

HEAD AND NECK

# Osteoperiosteal free fibula flap as an effective preprosthetic reconstructive option in severe jaw atrophy and oncological resection

## *Il lembo libero osteoperiosteale di fibula come opzione ricostruttiva preprotetica nelle atrofie severe e nei difetti post oncologici dei mascellari*

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### SUMMARY

The gold standard in modern surgical treatment of patients with severe maxillo-mandibular atrophy must include the aim to achieve restoration of function and aesthetics with immediate reconstruction of the oro-mandibular defects. The medical records of 14 patients who were treated in a 5-year period (2010-2014) at our department with severe maxillary and mandibular atrophy, and reconstructed by vascularised free fibula flap were reviewed. Among the former, a total of 14 patients underwent maxillary and mandibular reconstruction using the osteoperiosteal fibula free flap. No major complications were reported. The main advantage of this technique is that it allows the formation of keratinised gingiva, which provides the best implantological options. The only disadvantage of the technique is that the wounds have to heal for second intention, and for this reason patients have to undergo strict follow-up for the first months after the operation. The aim of this article is to evaluate the efficiency of the technique in bone reconstruction after jaw resection or severe atrophy.

KEY WORDS: Fibula free flap • Oncological reconstruction • Head and neck tumours • Jaw atrophy • Jaws rehabilitation

### RIASSUNTO

*Il gold standard nella ricostruzione dei mascellari nelle atrofie severe, siano esse di natura idiopatica o iatrogena, come nei casi di chirurgia resettiva oncologica, deve essere incentrato verso tecniche di ricostruzione immediata che consentano un veloce recupero funzionale ed estetico. I pazienti considerati in questo studio sono stati trattati durante un periodo di 5 anni (2010-2014) con ricostruzione immediata del deficit dei mascellari, eseguito per mezzo di lembo libero di fibula osteo-periosteale. Sono stati pertanto selezionati 14 pazienti sottoposti a ricostruzione con tale tecnica, senza riportare complicanze a medio e lungo termine. Il principale vantaggio di questo tipo di ricostruzione va ricercato nella formazione di gengiva cheratinizzata sovrastante il lembo libero che consente la migliore condizione possibile per una ricostruzione implantoprotesica. L'unico svantaggio di questa tecnica è da imputare alla necessità di lasciare che la ferita chirurgica intraorale guarisca per seconda intenzione in modo da promuovere la formazione di gengiva cheratinizzata dai bordi della ferita stessa, per tale ragione però il paziente necessita di un rigido follow up per il primo mese dopo l'intervento. Lo scopo di questo lavoro è valutare l'efficacia di tale tecnica nelle ricostruzioni ossee dei mascellari.*

PAROLE CHIAVE: Lembo libero fibula • Ricostruzioni oncologiche • Tumori testa collo • Atrofie dei mascellari • Riabilitazione implantoprotesica

Acta Otorhinolaryngol Ital 2015;35:394-399

## Introduction

The gold standard in modern surgical treatment of patients with severe maxillo-mandibular atrophy and post oncological resections must include the aim to achieve restoration of function and aesthetics with an immediate reconstruction of the oro-mandibular defects<sup>1</sup>. Several techniques have been described to rehabilitate the atrophy of bone and the lack of mucosa, skin and muscles in the orofacial region. Bone splitting of narrow ridges<sup>2</sup>, alveolar distraction osteogenesis<sup>3</sup>, zygoma implants<sup>4</sup>, guided bone regeneration<sup>5</sup> and Le Fort I osteotomy with interpositional bone grafts<sup>6</sup> are used.

The current gold standard is represented by the reconstruction with autogenous bone grafts taken from intraoral or extraoral sites, in case of larger defects, which require a greater amount of bone which is not possible with the aforementioned techniques, the use of free flaps becomes mandatory. Vascularised rib, iliac crest, scapula, fibula and radius free flap have routinely been employed as donor sites to reconstruct the defect.

Specifically, as the longest bone segment in the body, the free vascularised fibula flap has selectively been used for extensive oromandibular reconstructions<sup>7</sup>. A fibula graft has been indicated to have several advantages such as ide-

al length, which facilitates numerous osteotomies, good bone height and width for implants rehabilitation, low donor site morbidity, good vascularisation, and a location of the donor site that allows two contemporary surgical approaches<sup>8</sup>.

