

The Advantages of Vascularized Fibular Bone Graft For Mandibular Tumor Reconstruction

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Background: Mandibular reconstruction are often indicated in patient who underwent ablation or excision of the mandible due to malignancy of the oral cavity. In this paper we will discuss about the mandibular reconstruction with use of alloplastic implant, and vascularized bone graft

Method: Four cases of oral cavity tumor which were referred to the plastic surgery division at Cipto Mangunkusumo hospital during 2005-2011, after being diagnosed with oral cavity tumor were re-viewed.

Result: Mandibular reconstruction can be done using alloplastic implant, non-vascularized bone graft or vascularized bone graft. In this paper we studied four patients who needed mandibular reconstruction after ablation of oral cavity tumors. Patients who underwent reconstruction with alloplastic implants all had complications such as broken hardware. Where as in patient who underwent free fibular tissue transfer there were no complications at all.

Summary: We can conclude that in less vascularized surrounding tissue as in cases that received or will receive other treatment such as chemotherapy or radiation that vascularized bone graft are superior. The bone healing in vascularized bone graft also does not depend on creeping substitution like in non vascularized bone graft.

Keywords: Mandibular reconstruction, free fibular tissue transfer, alloplastic implant, vascularized bone graft

Latar belakang: Rekonstruksi mandibula sering diindikasikan untuk pasien yang menjalani eksisi mandibula akibat keganasan dalam rongga mulut. Dalam jurnal ini kami akan membahas rekonstruksi mandibula dengan menggunakan materi aloplastik dan tandur tulang yang bervaskularisasi.

Metodologi: Empat kasus dengan tumor rongga mulut yang dirujuk ke tim bedah plastik RSCM pada tahun 2005- 2011 akan dibahas dalam jurnal ini.

Hasil: Rekonstruksi mandibula dapat dilakukan dengan menggunakan materi aloplastik, tandur tulang yang bervaskularisasi maupun tidak. Dalam jurnal ini kami akan membahas empat pasien yang membutuhkan rekonstruksi mandibula setelah ablasi tumor rongga mulut. Pasien yang menjalani rekonstruksi dengan materi aloplastik mengalami komplikasi seperti kerusakan plate atau screw. Pasien yang menjalani free fibular tissue transfer tidak mengalami komplikasi.

Ringkasan: Kami dapat simpulkan bahwa pada jaringan yang tidak terlalu bervaskularisasi seperti pada kasus-kasus yang akan menerima kemoterapi atau radiasi maka tandur tulang yang bervaskularisasi lebih superior. Penyembuhan tulang dengan tandur tulang bervaskularisasi tidak bergantung pada creeping substitution seperti pada tandur tulang yang tidak bervaskularisasi.

Kata kunci: Mandibular reconstruction, free fibular tissue transfer, alloplastic implant, vascularized bone graft

Mandibular reconstructions are often indicated in post ablation or excision on patient with oral cancer. Other indications are mandibular defects caused by trauma, infection/inflammation, osteoradionecrosis and congenital anomaly. In this paper we will discuss about segmental mandibular defect reconstruction and emphasizing on the super-

riority of mandibular reconstruction using vascularized bone graft compared to alloplastic material such as plate and screws.

Mandibular Reconstruction

Historically, free bone grafts are often used for this procedure. Calvarial bone, ribs, iliac bone, tibial bone, fibular bone scapular bone and radial bone are bones that are often used for it. ¹ But in the last twenty years the

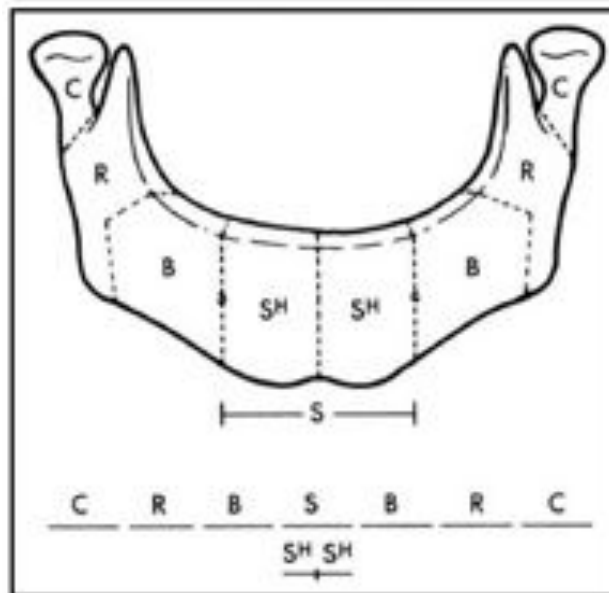
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Presented at Chang Gung Mayo clinic " Symposium on reconstructive surgery", October 2011, Taiwan.

