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# Computed tomography-guided implant surgery for dental rehabilitation in mandible reconstructed with a fibular free flap: description of the technique

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**Abstract**

The fibular free flap, with or without a cutaneous component, is the gold standard for reconstructing mandibular defects. Dental prosthetic rehabilitation is possible this way, even if the prosthesis-based implant is still a challenge because of the many anatomical and prosthetic problems. We think that complications can be overcome or reduced by adopting the new methods of computed tomography (CT)-assisted implant surgery (NobelGuide®, Nobel Biocare AB, Goteborg, Sweden). Here we describe the possibility of using CT-guided implant surgery with a flapless approach and immediate loading in mandibles reconstructed with fibular free flaps.


*Keywords:* Fibula free flap; CT guided implant surgery; Immediate loading

## Introduction

The osseous free-flap, with or without a cutaneous component, has become the gold standard for the reconstruction of mandibular defects. Among the alternatives, the fibular free flap[1] has shown itself to be both reliable and adaptable in the reconstruction of the mandible, because of its length, long vascular pedicle, and ability to be cut to follow the shape of the interrupted mandible. Dental prosthetic rehabilitation (the ultimate goal of treatment) is possible with it, even if prosthesis-based rehabilitation is still a challenge because of the many anatomical and prosthetic problems.

Insufficient bony height and inadequate mechanical retention of the prosthesis during function, altered soft tissue, xerostomia (regularly seen in irradiated patients) that reduces the vacuum effect between dentures, and underlying immobile soft tissue, are all problems. Additionally, irradiated mucosa is often unable to tolerate the friction created by an acrylic base. A prosthesis fixed to an implant that cannot be removed by the patient is the best solution for dental rehabilitation with fibular free flaps.[2–6]

Individually, implant-based dental restorations in patients whose reconstruction was with fibula flaps confer many benefits such as sufficient stabilisation of the prosthesis (even in patients with irregularities of the hard and soft tissues), the possibility of compensating for smaller local soft tissue deficiencies, and an improved aesthetic result (by supporting the lip profile). Functional aspects, such as chewing, swallowing, and speech, are preserved much better than with conventional dentures. Implants also reduce the load on the soft tissues and the risk of mechanical irritation with consequent ulceration and discomfort.

Unfortunately when an implant-based prosthesis is planned for rehabilitation there are problems to be overcome. First, the placement of the implants, which is usually easy, may encounter difficulties: the limited opening of the scar-contracted oral cavity; the huge amount of soft tissue

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covering the fibula, with little information about the profile of the underlying bone that is necessary for harvesting; and the need for limited bony exposure in a field that may well have been irradiated. Secondly, problems from scars and soft tissues impair the prosthetic procedures. Even taking impressions using standard transfers for plasters can be difficult and lead to imprecise results. Thirdly, prosthetic guidance in positioning of implants is strongly recommended to achieve good functional results. The simple placement of implants in a fibular free flap, followed by the referral of the patient to a prosthodontist to make a fixed denture, can lead to disappointing results; loading the implants can be impossible if the inclinations of the fixture do not reflect the actual skeletal relations of the dental arches.

We think that these complications can be overcome, or at least reduced, by adopting the new methods of computed tomography (CT)-assisted implant surgery (NobelGuide®, Nobel Biocare AB, Goteborg, Sweden). This procedure, which is currently used to rehabilitate edentulous atrophic jaws,[7–11] permits accurate placement of implants using a flapless technique, with the guidance of an acrylic surgical template generated from preoperative CT. The position of the implant, decided preoperatively on a virtual model of the reconstructed mandible, is chosen with reference to the prosthesis that has to be built. The virtual planning allows positioning of the implant precisely through a thick layer of soft tissues using the computer-generated surgical guide, and avoids obstacles in the reconstructed bone such as screws or osteotomy sites.

In this paper we assessed the possibility of applying CT-guided implant surgery with a flapless approach and immediate loading to mandibles reconstructed with fibular flaps.

## Patient, methods, and result

During the past three years we have successfully used implant rehabilitation of fibular free flaps for microvascular reconstructions of the mandible with computer guided techniques in selected cases (NobelGuide®, Nobel Biocare, Goteborg, Sweden). The inclusion criteria were as follows: a good prognosis after the tumour had been resected, no sign of recurrence, good oral hygiene, and a request from the patient for prosthetic rehabilitation.