Commonly the fibula flap<sup>9</sup> is harvested as osteocutaneous flap, so that a skin paddle is harvested with the fibula bone graft. This is associated with a notable series of limitations: thickness, fat patients hair-bearing surface, desquamation, difficult inseting into complex maxillary defects and unideal surface for dental prosthesis rehabilitation<sup>10</sup>. Different techniques have been described in literature to avoid these drawbacks<sup>11,12</sup>, although in tumours infiltrating soft tissues. The disadvantage of the osteo-periosteal flap of the fibula is that it is not applicable in all patients. In fact, in the case of malignant tumours in which resection of large areas of soft tissue and mucosa is required, the use of a skin paddle becomes inevitable. The approach of our unit aims to obtain with a single surgical phase a suitable preprosthetic tissue to harvest a osteo-periosteal fibula flap.

## Materials and methods

The medical records of 14 patients who were treated in a 5-year period (2010-2014) at the maxillo-facial department of the Complesso Integrato Columbus (Catholic University of Sacred Heart, Rome, Italy) with severe maxillary and mandibular atrophy and reconstructed by vascularised osteo-periosteal free fibula flap were reviewed. The study was conducted by adhering to the guidelines of the Declaration of Helsinki. Inclusion criteria were: no general comorbidities and no need for radiotherapy.

In 5 patients, the atrophy concerned the maxillary bone and in the remaining 9 patients the atrophy involved the mandibular bone. The atrophy was caused in 8 cases by maxillary and mandibular secondary to resection for ameloblastoma and in 6 cases by progressive atrophy in edentulous patients. None of the patients had comorbidities, and all were educated to maintain good oral hygiene. No patient had to undergo to radiotherapy after surgical resection.

Patients treated for ameloblastoma underwent a resection phase and reconstructive phase as a one-stage surgery, and the periosteum was removed when the overlying mucosa was involved by the tumour.

The surgery procedures were performed in all patients under general anaesthesia with naso-tracheal intubation. The osteo-periosteal graft used in our technique is similar to the surgery described by Smith et al. (2012) for mandibular and maxillary reconstruction. The patient is placed in a supine position and the proximal and distal fibula are marked and the axis of the bone is drawn. The incision is made down to the fascial level, exposing the lateral compartment; the periosteum is left attached to the

fibular bone as the surgeon proceeds with the dissection. Once the osteotomies are made, bone clamps are placed at the superior and inferior ends of the bone to provide traction on the intraosseous membrane. When the membrane is divided, the peroneal artery and the accompanying veins can be seen, their distal aspects are ligated and divided and the flap can be raised superiorly on the vascular pedicle.

Once harvested, the fibular bone segment is modelled by osteotomies to match the defect morphology and fixated to the residual bone with osteosynthesis plates and screws. It is mandatory to sculpt bone segments more than 2 cm in length in order to lessen the risk of their devascularisation. For the same reason, it is necessary to reduce damage to the periosteum during flap shaping, especially in case of multiple osteotomies. We fix the periosteum and mucosa with tight Donati's stitches using Vicryl 3/0, taking care to spare the vascular pedicle from injuries. After flap insertion, microvascular anastomoses are performed to the facial or lingual artery and to the internal jugular, lingual or facial vein (Fig. 1a-b).

The bone is left covered only by its periosteum without any coverage by cutaneous or subcutaneous paddles as protective layer. It means that the periosteum itself is left exposed in the oral cavity. In our hands, this is not a risky procedure as it mucotises in a few days. Thus, the graft is left to heal by second intention, requiring daily care.

All patients were administered 2.2 gm of amoxicillin iv every 12 hours, starting at the time of general anaesthesia induction and continuing for six days after surgery. A nasogastric tube was maintained for one week. Post-operative instructions included an appropriate oral hygiene by teeth brushing and mouth rinse with 0.2% chlorhexidine. Sutures were removed 14 days post-operatively. A soft diet was suggested for the first post-operative month. Histological samples from the newly formed mucosa were obtained randomly from 7 patients at the moment of implant placement.

## Results

A total of 14 patients underwent maxillary and mandibular reconstruction using the osteo-periosteal fibula free flap.

