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Research Paper

Evaluation of mandibular reconstruction with free vascularized fibular flap ☆

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Abstract

Objective: To evaluates mandible reconstruction by free vascularized fibular flap with special emphasis on the immediate complications. Methods:The clinical data of 63 patients were reviewed, 35 male and 28 female(age range 16 to 73 years). Aesthetic and functional outcomes were evaluated by follow-up and/or telephone conversation. Results:Among the 63 fibular flaps, 29 were osteocutaneous flaps with one or two skin islands. All the flaps were surviving well and the success rate was 100%. Long term donor site disability was not recorded for any patient. Thirty-one patients responded for aesthetic and functional evaluation, 20 cases(64.5%) reported their facial appearance as excellent or good, 11 (35.48%) felt fair; 14 cases (45%) could eat unrestricted diet, 17(55%) could eat soft diet; 21 cases were(67.67%) speech normal, 10(22.33%) speech intelligible. Conclusion:Free fibular flap reflects good functional and esthetic results with a high degree of consistency, and acceptable level of complications, and we strongly believe the vascularized fibular flap is the first choice for mandibular reconstruction.

Key words: mandibular reconstruction; free fibular flap; osteocutaneous flap; functional; aesthetic; evaluation.

INTRODUCTION

Mandibular reconstruction following ablative surgery for neoplastic processes and defects of oral cavity and oro-pharynx has always been a challenge in head and neck reconstruction. The first transfer of autogenous bone for the mandible reconstruction was done by Sykoff in 1900[1]. In 1973, the fibula was discovered to be suitable transplant material for microsurgical transplantation independently by both Ueba and Fujikama in Japan and O' Brien and Morrison in Melbourne, Germany[2-3]. Hidalgo was the first to describe the free fibula transplantation for reconstruction of mandible in 1989[4]. The free vascularized fibular flap has been used for mandibular reconstruction in The Department of Oral and Maxillofacial Surgery, Affiliated Hospital of Stomatology, Nanjing Medical University since 1998[5]. In this paper, we retrospectively analyzed all 63 cases of free vascularized fibula flaps used to reconstruct the mandible from 1998 to June 2007 in The Department of OMS, in the above location. The objective of this study was to critically review these free fibular flap used in mandibular reconstruction and evaluate the functional and aesthetic outcomes with special emphasis on immediate complication.

MATERIALS AND METHODS

Hospital records were reviewed for demographics and the details of surgical procedures. Flap success rate, early and late postoperative complications, donor site morbidity, and reoperation were reviewed by the use of standard proforma designed for the study. Aesthetic and functional outcomes were evaluated in patients 6 months operatively by telephone conversation with the patient or guardian and/or direct examination using the proforma. The patient without phone number or those

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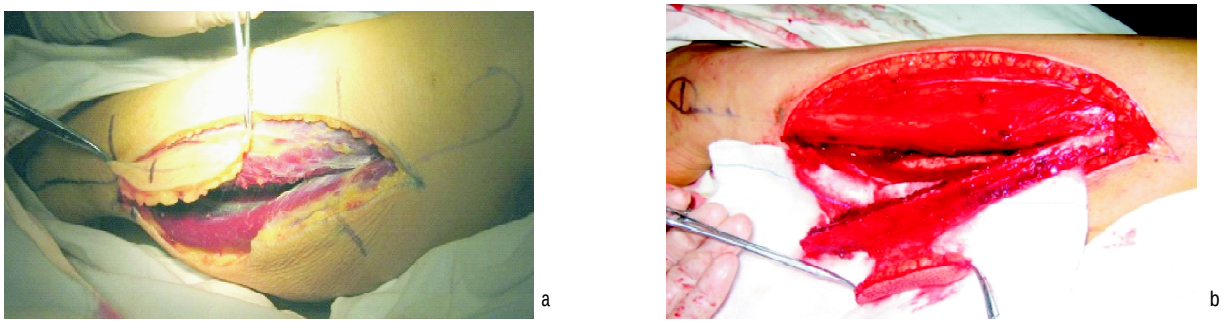
who did not respond to phone calls were not included for the functional and aesthetic evaluation.

