins, ease of implant supported dental rehabilitation, minimal donor site morbidity, make it the flap of choice for most facial reconstructions.

The most important finding from our series is the functional and aesthetic rehabilitation that all the patients have received. The FFF provides a better base for oral and dental rehabilitation than that offered by other kinds of reconstruction.

Soft tissue flaps like latissimus dorsi free flap or rectus abdominis free flap, achieve good bulk to fill the defect, however they do not address the bony skeleton particularly the mandible, zygoma, orbit or alveolus.

The scapula osteocutaneous free flap offers the potential to address these needs but it may not always be suitable for placement of osseointegrated implants [14, 15]. Further

Fig. 11 **a, b** Distraction osteogenesis of fibula free flap; **c, d** dental implant placement in distracted fibula free flap

disadvantages include inability to harvest the flap simultaneously with the extirpative procedures, difficulty in orienting the bone to provide mandible, orbit, zygoma, alveolar reconstruction and the relatively short pedicle length.

The disadvantages of iliac crest myo-osseous flap are its potentially excessive bulk, limited soft tissue mobility in relationship to the bone and short pedicle length [16, 17].

The composite radial forearm flap is not adequate for the quantity and quality of bone it can supply [18].

The FFF provided the best bone source for functional reconstruction of maxilla and mandible in terms of quality and esthetic contouring of the face. This flap has an added advantage of providing sufficient height of bone using ‘double-barrel technique’, for ease of dental rehabilitation and also performing vertical distraction osteogenesis, to increase the height of bone to achieve the same in case of single-barrel reconstructions.

Use of stereolithographic models for pre-operative planning of the osteotomy cuts and the shape of the jaw, should be considered to achieve better and quicker results. Long term studies of a larger population is required to further support the data provided in this article.

Considering the advantages and versatility with less complications and limitations, FFF should be considered as gold standard in reconstruction of facial defects.

Conclusion

The various advantages of fibula free flap with minimal complications and limitations make it the most versatile flap for reconstruction of facial defects. Hence, fibula microvascular free flap should be considered as the, ‘gold

standard in reconstruction of facial defects’. However, long term studies with a larger population and minimal bias is needed.

Compliance with Ethical Standards

Conflict of interest All the authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Human and Animal Rights This article does not contain any studies with animals performed by any of the authors.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

1. Taylor GI, Miller GD, Ham FJ (1975) The free vascularized bone graft. A clinical extension of microvascular techniques. *Plast Reconstr Surg* 55:533–544
2. Hidalgo DA (1989) Fibula free flap: a new method of mandible reconstruction. *Plast Reconstr Surg* 84:71–79
3. Chaine A, Pitak-Arnnon P, Dhanuthai K, Ruhin-Poncet B, Bertrand JC, Bertolus C (2009) A treatment algorithm for managing giant mandibular ameloblastoma: 5-year experiences in a Paris university hospital. *Eur J Surg Oncol*. doi:10.1016/j.ejso.2009.04.006
4. Hidalgo DA, Rekow A (1995) A review of 60 consecutive fibula free flap mandible reconstructions. *Plast Reconstr Surg* 96:585–596
5. Foster RD, Anthony JP, Sharma A, Pogrel MA (1999) Vascularized bone flaps versus nonvascularized bone grafts for mandibular reconstruction: an outcome analysis of primary bony union and endosseous implant success. *Head Neck* 21:66–71
6. Guerra MFM, Gías LN, Campo FJR, González FJD (2001) Vascularized free fibular flap for mandibular reconstruction: a report of 26 cases. *J Oral Maxillofac Surg* 59:140–144

7. Eckardt A, Fokas K (2003) Microsurgical reconstruction in the head and neck region: an 18-year experience with 500 consecutive cases. *J Craniomaxillofac Surg* 31:197–201
8. Klein S, Hage JJ, Woerdeman LA (2005) Donor-site necrosis following fibula free-flap transplantation: a report of three cases. *Microsurgery* 25:538–542
9. González-García R, Naval-Gías L, Rodríguez-Campo FJ, Muñoz-Guerra MF, Sastre-Pérez J (2008) Vascularized free fibular flap for the reconstruction of mandibular defects: clinical experience in 42 cases. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 106:191–202
10. Jones NF, Vögelin E, Markowitz BL, Watson JP (2003) Reconstruction of composite through-and-through mandibular defects with a double-skin paddle fibular osteocutaneous flap. *Plast Reconstr Surg* 112:758–765
11. Jewer DD, Boyd JB, Manktelow RT, Zuker RM, Rosen IB, Gullane PJ et al (1989) Orofacial and mandibular reconstruction with the iliac crest free flap: a review of 60 cases and a new method of classification. *Plast Reconstr Surg* 84:391–403
12. Futran ND, Stack BC, Zaccardi MJ (1998) Preoperative color flow Doppler imaging for fibula free tissue transfers. *Ann Vasc Surg* 12(5):445–450
13. Gilbert A (1979) Vascularized transfer of the fibula shaft. *Int J Microsurg* 1:100–106
14. Frodel JL, Funk GF, Capper DT et al (1993) Osseointegrated implants: a comparative study of bone thickness in four vascularized bone flaps. *Plast Reconstr Surg* 92:449–458
15. Moscoso JF, Keller J, Genden E et al (1994) Vascularized bone flaps in oromandibular reconstruction. *Arch Otolaryngol Head Neck Surg* 120:36–43
16. Brown JS (1996) Deep circumflex iliac artery free flap with internal oblique muscle as a new method of immediate reconstruction of maxillectomy defect. *Head Neck* 18:412–421
17. Brown JS, Rogers SN, McNally DN, Boyle M (2000) A modified classification for the maxillectomy defect. *Head Neck* 1:17–26
18. Richardson D, Fisher SE, Vaughan DE, Brown JS (1997) Radial forearm flap donor site complications and morbidity: a prospective study. *Plast Reconstr Surg* 99:109–115