The mean hospital stay after the reconstructive procedure was 7 days (range 5-13 days). During this time, patients received daily medication of the reconstructed and donor site. They were followed weekly in the first month and monthly in the first year post-surgery. In all patients the fibula demonstrated a good post-operative perfusion of all segments. The time to complete epithelialisation of the osteo-periosteal surface ranged from 6 to 8 weeks. All patients were able to tolerate a soft diet postoperatively after removal of the nasogastric tube. Four of the 14 patients required prolonged hospitalisation for difficulties

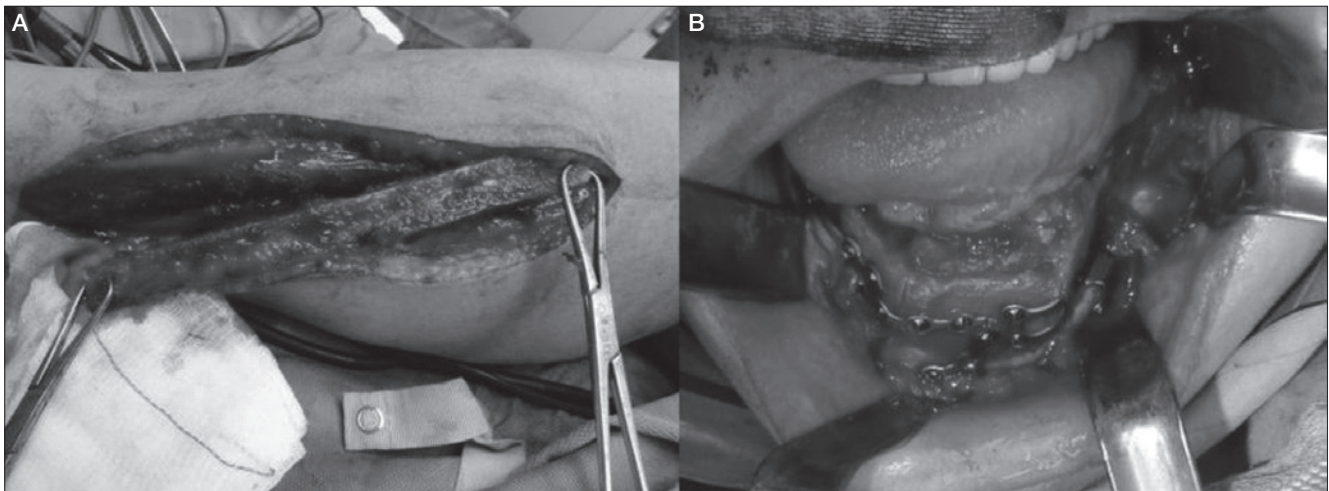


Fig. 1. (a, b) Surgical phases: modelled fibula flap, fixation of fibula flap.

in eating and swallowing. Three of the 14 patients had complications during healing: they had exposure of the bone graft and were treated with weekly curettage of the reconstructed site. However, none of these patients lost the flap. Donor-site complications included patients with minimal epidermolysis at the lower portion of the leg incision that healed spontaneously and one patient who developed a hypertrophic scar at the donor site.

In all cases a layer of newly formed mucosa over the flap covering the bone was adherent. Thus, a second preprosthetic surgery to prepare the soft tissues for future implant rehabilitation was not necessary.

A total of 72 implants were placed after a mean of 6 months (range 4-8 months) in all patients; implants had a mean width of 4.2 mm and length of 11.5 mm. During the same surgery, in 8 patients the osteosynthesis previously used for fibula stabilisation was removed. The remaining 6 patients refused to remove the osteosynthesis due to the increased invasiveness of surgery (Figs. 2ab, 3, 4).

In the 7 patients in whom histological samples were obtained, microscopical findings showed the formation of orthokeratinised mucosa, with no difference compared to normal gingival mucosa (Fig. 5).

The mean follow-up time after reconstruction was 25 months (range 12-50 months): two of the 14 patients experienced the loss, respectively, of one and two implants about a year after prosthetic loading; the other 69 implants showed no complications.

