

CLINICAL TECHNIQUES AND TECHNOLOGY

Step-by-step mandibular reconstruction with free fibula flap modelling

Tecnica di ricostruzione mandibolare con lembo libero di fibula

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SUMMARY

The functional and aesthetic outcomes after segmental mandibular resection are closely related to the technique used during mandibular reconstruction with bone graft. The fibula free flap approach allows the possibility of using bone with/without skin for restoring the defect. Here, we aimed to establish the preplating technique for oromandibular reconstruction in a step-by-step fashion, based on 41 patients. The surgical technique is expounded in 8-10 steps. Preplating, plate removal, resection, replating, template modelling, contouring and fixation of the fibula represent the key points of the procedure. In this report, we show that the preplating and template modelling method is easy, does not incur extra costs and can be successfully used for mandibular reconstruction with bone graft. Functional and aesthetic results confirm the feasibility and reproducibility of the technique.

KEY WORDS: Fibula flap • Mandibular reconstruction • Preplating • Free tissue transfer • Mandible

RIASSUNTO

I risultati estetici e funzionali dopo resezione segmentale di mandibola sono strettamente legati alla tecnica chirurgica utilizzata al momento della ricostruzione mandibolare con innesti ossei. L'approccio con lembo libero di fibula consente di ripristinare il difetto mediante osso con o senza pelle. Abbiamo presentato la tecnica "step-by-step" di fissaggio della placca per la ricostruzione oro-mandibolare utilizzata in 41 pazienti. La tecnica è composta da 8-10 passaggi. Il fissaggio della placca, la rimozione della placca, la resezione, il riposizionamento della placca, la preparazione del modello e della fibula, nonché il suo fissaggio sono i punti chiave della procedura. Nel presente studio, mostriamo come la tecnica di fissaggio della placca e realizzazione del modello della fibula siano semplici da realizzare, non richiedano costi aggiuntivi e possano essere adottati per la ricostruzione della mandibola con innesto di osso. I risultati funzionali ed estetici confermano la buona riproducibilità della tecnica.

PAROLE CHIAVE: *Lembo libero di fibula • Ricostruzione mandibolare • Fissaggio della placca • Trapianto di tessuto • Mandibola*

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Introduction

In 1989, the first lower-jaw reconstruction with a fibular flap, using osteotomies to mimic the shape of the mandible, was described. Since then, the use of the revascularized free fibula flap as bone graft has become a cornerstone in the head-neck armamentarium. Many authors contributed to optimization of the technique by using skin paddles for closure of defects, using the soleus muscle connected to motor branches at the recipient site to restore the motor function or by using the sural cutaneous nerve together with a skin island for restoring sensation.

The functional and aesthetic outcomes of the procedure are dictated by the technique used for mandibular reconstruction with bone graft. One of the main points of debate regarding the procedure concerns the technique for modelling the flap. Restoration of the mandibular shape and its occlusal relationship with the maxilla may be dif-

icult, as the fibula is a linear bone. A good strategy for the preparation of the graft can avoid wastage of time and poor outcomes.

Herein, we present a step-by-step technique for modelling the flap; we also clearly describe the timing for preplating, templating and inseting the mandible.

Clinical techniques and technology

Data were obtained from a prospectively maintained clinical database of patients who underwent head and neck reconstruction for malignancy of the oral cavity or bone tumours at our Institution between 2006 and 2011.

Viability of the osteo-cutaneous flaps was assessed by clinical monitoring, inspecting the flap every three hours for the first 4 days. Osseous flaps without external component were monitored by daily Doppler ultrasonography of the pedicle.

The detailed steps of the surgical technique are outlined below. Pre-plating, plate removal, resection, replating, template-modelling, contouring and fixation of the fibula represent the key points of the procedure.

