

# A REVIEW OF MANDIBULAR RECONSTRUCTION WITH FREE MICROVASCULARISED FIBULAR FLAP

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## Summary

Mandibulectomy has traditionally been the mainstay of surgical therapy for oral squamous cell carcinoma adjacent to or invading the mandible, osteoradionecrosis, osteomyelitis of the jaw and is the “gold standard” against which all other operations must be compared. Defects can be restored using mandible bone grafts or grafts from other anatomical spaces like iliac crest, scapula, skull, tibia. For large mandible defects combined osteofasciocutaneous, osteoseptocutaneous, osteocutaneous grafts are used. Literature shows up to 10 years of follow up of integrated fibular grafts without major complications and up to 3 years of fully osteointegrated and functioning dental implants in fibular grafts.

## INTRODUCTION

Mandibulectomy has traditionally been the mainstay of surgical therapy for oral squamous cell carcinoma adjacent to or invading the mandible, osteoradionecrosis, osteomye-



Fig. 1. Exposed titanium plate

litis of the jaw and is the “gold standard” against which all other operations must be compared [1]. Its advantages include adequate margins of resection, excellent exposure, and ease of closure. However, the functional and cosmetic consequences of this procedure are devastating to the patient.

The goal of mandible reconstruction is to restore hard and soft tissues, reestablishing masticatory function and esthetics [2-5]. Reconstructive titanium plate is the main treatment method. Plate works like a pattern and helps to maintain mandible form and occlusion. Osteosynthesis with reconstruction titanium plate is just an initial stage of full rehabilitation [5, 7, 8].

Bone resorption under the plate can cause loosening of fixation screws, plate fracture and intraoral or extraoral exposure [6] (Fig.1). However, it could be avoided using free vascularized bone grafts [3, 6, 9, 10].

## MATERIAL AND ANALYSIS

**Donor sites.** Small defects can be restored using mandible bone grafts (grafts from mandible branch, chin or re-

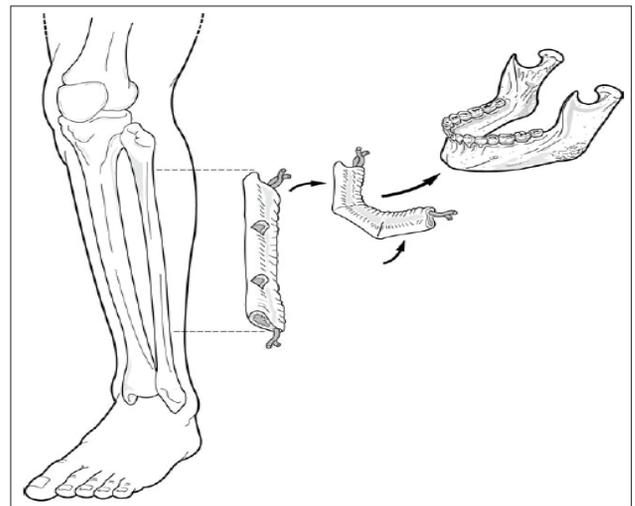


Fig. 2. Osteotomised fibular graft

tromolar sites) or grafts from other anatomical spaces (iliac crest, scapula, skull, tibia). For large mandible defects combined bone grafts are used [10-12]. Since microanastomosed bone grafts consist of living tissue, they are capable of independent survival within a compromised recipient site. Furthermore, vascularized grafts are able to improve the local wound regenerative situation. Most commonly used donor sites are iliac crest and fibula. Restoring mandible vascularized fibula grafts present numerous advantages [3, 10-12]. Their bony architecture is similar to that of the mandible, unlike iliac crest and they are capable of restoring defects up to a length of 25 cm. The grafts can be easily adjusted to the curvature of the mandible using the osteotomy technique. They are associated with very low postoperative donor site morbidity and facilitate the insertion of dental implants [3, 13, 14]. Since vascularized grafts behave like an edentulous mandible, osseointegration of dental implants can generally be achieved.

**Fibula free flap.** The fibular osteocutaneous free flap was originally described for use in mandibular reconstruction by Hidalgo in 1989 [11]. The fibula is a tubular, primarily cortical, bone and is the longest available microvascular bone for mandibular reconstruction. Since the bone is perfectly straight, several osteotomies are usually required (Fig.2.), especially if it is being used to replace the mandibular symphysis. The blood supply to the bone is based on the peroneal artery and vena comitantes [3, 15, 16]. A skin paddle can be harvested with the fibular bone up to 6 cm wide along the entire length of harvested bone. Sensory reinnervation is possible if the lateral sural cutaneous nerve is harvested with the skin paddle. This flap has only one major contraindication, that is vascular diseases.

**Surgical techniques.** After the resection of mandible, surgeons adjust the titanium reconstruction plate to the remaining mandible. Plate is bent to precisely match the native mandible and then fixed into place with screws. The appropriateness of the shape and orientation of the plate is



Fig. 3. Marks on fibula before surgery

checked. This will allow precise placement of the graft in reference to the existing mandible. The plate is subsequently removed, set aside, and the resection completed.