## Discussion

The target of maxillo-mandibular reconstruction in patients with severe atrophy of the oral cavity is achieved with integration of the osseous flap and when bone and oral mucosa are able to load osteointegrated implants<sup>13,14</sup>. Several vascularised bone grafts have been used for reconstruction of oral cavity defects, including the radius, rib, scapula, iliac crest and fibula. The vascularised fibula

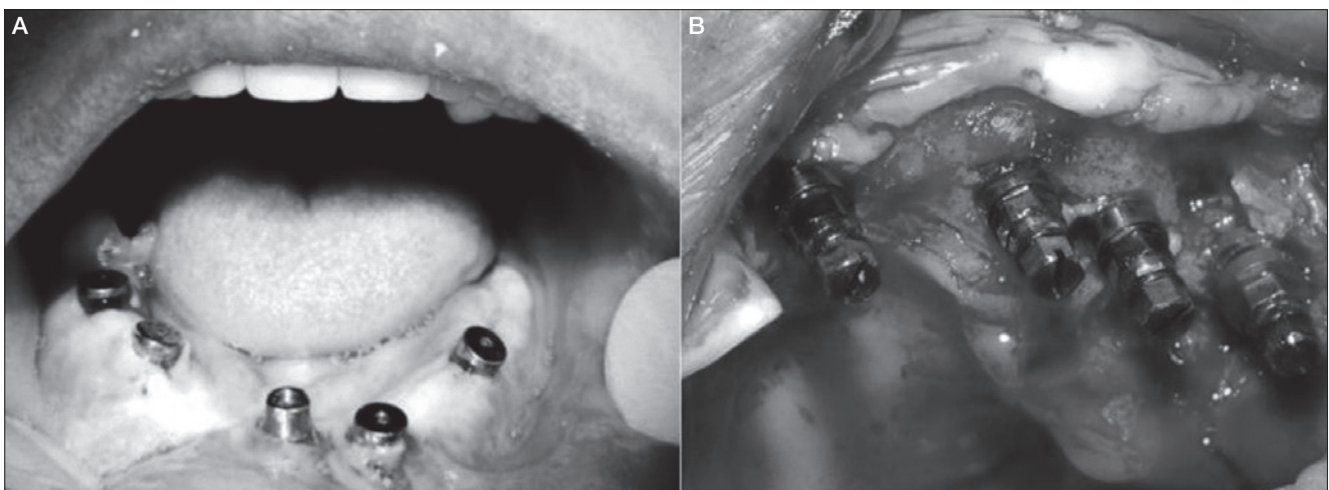


Fig. 2. (a, b) Implant insertion.

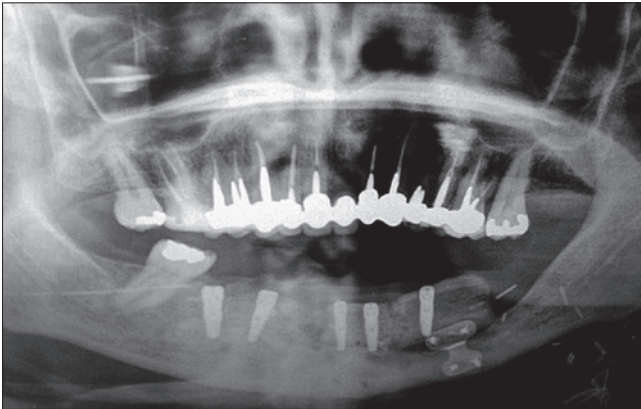


Fig. 3. Rx orthopantomographic image after implant positioning.



Fig. 4. Prosthetic rehabilitation.

flap is the widely most used in reconstructive maxillo-mandibular surgery because of its advantages compared to others such as length and shape of the bone, good blood supply and low donor site morbidity<sup>15 16</sup>. The biggest problem with this free flap consists in obtaining adequate soft tissue including keratinised mucosa to allow optimal pre-prosthetic rehabilitation<sup>17</sup>.

No existing flap can reproduce the physiology of the oral mucosa better than the oral mucosa itself. Smaller mucosal defects can be repaired by local mucosa flaps or by prelaminated fascio-mucosal free flaps<sup>18</sup>. For larger defects, skin grafted fascia, muscle flaps or fasciocutaneous flaps have been used<sup>19 20</sup>. Among these, skin grafts are still used frequently in oral cavity reconstruction. However, their many disadvantages include hair growth, fistula, stone formation and significant contraction deformity<sup>10 11</sup>.

Even when skin grafts are used, the subcutaneous tissue is always different in terms of quality and thickness compared to the submucosal tissue. The attached gingiva is a peculiarity of the oral mucosa and is very difficult to get this new formation<sup>21</sup>. Only a regeneration of the gum itself by second intention can ensure appropriate peri-implant tissue and, therefore, may increase the survival of long-term implants<sup>22</sup>.

In our study, clinical findings of keratinised mucosa were supported by histological findings on randomly obtained histological samples from 7 patients.