1. *Bone exposure.* The lateral aspect of the mandible is exposed as necessary for bone resection with clear margins, and for inseting and fixing the reconstruction flap. At least a 3-cm margin over the osteotomy is required to fix the plates.
2. *Preplating.* After the resection limits have been marked, a 3-mm bone plate is fixed by 7-11 mm screws to the vestibular side of the mandible. Use of the inferior margin of the bone is preferred when the external cortical bone is involved (Fig. 1a).
3. *Plate removal.* The plate is removed, with cognizance of the screw-holes that will be used for definitive fixation. Plate holes and mandibular screw holes can be marked to guarantee the correct matching at the time of re-plating.
4. *Resection.* The lesion is resected with safe margins, i.e., a segmental mandibulectomy is performed. A minimum of 2 screw-holes on each mandibular stump should be clearly identifiable for reconstruction.
5. *Re-plating.* The plate is replaced using the previously made screw-holes. Careful attention should be paid to correctly identify and match the plate holes and mandibular screw holes. The mandibular profile is regained in this step (Fig. 1b).
6. *Definitive plating.* When the preplating is performed on the inferior margin of the mandible, a second definitive plate is fixed onto the lateral aspect of the mandible (Fig. 1c).
7. *Preplating removal.* The preplating is removed, and the definitive plate is left in place (Fig. 1d). (Steps 6 and 7 are not required when the lesion does not affect the outer cortex of the mandible.)
8. *Template modelling.* A plastic sheet is shaped to create a template that will be used to model the flap, taking into consideration the estimated number, length and orientation of fragments of the fibula and the location of osteotomies that will be used, and the gap between the mandible stumps, as well as the curvature of the plate (Fig. 2).
9. *Contouring of the fibula.* The fibula flap is detached from the donor site and modelled according to the shape of the template (Fig. 3).

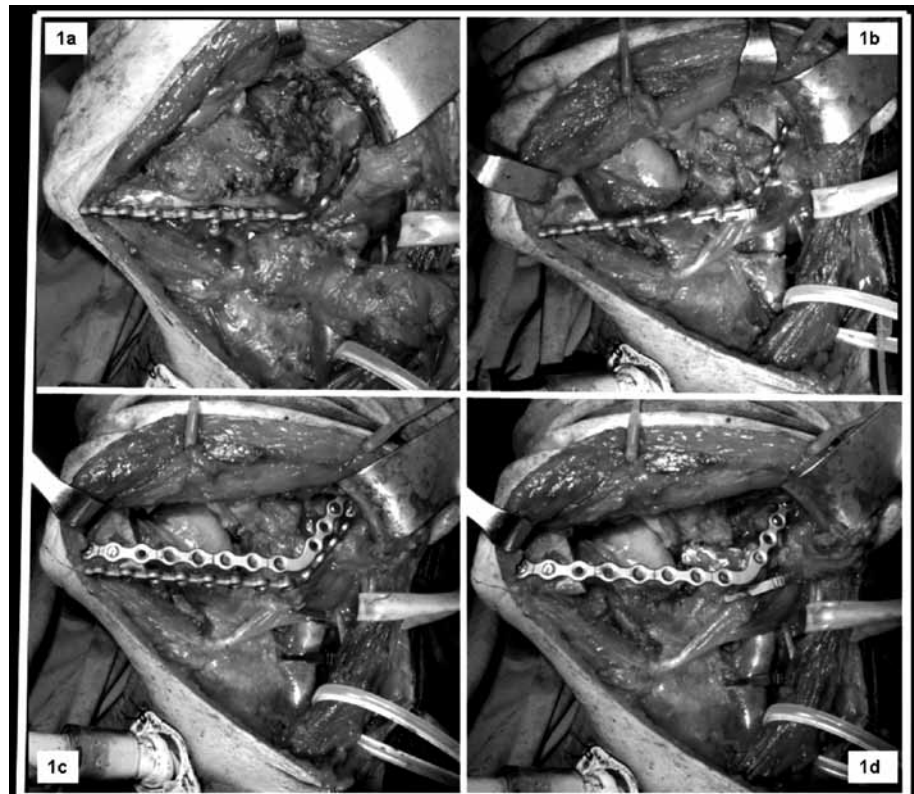


Fig. 1. a) Preplating. b) Re-plating. c) Definitive plating. d) Preplating removal.