We report a case of mandibular reconstruction with fibular free flap to introduce this computer-assisted surgical and prosthetic technique.

A 56-year-old man was operated on for an undifferentiated squamous cell carcinoma of the mandibular alveolar crest and the anterior floor of his mouth. Resection of the tumour and bilateral selective neck dissection were followed by immediate reconstruction with a right fibular free flap. The osseomyocutaneous flap was modelled to match the morphology of the defect and fixed rigidly to the residual bone with titanium plates and screws.

After the reconstruction the patient was given adjuvant radiotherapy because invaded lymph nodes were found in the specimen from the neck (T4N2BM0). He was followed up every 3 months during the first postoperative year, and every 6 months during the second year, and had CT with contrast every 6 months.

One year after irradiation (Fig. 1), he had dental rehabilitation with CT-guided implants, following the NobelGuide® protocol.

## Operative technique

After informed consent had been obtained, impressions, initial photographs, and measurements with a facebow for aesthetic-functional evaluation, were taken.

Study models were mounted in a mean value articulator, and a diagnostic wax model was made. The patient was then evaluated functionally, aesthetically, and phonetically. Finally, a provisional denture was made.

The same denture was filled with radiopaque markers (gutta percha) as reference points, and used as a radiographic guide. A silicone interocclusal record was made as a radiographic index. A three-dimensional CT (Cone Beam CT, KaVo Dental GmbH, Biberach, Germany) was made to evaluate the shape and relations of the maxillary bones and to plan the position of the implant.

In accordance with the NobelGuide protocol for the acquisition of data, CT was taken twice: the first time with the patient wearing the denture (radiological guide) and the radiological index, and the second the denture alone. The CT data were transferred to the NobelGuide Procera software for three-dimensional diagnostic and virtual implant planning (Fig. 2).

The final positions of five implants (Replace Tapered Groovy) were projected into the ideal positions for prosthetic rehabilitation in accordance with the ideal dental position of the radiological guide. The CT virtual implant planning allowed the insertion of implants while avoiding screws and the plate in the fibular flap. A restorative dentist skilled in computer-assisted placement of implants cooperated with the surgical staff to plan the best position for the implant on the reconstructed mandible.

The software planning data were sent to Nobel Biocare (Goteborg, Sweden), where a surgical template was made with the guide implants in the positions planned virtually. Then, based on the surgical guide and the model obtained with the planned positions of the implants, a metal and acrylic resin provisional prosthesis was manufactured.

The patient was operated on under local anaesthesia (articaine chlorhydrate with adrenaline 1:100,000). He was sedated with diazepam (Valium 10 mg, Roche) preoperatively. Amoxicillin 875 mg and clavulanic acid 125 mg were given 1 h preoperatively and twice daily for 6 days thereafter. An anti-inflammatory (ketoprofen 80 mg twice daily) was given for 4 days postoperatively. Omeprazole 20 mg was

Fig. 1. Intraoral picture of the deconstructed mandible.

given on the day of operation and then daily for 6 days. The patient rinsed with chlorhexidine gluconate 0.2% for 1 min before the intervention.

The surgical template was oriented using a surgical index fitted to the opposing arch and fixed with anchor pins. Five anchor pins were used to confer more stability to the template because of the unfavourable anatomical structure of the floor

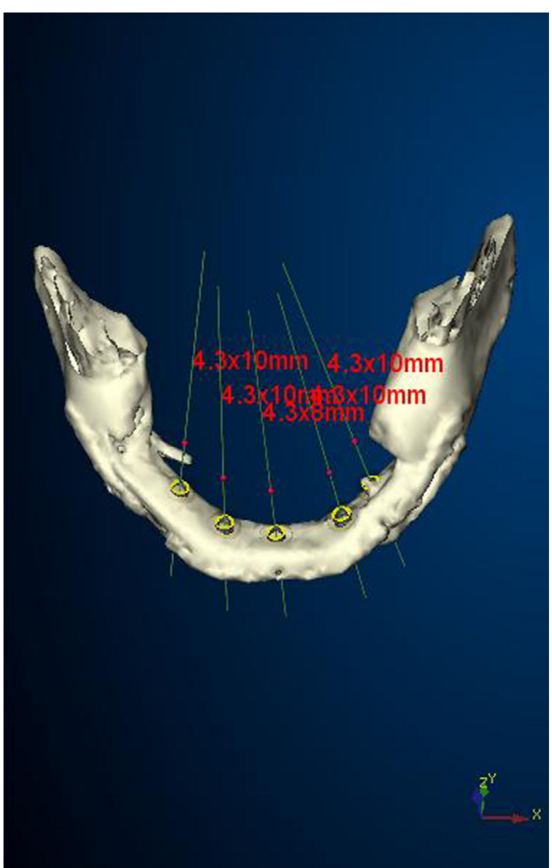


Fig. 2. Computed tomographic virtual implant planning (Procera software).