The absence of an adequate keratinised mucosa around implants was associated with higher plaque accumulation, gingival inflammation, bleeding on probing and mucosal recession. This occurs because is very difficult to achieve good oral hygiene around dental restorations without the protection of a band of gingival tissue<sup>23</sup>. In patients exercising good oral hygiene and receiving regular implant maintenance therapy, implants with a reduced width of < 2 mm of peri-implant keratinised mucosa were more prone to lingual plaque accumulation and bleeding as well as the buccal soft-tissue recession over a period of 5 years<sup>24</sup>.

Skin flaps also result in bulky reconstruction and excessive mobility of the skin. The subcutaneous tissue with a conventional free fibula flap is always too thick, and sev-

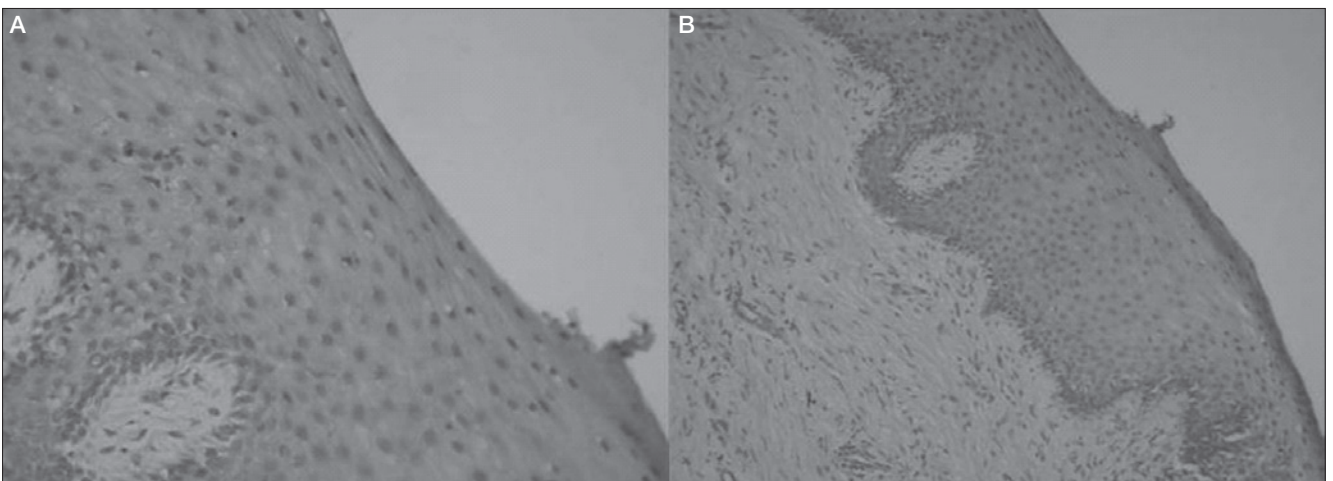


Fig. 5. (a, b) Histological appearance of samples of the newly formed gingiva of the flap showing a parakeratotic appearance, typical of keratinised mucosa.

eral pre-prosthetic procedures are needed to obtain a suitable site for implant placement<sup>25,26</sup>.

The osteo-periosteal fibula flap used in this protocol seems to avoid these drawbacks. Unlike other procedures, the skin paddle is not used; therefore, despite the healing for secondary intention, this flap begins to provide thin and foldable tissues for a very effective implant rehabilitation by osteointegrated implants and prosthetic devices in a few weeks.

The disadvantage of the osteo-periosteal flap of the fibula is that it is not applicable in all patients. In fact, in the case of malignant tumours in whom resection of large areas of soft tissue and mucosa is needed, the skin paddle becomes inevitable<sup>27-29</sup>. However, in some situations, as in the case of rehabilitation for atrophies important or in the case of removal of tumours confined to the bone tissue with preservation of the mucosa, the technique described is revealed of considerable utility in our experience. Only with revascularised flaps, since they have more intrinsic vascularity than bone grafts, is it possible to leave the bone covered by its periosteum only without the risk of necrosis. The exposure of the bone, in these cases, individually heals by secondary intention or curettage, without phenomena of avascular necrosis following exposure in the oral cavity. In fact, compared to a more frequent need for care in the period of healing by second intention, the quality of the mucosa formed after the new formation of epithelium is excellent and compatible with a good soft tissue peri-implant integration.

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Received: May 1, 2015 - Accepted: June 18, 2015