Fig. 2. Template modelling.

10. *Fixation of the flap.* The modelled fibula flap is inserted between the mandibular stumps and fixed to the plate with multiple bicortical screws (length 7-11 mm). Finally, the micro-anastomoses are made and the skin of the flap, if present, is sutured in its definitive position (Fig. 3).

Post-operative aesthetic results and correct dental occlusion are confirmed by evaluation of the oral cavity (Fig. 4) and computed tomography (CT) (Fig. 5).

The reconstruction of a mandibular defect with revascularized free fibula flap (30 osteocutaneous and 11 osseous) was performed in 41 patients (26 male and 15 female). The mean age was 56.3 years. 39 patients were affected by squamous cell carcinoma of the oral cavity, while 2 patients were affected by ameloblastoma of the lateral aspect of the mandible. All cases had preoperative head and neck CT scan or MR imaging and angio-CT of the legs. Biopsy of the lesion was obtained in all cases with the exception of the 2 patients with radiological suspicion of ameloblastoma. Two cases showed tumour persistence after definitive chemoradiotherapy performed in other hospitals.

Composite resection with segmental mandibulectomy followed by re-vascularized free fibula flap was performed in all cases (anterior arch was removed in 15 cases while the resection was limited to the lateral aspect in 26 patients). The final pathology report showed massive bone infiltration of the mandible in 28 of 39 patients with oral cavity malignancy, in 11 patients the bone infiltration was limited to the outer cortex of the bone, and in the remaining 2 patients the suspicion of ameloblastoma was confirmed.

In all cases a preplating technique was adopted at the time of mandibular reconstruction. The flap harvesting time ranged from 50 to 125 min. The ischaemia time for the modelling procedure and microanastomoses ranged from 50 to 90 min. 1000 mg of acetylsalicylic acid was administered 5 min before clamping the vascular pedicle of the flap. One g iv paracetamol 2 or 3 times daily was delivered for the first postoperative 48 hours. Antibiotic therapy with amoxicillin and clavulanic acid 2.2 g iv twice a day was maintained for 1 week after surgery. Flap monitoring showed venous impairment in 4 (9.7%) cases between 18-37 hours postoperatively, and warranted re-exploration of the micro-anastomoses. Three (7.3%)

flap failures were observed, a major pectoralis pedicled flap was used for salvage. Return of oral function was achieved in all patients (64% soft and 36% normal diet). Ten patients had bone implants for dental rehabilitation on native bone and fibula flap in a period ranging from 6 to 24 months after surgery; 9 patients had dental prosthe-



Fig. 3. a) Contouring of the fibula. b) Fixation of the flap. c) Fibula flap.



Fig. 4. a-b) Before surgery. c-d) 60 days after surgery.

ses without bone implants; the remaining 22 patients did not have any type of dental rehabilitation. All patients had a correct occlusion, confirmed by panoramic radiographs or CT scan. No patients complained about the aesthetic result.

Discussion

All the surgical steps in mandibular reconstruction are important, but preplating is considered crucial for obtaining good functional and aesthetic results. When the preplating is not correctly performed, or not performed at all, the best outcome may not be attained. The preplating acts as a guide, allowing maintenance of the same distance and orientation of the mandibular stumps prior to the mandibulectomy. The presence of at least 2 screws fixing the plate to each mandibular stump avoids the dislocation of the residual mandible, and guarantees the maintenance of the jaw profile and correct dental occlusion.

In most cases, when the outer cortex is unaffected by the tumour, the plate used for the preplating will become the definitive plate after the resection; consequently, the procedure takes less time, as the number of steps required is reduced from 10 to 8. In the presence of lesions that extend through the bone, or when the tumour modifies the external profile of the mandible, the preplating plate cannot be used as a definitive fixation plate. In such cases, we usually prefer to perform the preplating on the inferior margin, but, if this is not possible due to oncologic reasons, preplating can be performed on the lingual aspect of the mandible, or on the lateral aspect of the mandible by surrounding the lesion with a plate different from the definitive one.

