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Technical note

Prefabricated fibula free flap with dental implants for mandibular reconstruction

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ABSTRACT

Free fibula transplant is routinely used for mandibular reconstruction in head and neck cancer. Dental rehabilitation, the objective of mandibular reconstruction, requires the use of dental implants as supports for fixed or removable dentures. Positioning of fibular bone grafts and implants determines implant osseointegration and the possibilities of dental rehabilitation.

Prefabrication of a fibula free flap with dental implants prior to harvesting as a free flap can promote implant osseointegration. The position of the implants must then be precisely planned.

Virtual surgery and computer-assisted design and prefabrication techniques are used to plan the reconstruction and then reproduce this planning by means of tailored fibula and mandible cutting guides, thereby ensuring correct positioning of fibular bone fragments and implants.

The prefabricated fibula free flap technique requires two surgical procedures (prefabrication and flap transfer) and precise preoperative planning.

Prefabricated fibula free flap with dental implants, by improving the quality of osseointegration of the implants before flap transfer, extends the possibilities of prosthetic rehabilitation in complex secondary mandibular reconstructions.

1. Introduction

Free fibula transplant is commonly used for mandibular reconstruction in head and neck cancer. Dental rehabilitation, the objective of mandibular reconstruction, requires the use of dental implants as supports for fixed or removable dentures. Prosthetic dental rehabilitation improves the patient's mastication, speech and quality of life.

Due to its volume and its low rate of resorption, the fibula can be used for insertion of implants. However, the success of implant osseointegration and prosthetic rehabilitation varies as a function of numerous factors including the positioning of bone grafts and implants [1].

Prefabricated fibula free flap with dental implants prior to harvesting as a free flap promotes implant osseointegration, but the position of fibular bone fragments and implants must be precisely planned. This two-stage procedure, developed in the 2000s by Rohner [2], is now easy to perform with the growth of virtual surgery and computer-assisted design and prefabrication techniques [3,4]. This technology allows planning of the reconstruction by virtual surgery and this planning is then reproduced by using tailored fibula and mandible cutting guides.

This article describes the prefabricated fibula free flap mandibular reconstruction technique.

2. Surgical technique

2.1. Preoperative planning based on imaging of the facial bones and lower limbs

Diagnostic thin section (0.4–0.7 mm thick) CT scan of the facial bones is sufficient to allow 3D craniofacial reconstruction provided the temporomandibular joints are included in the acquisition field. CT angiography of the lower limbs with 1 mm sections to assess the patency of the vessels is used for fibular modelling.

These images are transferred to the laboratory selected to create the cutting guides and conformation of fixation plates. The reconstruction project is established by the surgical team and the laboratory's biomedical engineer. Resection and reconstruction are planned virtually by taking into account the extent of mandibular resection, the number and position of osteotomies, the position of

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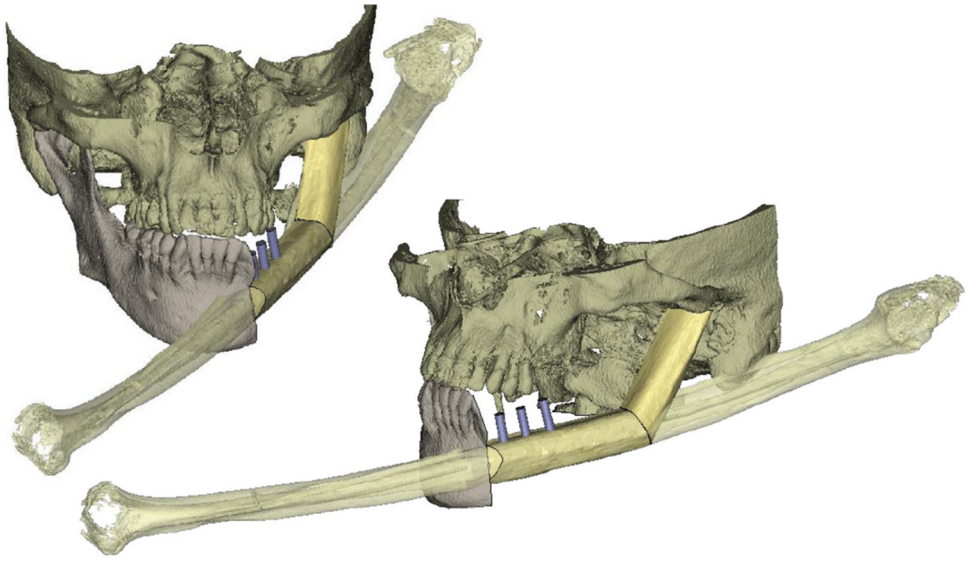

Fig. 1. Planning of the number of bone segments and implants necessary for mandibular reconstruction (OBL Materialise, Chatillon, France).

the vascular pedicle, and the number of implants and their positioning (Fig. 1).