Then the patient is positioned supine on the table with a roll under the hip of the donor leg. The course of the fibula is noted. The fibular head is palpated at the knee and marked (Fig.3.). The peroneal nerve is palpated and marked in its location just below the fibular head. The majority of significant perforators emerge at 10 to 20 cm below the fibular head, thus it is preferable to locate the skin paddle within this location. As the anterior incision is made through the deep fascia, care should be taken to avoid injury to the superficial branch of the peroneal nerve. The dissection continues posteriorly to the posterolateral intermuscular septum, exposing the peroneal muscles. The anterior surface of the septum is then followed down the fibula, and the peroneal muscles are elevated from the lateral and anterior surfaces of the bone. The posterior skin incision is then made through the deep muscle fascia, and the skin paddle is elevated to the edge of the soleus muscle. A 1-cm cuff of soleus muscle is taken from the lateral edge. The fibular cuts are made with an oscillating saw. The proximal cut in the fibula is made first and positioned as superiorly as possible without endangering the peroneal nerve. To ensure stability of the knee the proximal 10 cm of fibula are preserved. Once both cuts are made, the fibula is retracted laterally. The peroneal vessels are located and followed distally where they are ligated and divided. The flap dissection continues in a medial to lateral direction to avoid injury to the perforating vessels of the skin.

The previously shaped reconstruction plate is then brought to the leg. Measurements from the mandibular defect are used to determine bone length and location of the osteotomy. To minimize ischemic time, the fibular osteo-

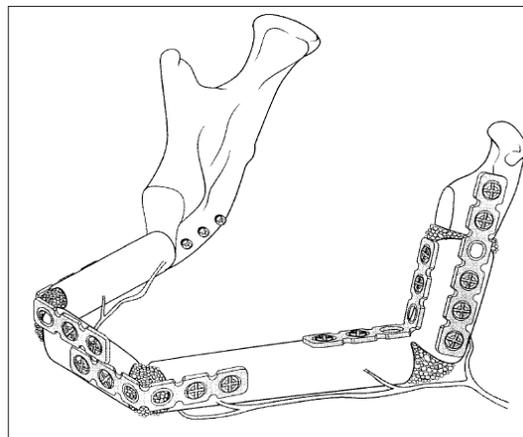


Fig. 4. Fibula placed in defect site

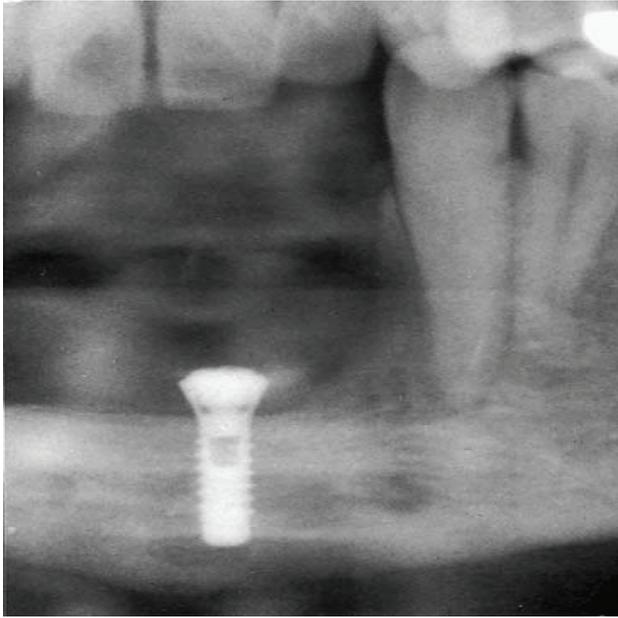


Fig. 5. Radiograph demonstrating a step between the remaining dentate mandible (right) and the fibula bone graft (left)

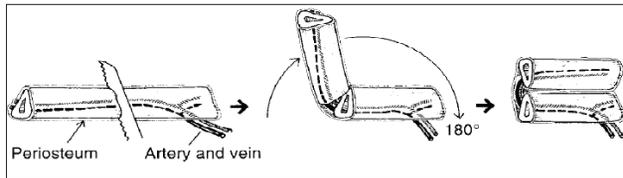


Fig. 6. After cutting the bone graft into two equal pieces without damaging the vascular pedicle, one of the two pieces is rotated 180° and placed over the other

mies are made in situ while the graft is still being perfused. With the reconstructive plate used as a template, a single closing wedge osteotomy is made to create a neoangle. The bone fragments are then stabilized to the plate with screw fixation to avoid injury to the underlying vascular pedicle. The recipient vessels are prepared prior to division of the pedicle and flap transfer. Once the status of the neck vessels is assured, the peroneal vessels are divided, and the flap is transferred to the oral defect. Since fixation of the graft often makes subsequent intraoral repair very difficult, the skin paddle is inset first. The fibula is tailored to fit the defect, placed in anatomic position, and secured to the native mandible by screws placed in the previously drilled holes (Fig.4.). The graft is then revascularized using microvascular techniques. After checking for a watertight intraoral closure, the neck flaps are replaced, and the skin is closed over drains. The leg incision is closed primarily or with a skin graft as needed. Suction drains are placed in the leg.