of the mouth and the retruded lower lip. After the template had been placed, flapless implants were inserted (Fig. 3). Five dental implants (Replace Tapered Groovy) were inserted using a torque of 35–45 N cm (Fig. 4).

The pedicle of the flap, located deep in the reconstructed anterior lingual sulcus, was some distance from the planned position of the implants. Skin perforators and soft tissues vitality were not a problem, either for the flapless technique or for the random peripheral vascularisation of the flap, by now well established (one year after reconstruction).

The prefabricated prosthesis was placed immediately, although minor adjustments of occlusion were needed (Fig. 5). A postoperative orthopantomograph was done immediately postoperatively (Fig. 6), ice packs were provided, and a soft diet was recommended for a month.

The patient was enrolled in an implant maintenance programme. Chlorhexidine gluconate mouthwash 0.2% was prescribed for 1 min twice daily for 4 weeks. The patient was given instructions about oral hygiene, and examined weekly for 3 months.

After six months, there was no relevant problem. The patient reported that his quality of life, aesthetic appearance, and chewing function had improved.

## Discussion

Since its introduction, the fibular free flap has become a routine procedure for the reconstruction of extended defects of both the mandible and maxilla.[1] One of its advantages is the option of harvesting the fibula as an osseomyocutaneous flap, allowing the reconstruction of both hard and soft tissue defects. Finally, the harvested fibula favours the placement of implants because of its diameter and the quality of its cortical bone.

Intraoral rehabilitation of the patient after mandibular reconstruction is directly influenced by the reconstructive

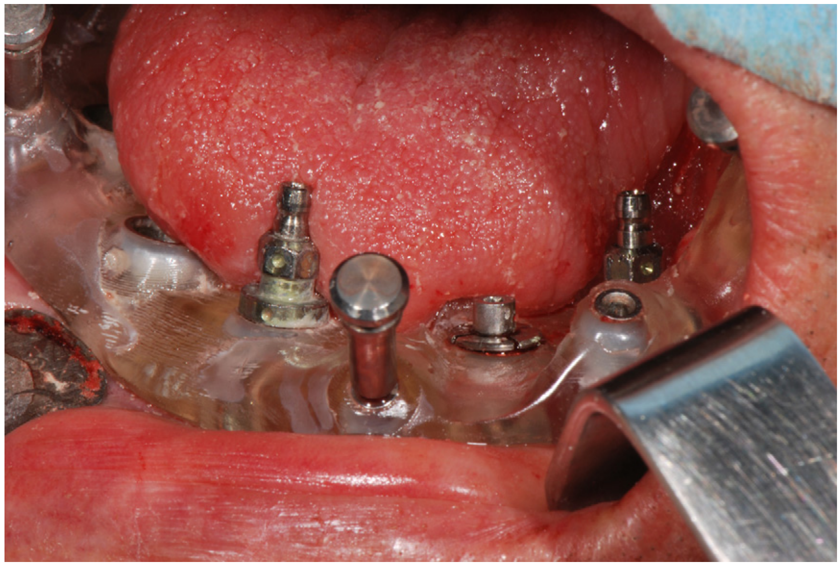

Fig. 3. Intraoperative view of computed tomography-guided implant surgery: implant placement through the surgical guide.

surgical team's knowledge of basic prosthodontic principles. A mandibular reconstruction procedure done without this understanding may provide continuity of the mandible, but may leave the patient crippled, aesthetically and functionally.

When evaluating the patient for oral rehabilitation after mandibular reconstruction the dentist assesses the oral opening; the relation of the reconstructed mandible to the maxilla and temporomandibular joints; the vestibular depth between the tongue, mandible, and cheeks; the character of the supporting tissue covering the reconstructed alveolar ridge; and the function of the tongue. The reconstructed mandible must be properly aligned with the maxilla in both the horizontal and vertical planes, with adequate intermaxillary space to insert a prosthesis. The tissue overlying the reconstructed mandible should be of proper consistency and thickness to resist abrasion and distribute the load placed by the prosthesis evenly along the underlying bone.