A fibula implant guide is prepared for the first operation. Fibula and mandible cutting guides and prefabricated titanium plates are manufactured for the second operation.

The implant guide and cutting guides are designed directly from the modelling and are then manufactured by polyamide rapid prototyping (OBL Materialise, Chatillon, France).

2.2. First phase of the operation: prefabricated fibula flap

During the first phase of the operation, the fibula is prefabricated with dental implants and a split-thickness skin graft, which will be used as neomucosa.

Patient positioning is equivalent to that of free fibula flap harvesting. A lateral incision is performed and the peroneus longus muscle is displaced superiorly to expose the lateral surface of the fibula that will be implanted.

The height of the cutting guide on the fibula is defined with respect to the lateral malleolus. The implant guide is fixed by mini-screws placed in fixation holes designed for this purpose (Fig. 2a). The guide is placed on the anterolateral surface of the fibula so that the pedicle and septum containing the fasciocutaneous perforators are situated away from the guide support zone.

Drill sleeves, identical to those proposed on conventional implant guides, are used for implant insertion. Drills of increasing diameter are used in each implant site, as recommended by the manufacturer, and the implant is then positioned in the fibula. The cutting guide is removed and the implants are covered by a cover screw (Fig. 2b). The implantation zone is covered by a split-thickness skin graft (Fig. 2c) and then by a Gore-Tex patch (W.L. Gore and Associates, Flagstaff, AZ). Skin closure is performed without drainage. The skin graft and implants are allowed to heal for 5 to 8 weeks.

2.3. Second phase of the operation: mandibular reconstruction

The second phase of the operation is performed at least five weeks after the first phase to ensure implant osseointegration.

The fibula is accessed via the previous scar. Dissection of the fibula, its pedicle and possibly a fascial or fasciocutaneous flap are performed according to the usual techniques (Fig. 3a). At the end of harvesting, the osteotomies and fibular conformation are performed directly on the leg, while maintaining the flap pedicle to reduce the ischaemia time.

The implants are exposed after removing the Gore-Tex, covered by the split-thickness skin graft adherent to the periosteum (Fig. 3b). The fibula cutting guide is positioned and stabilised on the cortex of the fibula by mini-screws placed in the predefined fixation holes.

Cortical perforations designed to receive the fixation plate maintenance screws are performed. Fibular osteotomies are performed with a reciprocating saw according to the plane of section indicated by the guide. Proximal and distal osteotomies are performed first, while protecting the vascular pedicle, and intermediate osteotomies are then performed in a similar way. The cutting guide is removed and the prefabricated fixation plates are positioned.

The recipient site is prepared using specific mandibular cutting guides when osteotomies are necessary. A positioning guide may be used to perform drilling for fixation plates.

The prefabricated flap is weaned and positioned in the mandibular defect according to the reconstruction anatomical and occlusal landmarks (Fig. 3c and d). Fixation plates are screwed into the perforations performed during preparation of the recipient site and the skin graft covering the implants is sutured to the oral mucosa. The ischaemia time is limited to positioning and fixation of the flap and creation of microanastomoses.

An immediate temporary dental prosthesis can be positioned at the end of operation or after healing.

Mandibular imaging, cone beam or dental panoramic imaging is performed at the third postoperative month to assess bone healing and implant osseointegration and an implant-supported prosthesis is then fitted onto the implants (Fig. 4a and b).

3. Discussion

Prefabricated fibula free flap with dental implants extends the possibilities of prosthetic rehabilitation in complex secondary mandibular reconstructions. The prefabricated fibula free flap technique involves two operations (prefabrication and flap transfer) and precise preoperative planning.

Correct positioning of implants is essential to ensure dental rehabilitation, as malposition of the implants makes fitting of the prosthesis impossible or inadequate [1]. The use of an implant guide ensures ideal positioning of the implants in the fibula during the

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