Many techniques for moulding the titanium plate have been reported by other authors. Some propose 3D-template preoperative modelling for reconstruction^{1,2}. A facsimile 3D-biomodel of the mandible with the lesion, and a second with the “virtual” reconstruction in place, are obtained from CT data^{3,4}. Before surgery, the surgeon can use the initial biomodel with the tumour to plan the excision. After tumour resection, the second model is used as a guide for the surgeon to model the bone graft taken from the fibula. This procedure can become impractical if, at the time of surgery, it is found that the resection of the tumour requires a wider excision than that already planned. To date, even when the accuracy of the prototype appears

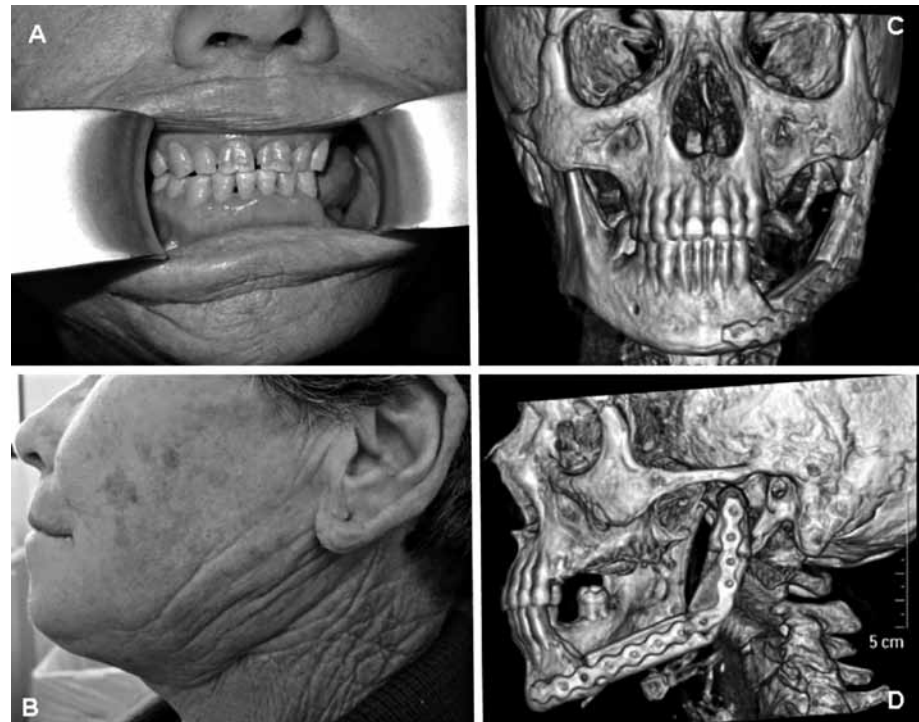


Fig. 5. a-b) Frontal and lateral view of the patient after surgery. c-d) 3D-CT 6 months days after surgery.

to be relatively high, the extension of the resection can be wider than predicted. Therefore, we consider use of the 3D-template preoperative modelling only for reconstruction after excision of a benign lesion, such as an ameloblastoma.

Some authors propose to model the flap according to the shape of the template while keeping it in place at the donor site^{2,7}. This reduces the exposure to ischaemia in the flap, and allows more time for microanastomosis. In our technique, we suggest that the fibula first be detached, and modelled thereafter. We are convinced that the risk of damage while manipulating the vascular pedicle at the time of modelling the bone graft is higher when it is still attached to the leg by the vessels. Using the present technique, the ischaemia time never exceeded 90 min, and intraoperative monitoring of the flap confirmed the vitality of the flap at the time of the surgery.

In conclusion, mandibular reconstruction using a free fibula flap can achieve good functional and cosmetic outcomes. Even though each step in modelling the flap is important, fibula preplating and templating should be considered to be crucial steps for facilitating the procedure and guaranteeing a satisfactory result.

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