After ablative and reconstructive surgery there is always some intermaxillary discrepancy and interference between the tongue, floor of the mouth, lips, and reconstructed mandible. For these reasons, implant-based dental restoration in patients whose reconstruction has been with fibular flaps has many benefits, such as stabilisation of the prosthesis, even in patients with marked irregularities of hard and soft tissue anatomies. Only the prosthetic-guided insertion of oral implants permits the preservation of good occlusion, and adequate function such as chewing, swallowing, and speech. Finally, the implant-fixed prosthesis reduces the load

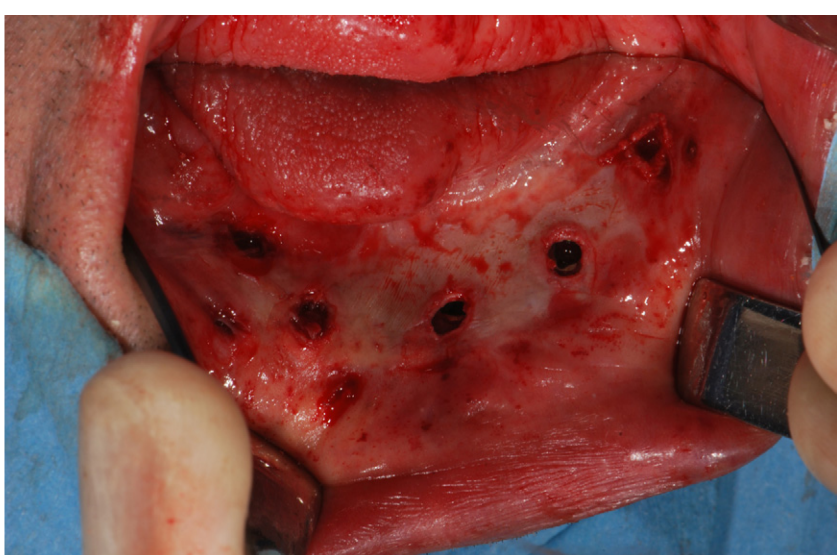

Fig. 4. Postoperative view of computed tomography-guided implant surgery: flapless insertion of five fixtures.

Fig. 5. Prosthetic restoration (immediate loading).

on the soft tissues and the risk of mechanical irritation with consequent ulceration and discomfort.

The classic approach to patients with fibular free flaps is based on a radiological assessment, and surgical guides made from plaster casts, to allow adequate insertion of implants from a prosthetic perspective. Despite the ideal perspective, the use of this type of surgical template does not permit accurate endosseous positioning of implants because of the difficulty in defining the position of the underlying bone precisely without raising a flap, and the impossibility of fixing the template to the bone once the thick musculomucosal flap is raised. As these patients have often been treated with irradiation, large areas of bony exposure should be avoided, reducing the surgical view required for standard two-step implant surgery.

With CT-guided surgery the implants are positioned exactly where planned virtually. Precise prosthetic guidance of the positions of the implants is achieved with little room for error when the computer-generated template is seated correctly and the anchor pins, five instead of the normal three, are fixed in the jaw in the correct positions. As a result it is possible to avoid the removal of screws and plates and to insert implants in segments of fibula with minimal bone volume.

Another advantage of this technique is the option to place a provisional prosthetic restoration at the end of operation that has been computer-generated or developed from the template, without the time-consuming need for difficult impressions with transfers fixed on the fibula in a narrow oral cavity. The prosthesis can be loaded immediately if there is adequate torque on insertion, which reduces discomfort for the patient and shortens the operating time.

A different prosthesis can be fabricated with the aid of a dedicated computer-aided design and machining (CAD–CAM) scanner, ranging from metal and acrylic resin provisional prostheses (used in this case, as a provisional, medium-term prosthesis) to titanium or zirconia implant bridges (as long-term prostheses).

Further studies are needed of larger numbers of patients to discover possible contraindications to or complications of

Fig. 6. Panoramic postoperative view showing the prosthetic framework fitted to the implants, and their depth.

this procedure in suitable patients, and to discover further applications for the method.

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