**Double barrel technique.** The main disadvantage of fibula grafts is their limited height. This especially causes problems in dentate patients, in whom the residual bone segments are normal size. The use of a single strut fibula bone graft with its height of approximately 1.5 cm produces a considerable step between the graft and residual bone segment (Fig.5.). That makes the rehabilitation with dental implants complicated [16, 18, 19]. Fibula can be transversally osteotomized into different segments without danger of necrosis. The principle of setting one fibular segment beside the other was primarily used for reconstruction of the tibia. In 1994 Bähr was the first to introduce this method for the reconstruction of mandibular defects. At first, the crural fascia is separated and then the fibula is degloved between the long lateral peroneal muscle and the soleus muscle. The diaphysis is osteotomized proximally and distally so that the removed bone segment is at least twice as long as the resected section of the mandible. One of the two pieces is now rotated 180° and is laid on the other (Fig.6.). The graft can later be adjusted to the mandibular curvature. Adaptation of the graft segments can be accomplished by using miniosteosynthesis plates. The artery and the two accompanying veins of the vascular pedicle of the graft are anastomosed at the recipient site. Since this vascular pedicle is relatively long (6 to 8 cm) and the diameter of the vessels relatively large (1.5 to 4 mm) the anastomosis can be accomplished safely. Finally the fibula double-barrel bone graft is inserted into the resection defect, which was maintained by using a reconstruction plate [20].

**Vertical distraction of the graft.** Vertical discrepancy between fibula and the unaffected dentate side because of insufficient height of the fibula, could jeopardize the long term success of dental implants. For this reason, vertical distraction osteogenesis of the reconstructed mandible can be done to increase the height of the fibula flap before implant placement. The fibula flap is approached via a



Fig. 7. Radiograph with fixed distractor

vestibular incision, taking care to preserve lingual mucoperiosteal attachment. The bidirectional vertical intraoral alveolar distractor is then positioned on the vestibular bony surface. Adjustment of the distractor is performed before starting the osteotomy. A box-shaped osteotomy is done using a sagittal saw and osteotomes on the vestibular aspect of the reconstructed mandible, and the green stick fracture is achieved on the lingual side with chisels. The distractor is then applied, fixed, and temporarily activated to test for movement of the distracted segment. Subsequently, the distracted segment is repositioned to its initial position and then the surgical incision is closed, leaving part of the distractor passing through the incision (Fig.7.). After 7 days of latency period, activation of the distractor starts at 1 mm per day, using a frequency of 0.5 mm distraction every 12 h. The bone can be distracted by about 10 mm. The distractor is then maintained in position passively for 3 months to allow consolidation of neocallus formed between the 2 bone segments during distraction. After the device removal dental implants can be placed into fibula graft and prosthetic rehabilitation can be performed successfully after 3 months of osseointegration period [21, 22].

**Dental implants in fibular graft.** Fibula bony structure is very similar to mandible, where cortical bone dominates. The similarity of structure lets good osteintegration of dental implants, the same as in the mandible.

Fibular graft is fully integrated after 18 months. Immediately after integration of the graft implantation of dental implants can be done. All the implants immediately gets primary stability. 3 months later, after full osteointegration prosthetic rehabilitation can be achieved. Literature shows up to 10 years of follow up of integrated fibular grafts without major complications and up to 3 years of fully osteointegrated and functioning dental implants in fibular grafts [3, 10, 13, 17, 23].

## CONCLUSIONS

Researchers data shows that combined fibular graft is one of the best options for reconstruction of large mandible defects. After long term follow up no significant complications were observed. After full prosthetic rehabilitation patients are happy with achieved estetic view and restored function.

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*APATINIO ŽANDIKAULIO REKONSTRUKCIJA ŠEIVIKAULIO AUTOTRANSPLANTATU: LITERATŪROS APŽVALGA*

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*Santrauka*

*Raktažodžiai: rekonstrukcija, šeivikaulis, šeivikaulio autotransplantatas su maitinančia kojyte, dantų implantai.*

*Mandibulektomija – dalies ar viso patologinio proceso pažeisto apatinio žandikaulio rezekcija, sveikų audinių ribose. Taikoma gydant onko-*

*loginius ligonius, apatinio žandikaulio osteomielitą, osteoradeonekrozę. Defektai atstatomi klubakaulio, mentės ar kaukolės kauliniais autotransplantatais. Didelių defektų atkūrimui tinkamiausi kombinuoti kaulo ir raumenų ar odos autotransplantatai. Šio darbo tikslas apžvelgti esamos literatūros duomenis apie šeivikaulio autotransplantatus su maitinančiom kraujagyslinėm kojytėm, galimas komplikacijas bei kramtymo funkcijos atstatymą.*

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