Surgical technique

Flap harvesting

Patients were evaluated clinically, specifically for dorsalis pedis and tibialis posterior pulses as preoperative angiography was not performed[6-7]. The standard lateral approach was used and dissection was performed with a tourniquet inflated to 350 mmHg. If a skin paddle was planned, it was centered mainly over the lateral aspect of the fibula extending beyond the junction of the middle and the distal third of the lower leg(Fig 1a). The anterior margin was reflected, and the posterolateral intermuscular septum was exposed to visualize the septocutaneous branches. The posterior incision was then made down to the Soleus. Musculocutaneous perforators of Soleus muscle were also incorporated in the skin paddle. The peroneal muscles were elevated close to the fibula and reflected anteriorly. The thin anterior crural septum was incised to allow dissection in the anterior compartment. Sites of osteotomies were determined leaving at least 7 to 8 cm of the fibula bone proximally [3]. The bone was exposed above and below and divided with a Gigli saw. Further dissection was facilitated by traction and rotation of the fibula with bone clamps/holder. Extensor muscles were dissected off the fibula and the anterior tibial neurovascular bundles were preserved. The inter-osseous membrane was then incised and dissection was continued in the posterior compartment close to the bone. At this point the vascular anatomical distinction between the posterior tibial and peroneal vessels can be observed. Harvest could therefore be aborted if congenital Peronia Arteria Magna (PAM) or an absent peroneal artery were discovered[6-7]. Only the peroneal vessels and a cuff of flexor halluces longus muscle were preserved in the harvested fibula. The pedicle was dissected up to the bifurcation to gain additional length. The tourniquet was deflated to check perfusion of the flap before division of the pedicle(Fig 1b).



a b

Fig 1 Harvesting of fibula with skin island

The osteotomies were performed opposite from the peroneal vessels and kept to a minimum in order to preserve periosteal vascular supply after the free flap was divided and transferred. The contoured mandible was next inserted into the defect and attached to the remaining mandibular segments by fixation and anastomised to the recipient site vessels. Return of circulation to the graft was demonstrated by periosteal bone bleeding and skin-island monitoring. The donor site was closed and the lower leg was immobilized with a posterior splint from 5 days to a week. Monitoring of flap viability was based on direct clinical observation of its color, capillary refill, and tissue turgor and bleeding on needle pricking.

RESULTS

There were 63 patients, 35 males and 28 females. The age ranged from 16 to 73 years with average age of 37.87 years. The average duration of hospitalization was 26.53 days(from 17 days to 56 days). Duration of surgery was 3 h 20 min to 11 h 30 min(average 7 h 15 min). The prevalence of the lesions at each location was 26; right sided, 23; left sided, and 14 for midline symphysis. Among these, 59 cases were primarily and 4 cases were secondarily reconstructed. Average length of fibula was 13.91 cm ranging from 6-21 cm. The fibula was osteotomized maximum up to 6 pieces. Skin islands were harvested with 28 flaps, 9 extra orally and 19 intra orally placed. Size of skin island ranged from 13/6 cm to 2/1 cm. Bony segments were fixed by intraosseous wiring in 12, miniplates in 25 and reconstruction plates in 26 cases. All donor sites were closed by normal approximation except in Case no. 25, which was closed by split skin graft.

The vessels used for anastomosis were, Artery-facial 55, superior thyroid 4, external carotid 2, lingual 1(no record was found in 1 case). Veins-external jugular 28, anterior branch of retromandibular 17, common facial 8, facial 4, anterior jugular 2, superior thyroid 1, internal jugular 1, lingual 1 (no record was found in 1 case).

All the flaps and skin islands were successful, success rate being 100%. Dental implants were placed in 3 patients. Post operative infection was observed in 5 recipient

sites and 1 donor site.

Evaluation

Out of the 63 patients, 3 patients were deceased post operatively due to recurrence of tumor(SCC), the last 7 cases were not included as they had not reached 6 months postoperatively. Among rest of 53 cases, only 31 patients responded. Those 31 patients were interviewed according to our standardized proforma, the response rate was 58.49%. Post operative time of contact ranged from 7 months to 9 years(average 36.48 months). Malignant lesions were seen in six (one case of osteosarcoma and five case of squamous cell carcinoma of oral cavity) among 31 patients, the rest had benign lesions(Tab 1).

Tab 1 Functional evaluation

Group	Diet		Oral Seal		Speech				Loss Of Sensation
	Unrestricted *n* (%)	Soft *n* (%)	Normal *n* (%)	Drooling *n* (%)	Normal *n* (%)	Intelligible *n* (%)	Intelligible with Effort	Uninte-lligible	*n*
Benign Lesion (*n* = 25)	13(52.00)	12(48.00)	18(72.00)	7(28.00)	17(68.00)	8(32.00)	*	*	20
Malignant Lesion (*n* = 6)	1(16.67)	5(83.33)	4(66.67)	2(33.33)	4(66.67)	2(33.33)	*	*	6
Total (*n* = 31)	14(45.16)	17(54.84)	22(70.97)	9(29.03)	21(67.74)	10(32.26)	*	*	26

Loss of sensation at the recipient site depends upon the side of resected lesion, and normal recovery of sensation is reported only in 5 cases. Problematic mastication is present in 2 in the benign(8%) and 4 in the malignant group(66.67%) with remaining teeth. One patient of benign group complained of slight difficult in Deglutition. Mouth opening problem was slight in 1 case of benign and present in 1 case from the malignant group. Problem of tongue movement was present in 1 case in the malignant group(Tab 2).