Disclosure: This work did not receive support from any grant, and no author has any financial interests

Table 1. Donor sites for vascularized bone graft commonly used in mandibular reconstruction².

Component	Fibular	Scapular	Iliac crest	Radius
Bone	Up to 25 cm	12-14cm	14-16cm	Very limited
Soft tissue	Potential for sensate Adequate for dental implants	Abundant soft tissue, 2 cutaneous paddles as well as muscle	Skin paddle may be thick with limited mobility	Excellent , thin pliable tissue that can be re-innervated
Advantage and disadvantage	2 team approach Minimal morbidity donor site	2 team approach not possible Minimal donor site morbidity	2 team approach Moderate donor site morbidity	2 team approach Significant donor site morbidity



Adapted from Uken et al. (1991) [4].

Figure 1. Urken classification of mandibular defects : C-condyle, R-ramus,B-body, S-symphysis¹

vascularized bone graft have been the main technique used. Fibular bone, scapular bone, iliac crest and radial bones are the donor that can be used¹ (Table 1).

In deciding how to reconstruct an oromandibular defect, there are several factors that we have to consider, such as :² Size and location of the mandibular bone defect, Size and location of the soft tissue defect, Quantity and function of the remaining tongue, Prior radiation therapy to the surgical bed, Prior surgery to the neck resulting in a lack of suitable recipient vessels,

Distribution and quality of the remaining dentition

The mandibular defect can be classified using the Urken classification to express the bone and soft tissue defect of each patients (Figure 1)¹. After the defects are classified , the next step is to restore the shape and function. The ideal reconstruction is to give the mandibular contour nearing its normal or earlier contour to give the aesthetic results. While functionally we expect the glutition, mastication, articulation and maintaining adequate airway are kept.



Figure 2. Schematic of harvesting fibular bone graft .³

The goals of oro mandibular reconstruction are:² Re-establishment of mandibular continuity with firm union of bone flap to the mandible, re-establishment of the normal position of the condyles as well as normal occlusal relationships, re-establishment the height of the neo mandible in the tooth bearing segment to achieve reasonable height match to the native mandible to facilitate dental restoration and achieve normal masticatory function, preservation of normal mandibular motion, In patients who are able to chew it is desirable to restore opposing dentition in all four quadrant, restore oral competence, restore sensation to lips and oral soft tissue.

Vascularized free tissue transfer

Autogenous bone grafting is the mainstay of mandibular reconstruction. The use of free bone grafts is limited because these are frequently plagued by bone resorption and infection. This is especially evident in ablative cases requiring adjuvant radiation therapy. With the advent of vascularized osseous free flaps over the past thirty years, reliable mandibular reconstruction with success rates of over 90% is possible.¹

Free fibular tissue transfer

In 1975 the first free fibular flap was done by Taylor et al, and then Hidalgo on 1989 used it for the first time in mandibular reconstruction. Ever since 2009 this flap has been popularly used in reconstructing extensive mandibular defects.

The fibula is the workhorse of modern-day mandibular reconstruction. It is an excellent

choice for reconstructions that require primarily bone and reconstructions in which the native mandible is somewhat atrophic. The fibula can be used to reconstruct bony defects as long as 30 cm in length. The vascular pedicle can be 6 to 10 cm in length. The fibula allows placement of osseointegrated dental implants and is easily contoured. Preoperative evaluation of lower extremity vasculature is recommended to assess vascular disease precluding transfer. Magnetic resonance angiography has replaced traditional angiography as the study of choice. The use of CT angiography is also being evaluated. Reports defining specific vascular variants noted in the lower extremity are currently being presented. Postoperatively, dental malocclusion occasionally results from inaccurate contouring of the reconstruction plate or fracture of a mini plate. Chang et al describe successful treatment of malocclusion following fibular free flap mandibular reconstruction by performing an osteotomy at the junction of the fibula and native mandible and then realigning the mandible into correct occlusion

Donor Morbidity, The morbidity rates are very low: Ankle Instability: leaving the distal fibula (4cm-10cm) minimizes risk -usually unnecessary to fuse tibia to remaining fibula, leg weakness, temporary foot drop, residual pain, edema, may require skin graft

Alloplastic Implants

The most commonly used alloplastic implants for mandibular reconstruction are bone plates and screws¹. The use of mandibular