Except the implant born prosthesis in three(Case no. 7, 23, and 32) patients, nobody wore a denture.

No body needed braces help for walking. Ankle problem, knee problem and loss of sensation of foot don't limit their normal daily life(Tab 3).

Tab 2 Aesthetic evaluation

Group	Symmetry			Facial appearance			
	Normal *n* (%)	Accept Symme, *n* (%)	Asymmetry *n* (%)	Excellent *n* (%)	Good *n* (%)	Fair *n* (%)	Poor
Benign lesion	9(36.00)	13(52.00)	3(12.00)	6(24.00)	12(48.00)	7(28.00)	*
Malignant lesion	*	3(50.00)	3(50.00)	*	2(33.33)	4(66.66)	*
Total	9(29.03)	16(51.61)	6(19.35)	6(19.35)	14(45.16)	11(35.48)	*

Tab 3 Donor site evaluation

Group	Walking				Knee Problem *n*	Ankle Problem *n*	Loss of Sensation *n*
	Walking Normal *n* (%)	Feel Weakness *n* (%)	Pain on Walk *n* (%)	Need help			
Benign lesion	13(52.00)	10(40.00)	2(8.00)	*	1	1	2
Malignant lesion	4(66.66)	*	2(33.33)	*	1	*	2
Total	17(54.84)	0(32.26)	4(12.90)		2	1	4

DISCUSSION

The main goal of mandible reconstruction is early restoration of form, function and aesthetics of the face. Various non-vascular bone grafts, alloplastic materials used alone or in combination with pedicle soft tissue flaps show a high rate of failure due to infection, extrusion, resorption and poor recipient vascular bed[1-2]. Advances in the micro vascular surgery have allowed the transfer of well vascular autologous tissues from the distant sites like fibula, iliac crest, rib, scapula etc to achieve functional and aesthetic rehabilitation[8]. Among the free flap donor sites used for mandibular reconstruction, the fibula is becoming a very popular choice. It provides a rigid, strong, tubular haped, and has enough cortical bone stock with up to 25 cm of bone length and can maintain a consistent shape through out its length for shaping the anatomic structure of the mandible defects[3-4]. Its blood supply courses in parallel along the length, guaranteeing adequate vascularity to the osteotomized segments[9]. Abnormalities of the lower leg vascular anatomy and patients with an enlarged peroneal artery(prevalence 0.2 to 8.3%)[10] or impaired circulation to the leg is a valid contraindication for fibula transposition. Some microsurgery groups do not advocate the use of preoperative imaging of the donor limb in their literature[6-7]. They prefer to rely on a thorough preoperative clinical examination of the dorsalis pedis and posterior tibial pulses and an intraoperative assess-

ment of the vascular anatomy, stating that the harvest can be easily aborted if congenital PAM or an absent peroneal artery is discovered intra operatively. This study also follows this however to this purpose no cases of PAM were found.

Hidalgo[4] was the first to use the fibula free flap for mandible reconstruction in 1989. Since then, the fibula has been widely used for mandible reconstruction either alone or in combination with free soft tissue flaps like the anterolateral thigh flap[11], radial forearm flap and rectus abdominus myocutaneous flap where soft tissue defects are very large. The algorithm developed by Akihiko et al [12] in 2005 shows ileum is best for lateral mandibular bony defects only, and scapula is best for the extensive soft tissue loss with lateral bony defects. All other defects are best restored with the fibula alone or in combination with the soft tissue flap wherever the soft tissue defect is large. The lateral defects where microvascular reconstruction is not planned a combination of reconstruction plates with soft tissue pedicle flaps is recommended[13].

In this study among 28 skin islands; 19 were used as intraoral mucosal lining and 9 used as external monitor to asses the flap viability with isolated bone defects. Despite many skin island failures reported in literature[4,14-15], all 28 islands survived in this study. The skin paddle had a poor prognosis, based on the original series by Hidalgo[4] who harvested the attached skin based on septocutaneous perforators. The clinical success of the skin paddle is above 90% when the musculocutaneous perforators of soleus muscle are incorporated in the flap, whereas the viability of the skin is only 33% when the flap is based on septal branches[16]. Hidalgo et al[15] showed 90% success rate of the skin island in 60 patients.

For any flaps, the complications are divided into the recipient and donor site. The intraoperative complications on both sites are unremarkable. Immediate post operative complications are best avoided by a careful patient history, experienced surgeon hands and proper medications like anticoagulants, antibiotics, analgesics and anti-inflammatory agents[17]. In every case, during the anastomosis of vessels, copious amount of irrigation mixed with low concentration of heparin was used. The recommended concentration of heparin used is 10 to 100 U/ml, which removes the debris on the vessels and maintains the patency of the vessels[17]. All five postoperative infection cases were re-admitted and treated with debridement, curettage, antibiotic therapy and the removal of the fixating devices at the recipient site of infection. This study shows that the recurrent infection subsides after the removal of the fixating devices. This study believes that main causes of infection are due to a reaction with the bone wax used during surgery and fixating devices and oral fluid leakages. One case of donor site infection(which was due to dehiscence of split skin graft) was treated with debridement, dressing and finally another split skin graft. There were no long term disabilities related to donor site in this study, as reported by different authors [4,14,18-20].

In this study, the functional results were assessed as diet, oral competence, and speech. Regarding diet, 52% of patients resumed unrestricted diet in benign tumor group where as only 16.67% patients in malignant group. The rest of the patients depended on a soft diet. None of the patients were feeding tube dependent. This study shows that due to wide resection of oral cavity in malignant group, patients experienced difficulty resuming to the normal unrestricted diet when compared to the benign group. Abdal[18] reported 56% normal diet, 44% soft diet, no liquid and tube feeding in 16 cases and *Hidalgo et al* [15] reported 51% normal diet, 42% soft diet and 7% feeding tube dependent in 60 cases. These studies did not separate the benign and malignant group; their resumption on normal diet was higher in comparison to our study. Despite the high reliability and success of dental implants[21] only 3 patients were restored with implants and implant born prosthesis were inserted at least 3 months after reconstruction because of its cost.

Speech was documented as normal in 68.00% and intelligible in 32.00% in benign group where as 66.67% were normal and 33.33% intelligible in the malignant group, there was no significant difference within both groups. Abdal[18] reported speech as normal in 46%, intelligible in 23% and intelligible(with effort) in 31% of the patients. Hidalgo et al [15] reported normal speech in 39%, mildly impaired(intelligible) in 32% intelligible with effort in 19% and unintelligible in 10% of patients. This study agrees that speech is markedly affected in patients with resection of the central segment of mandible or with associated tongue resection[18].

Concerning the aesthetic outcome, success was judged in terms of symmetry and facial appearance. Asymmetry was reported in 12% patients of benign and 50% patients of malignant group(mainly because of more soft tissue loss in malignant cases and the absence of prosthesis in the oral cavity in both groups). Facial appearance was reported as fair in 28% of benign group and 66.67% in malignant group and no body reported as poor. Only 33.33% however reported good appearance, with no reporting of any excellent results seen in malignant group, mainly due to neck dissection and more of soft tissue loss. Evaluation of the functional results and facial appearance performed by a questionnaire for 11 ameloblastoma patients by Haluk et al[22] claimed that all patients could have a normal diet, intelligible speech, and oral continence and their evaluation of facial ap-

pearance showed as acceptable in 2 patients and even good or excellent in 9 patients. A 10 year follow up study of Hidalgo and Pusic shows free fibular flap mandible reconstruction provides excellent functional and aesthetic results that remain stable over time; only slight asymmetry became evident due to the facial aging processes[20].

In this study, the success rate was 100% in terms of the bony and soft tissue island transplant. Hidalgo[4] reported 100% success in bony transplant. Cordeiro et al[23] also reported 100% success of free flap. Abdal[18] success rate was 81%; 3 free flap failures due to venous thrombosis. Hidalgo et al[15] success rate was 98%. Even though the success rate of this study is 100%, aesthetic and functional outcomes are not outstanding, which could be further improved by a combination of other soft tissue flaps, placements of more of the implants, encouraging the patient towards the distraction osteogenesis of transplanted fibula and use of artificial prosthesis.

References

[1] Peter WB, Stephen AS, Jarg-Erich H. Maxillofacial Surgery. London:*Churchill Living Stone Publication* 1999: 527-528,549-556.

[2] Fonceka RJ. Oral and Maxillofacial Surgery. Philadelphia:*Sounders Company* 2000:364-365,407-12.