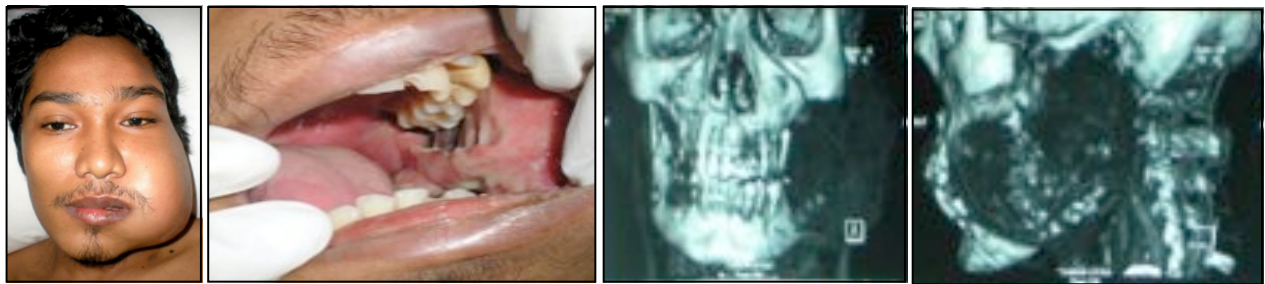


Figure 3. These are preoperative images of the patient. The frontal view and intra oral view of preoperative clinical images (upper row). Frontal and lateral view of the 3D CT scan showing the left mandibular destruction (Lower row).



Figure 4. Intraoperative images. After carefully dissecting and found the peroneal artery pointed by instrument (left image), the skin paddle size was 5 x 12 cm (middle image). The pedicle consists of one artery (red markings) and two veins (blue markings) as we can see in the right image.



Figure 5. The post operative images of the patient. One moth post operative (upper image). Intraorally we can see the skin paddle. On the lower image is post-operative x-rays

reconstruction plates is typically indicated in patients with poor performance status or in cases where the soft-tissue defect of the oral cavity/oropharynx is more extensive than the bony mandibular defect¹.

Case 1

A 22 years old male patient with mucoepidermoid carcinoma of the left parotid with invasion to the skin. When the patient was consulted to the plastic surgery division he already had paresis of the facial nerve, and the teeth of the left lower jaw was unstable. From the CT scan findings we can see that there is mass at the left parotid gland that has destructed the maxillary bone and infiltrated the left mandibular bone (Figure 3). The size of the tumor was

12x10.5x6 cm , after parotidectomy and hemimandibulectomy sinistra there was a bone defect that extended from the left parasymphysis to left condyle and mucosal defect (5x8cm). The skin paddle size was 5x12cm. the vascularized bone graft had one artery peroneal and two committantes vein as the pedicle (Figure 4). The recipient artery was thyroidea superior with two veins : jugular vein and committantes vein. The outcome in this patient was the vascularized bone graft was vital until 4 month follow-up, with complications such as muco cutaneous fistulae which was due to recurrences of the tumor. On the donor site there were no morbidity at all even after 6 month follow-up.



Figure 6. Preoperative views of the patient after she was referred to the plastic surgery division.



Figure 7. Intraoperative view of the The vascularized bone graft before the pedicle from the donor site was cut



Figure 8. One week post-operative view.

plate removal the patient underwent free fibular tissue transfer. And had no fistulae afterwards.

Case 2

The second patient is a 19 years old patient with complaints of a lump at her right lower jaw 8 years ago. The patient had it removed by a dentist and was said that it was a dental cyst. After two years the patient complained that the lump was recurring and had it removed. The histopathologic examination showed it was a conventional osteosarcoma with fibroblastic subtype. At this time the patient then was referred to the oncologic department of Cipto Mangukusumo hospital. She went through segmental mandibulectomy and mandibular reconstruction with plate and screw in one stage of operation. She was also given chemotherapy VAC 6 times (Figure 6-8)

A year after the operation the patient complaints of oozing from her right lower jaw was diagnosed with right mandibular sinus. The patient underwent her 4th operation to remove the sinus and was reconstructed with platysma muscle. The histologic findings were an infected fistulae and had no signs of malignancy. Two months afterwards the patient still complains of oozing from her right lower jaw skin. One year afterwards there was plate exposure on her right lower jaw. It was then decided to remove the plate by plastic surgery division.