[3] Wolff KD, Hözle F. Raising of Microvascular Flaps-A Approach. *Berlin:Springer-Verlag Berlin Heidelberg* 2005:107-137.

[4] Hidalgo DA. Fibula free flap:a new method of mandible reconstruction. *Plastic and Reconstructive Surgery Jul* 1989; 84(1): 71-9.

[5] Xing Shuzhong, Wan Linzhong, Wu Yunong, Tao Zhenjiang, Zhu Zhijun, Wang Laijie. Reconstruction of oromandibular composite defects with vascularized fibular osteocutaneous flap. *Acta Universitatis Medicinalis Nanjing*(in Chinese) 2002; 22(5):395-7.

[6] Lutz BS, Wei FC, Shu H, Chen IH, Chen SH. Routine donor leg angiography before vascularized free fibula transplantation is not necessary: a prospective study in 120 clinical cases. *Plast Reconstr Surg* 1999;103:121-7.

[7] Disa JJ, Cordeiro PG. The current role of preoperative arteriography in free fibula flaps. *Plast Recons Surg* 1998;102:1083-8.

[8] Ritvik PM, Daniel GD. Mandibular reconstruction in 2004: an analysis of different techniques. *Current Opinion in Otolaryngology & Head and Neck Surgery* 2004;12:288-93.

[9] Carr J, Macdonald DA, Waterhouse N. The blood supply of the osteocutaneous free fibular graft. *J Bone Joint Surg* 1988; 70-B: 319-21.

[10] Gedge DR, Singh NK. Devascularizing complications of free fibula harvest: peronea arteria magna. *Journal of Reconstructive Microsurgery* 2005; 21(8):533-8.

[11] Omer O, Ozgentas HE, Dikici MB. Simultaneous reconstruction of large maxillary and mandibular defects with a fibular osteocutaneous flap combined with an anterolateral thigh flap. *Journal of Reconstructive Microsurgery* 2004; 20(6):451-5.

[12] Takushima A, Harii K, Asato H, Momosawa A, Okazaki M, Nakatsuka T. Choice of osseous and osteocutaneous flaps for mandibular reconstruction. *Int J Clinical Oncology* 2005; 10:234-42.

[13] Mandpe AH, Singer MI, Kaplan MJ, Greene D. Alloplastic and microvascular restoration of the mandible: A comparison study. *The Laryngoscope* 1998;108(2):224-27.

[14] Jong HL, Myeong JK, Jong WK. Mandibular reconstruction with free vascularized fibular flap. *Journal of Cranio Maxillo-Facial Surgery* 1995;23: 2-26.

[15] Hidalgo DA, Rekow A. A series of 60 consecutive fibular free flap mandible reconstructions. *Plast Reconstr Surg* 1995, 96: 585-96.

[16] Editors Michael M, Ghali GE, Larsen PE, Waite PD. Peterson's Principle of Oral and Maxillofacial Surgery. 2 Ed. London:*BC Decker Inc* 2004: 811-2.

[17] Babak JM, Cordeiro PG. Avoiding and dealing with complications after head and neck microvascular reconstruction. *Seminars in Plastic Surgery* 2003; 17(3):267-74.

[18] Abdel WAA. Osteocutaneous free fibular flap for anatomical reconstruction of the mandible following tumor resection. *Journal of the Egyptian Nat Cancer Inst* 2003; 15(3): 243-51.

[19] Joel F, Benoit P, Blandine R, Jacques M. Advantages and Limitations of the Fibula Free Flap in Mandibular Reconstruction. *J Oral Maxillofacial Surg* 1997; 55: 440-8.

[20] Hidalgo DA, Pusic AL. Free-Flap Mandibular Reconstruction: A 10-Year Follow-Up Study. *Plastic and Reconstructive Surgery* 2002; 110(2): 438-49.

[21] Kramer FJ, Dempf R, Bremer B. Efficacy of dental implants placed into fibula-free flaps for orofacial reconstruction. *Clin Oral Impl Res* 2005;16:80-8.

[22] Haluk V, Fahri M, Adnan M, Mustaf Y. Surgical management of ameloblastoma in the mandible: segmental mandibulectomy and immediate reconstruction with free fibula or deep circumflex iliac artery flap(Evaluation of the long-term esthetic and functional results). *J Oral Maxillofacial Surg* 2006; 64:1532-9.

[23] Cordeiro P, Disa JJ, Hidalgo DA, Hu QY. Reconstruction of the mandible with osseous free flaps: A 10-year experience with 150 consecutive patients. *Plastic and Reconstr Surg* 1999;104 (5):1314-20.