The mandibular reconstruction was not done in one stage or immediately after the plate removal for considering the process of local infection was still present. One year after the

Case 3

The third case is a 26 yr old female patient with Fibrous dysplasia of the right mandible post excision and reconstruction with plate and screws (Figure 9). She had a tumor that was excised by an oral surgeon at 1993. 14 years after the first operation she had a lump on the upper right jaw that was then taken for a biopsy by an oncologist at RSCM. She then underwent hemi-maxilectomy and hemimandibulectomy dextraby the oncologist team at RSCM on March 2007. During the two months follow-up there was plate extrusion and the oncologist team tried to do a repositioning of the internal fixation. One year after this operation the patient still complains of pain and the patient then underwent mandibular reconstruction with free fibular tissue transfer on May 2008 (Figure 10). For the maxillary region , it was then reconstructed in a different operation with ribs as dead bone graft and radial forearm free flap (Figure 11).

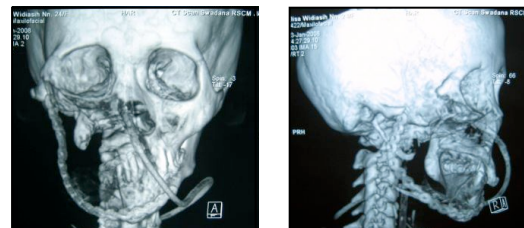


Figure 9. Preoperative CTScan images of the patient after mandibular reconstruction.

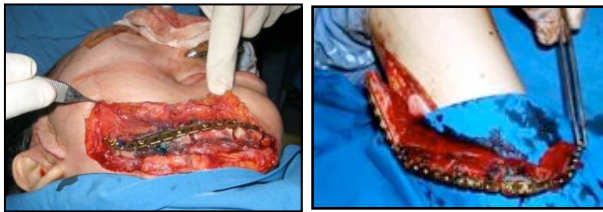


Figure 10. Intra-operative images of free fibular tissue transfer where the fibula is cut to adjust the shape of inferior margin of mandible bone.

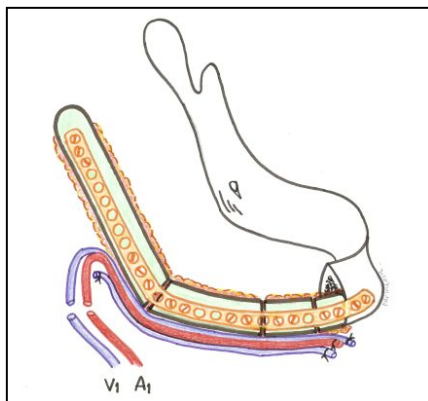


Figure 12. Schematic view of vascularized bone graft of Case 3 Patient.

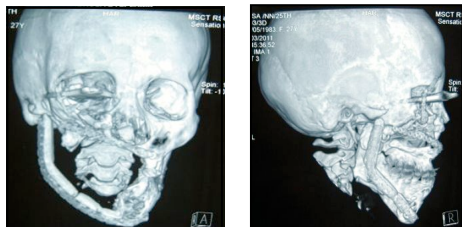


Figure 13. Post-operative CT Scan Images.

Case 4

The last case is a twenty seven years old male patient with right mandibular defect after excision of ameloblastoma (Figure 14). The patient was then referred to the oncologist and was done a hemimandibulectomy and reconstruction of the defect using plate and screws. But then the patient had complications, such as pain during glutton and mastication. After that during the 6 month follow-up we found screw loosening on the x-ray panoramic findings. The patient then had another operation to take the mandibular reconstruction plates and underwent free fibular tissue transfer on April 2009 (Figure 15). This patient was followed up until 18 months post operative. And we can see that the fibular bone has

showed healing at the osteotomi sites between the bone graft and native mandible (Figure 16).

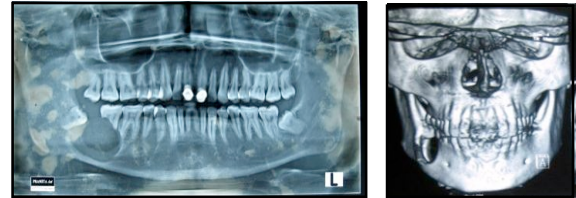


Figure 14. The mandibular defect is on the right corpus of mandible bone. The complications of screw loosening



Figure 15. Radiologic finding after excision of the ameloblastoma.

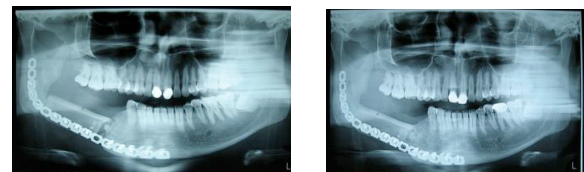


Figure 16. Postoperative panoramic images after 18 months followup has shown bone healing.

DISCUSSION

Mandibular reconstruction can be done using alloplastic implant, non-vascularized bone graft or vascularized bone graft. In this paper we studied four patients who needed mandibular reconstruction after ablation of oral cavity tumors.

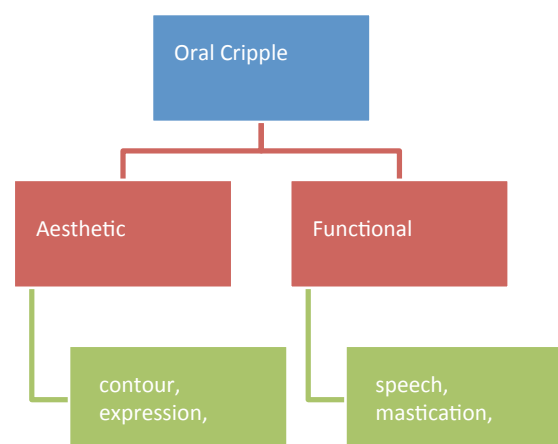


Figure 17. Oral Cripple Problem.



As shown in the picture above (Figure 17) , there is definitely an oral cripple after ablation of an oral cavity tumor aesthetically and functionally. The goals for mandibular reconstructions are i) Establishment of mandibular continuity with acceptable cosmetic result, ii) Establishment of osseous alveolar base and iii) Correction of soft tissue defect.⁴

The patients who underwent reconstruction with alloplastic implants (three out of four patients) all had complications such as plate extrusions, loosening of the screw and cutaneous fistulae. Where as in patient who underwent free fibular tissue transfer right after tumor excision (one out of four patient) there were no complications at all in five months follow up.

This way we have to think carefully on deciding what type of reconstruction are we doing. The patient that received alloplastic implants all had complications. We obviously needs vascularized bed in surrounding tissue for alloplastic implants reconstruction. While as in non-vascularized bone graft , there are risks of bone resorption, and it also needs vascularized bed in surrounding tissue. But the advantage is both of the operation took shorter time on operation time compared to vascularized bone graft where we need microsurgery. As almost every patient with oral cavity tumor they have less tolerance for longer operation time. With vascularized bone graft we can use any less vascularized surrounding tissue but we will need microvascular techniques, and take longer operation time. But the risks for bone resorption is definitely less.

Bone grafts, vascularized or not, have properties to promote bone healing : osteo conduction, osteoinduction, and osteogenesis.⁵ Osteoconduction refers to the process by which the graft provides a scaffold for the ordered 3-D ingrowth of capillaries, perivascular tissue, and osteoprogenitor cells.⁵ Osteoinduction refers to the recruitment of osteoprogenitor cells from surrounding tissue.⁵ Osteogenesis refers to the formation of new bone from either the host or graft tissue.⁵ It is also important to consider the mechanical strength and vascularity of the bone graft material. Vascularized bone grafts does not follow the rule of incorporation by creeping

substitution as in non vascularized bone graft and may instead incorporate into the adjacent native bone via primary (or secondary) bone healing.⁵

We can conclude that in less vascularized surrounding tissue as in cases that received or will receive other treatment such as chemotherapy or radiation that vascularized bone graft are superior. The bone healing in vascularized bone graft also does not depend on creeping substitution like in non vascularized bone graft. As seen in one of the cases, after 18 months post operatively there were complete bone healing in the fibular bone in conjunct with the native mandible. There are studies mentioning about that vascularized bone grafts be protected against fatigue fractures during the first year but the mechanical loading should gradually increase to enhance remodelling and hypertrophy.⁶

Another aspect that should be taken to consideration is the resistance to infection. Bone grafts are more resistant to infection.⁷ Especially the vascularized bone graft because it has its own nutritional supply so it does not depend on the surrounding tissue, making them more resistant to infection.

CONCLUSION

In the field of mandibular reconstruction there has been monumental advances leading to the current state-of-the-art reconstructive techniques. Vascularized osseous free tissue transfer is the preferred reconstructive modality today and has shown excellent long-term aesthetic and functional outcomes. The proven advantages are numerous especially for fibular bone graft : 1. No length limitation in adults, a straight 20–26-cm fibular segment can be harvested; 2. Large diameter of vessels of sufficient length which facilitates microsurgical vessel reanastomosis; 3. Periosteal blood supply is abundant which permits multiple osteotomies and flexible contouring to fit the mandibular defect; 4. Adequate bone height and width to support osseointegrated dental implants; 5. Reliable skin island which can be used to resurface intraoral or extraoral defects; 6. Low donor-site morbidity.⁸

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Acknowledgement

We thank Utama Tarigan, M.D. for help in reviewing this article.