

# Accuracy of mandibular reconstruction by three-dimensional guided vascularised fibular free flap after segmental mandibulectomy

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## Abstract

Mandibular reconstruction with a fibular free flap has become standard in specialised centres for head and neck reconstruction, particularly for defects with more than one osteotomy that are challenging even for experienced surgeons. Virtual surgical planning is a potential tool to facilitate harvesting of the fibula and the osteostomy. The purpose of this study was to compare the two methods of mandibular reconstruction - conventionally planned (conventional group) and “virtually” planned (virtual group) - with regard to accuracy, bony consolidation, complications, and operating time. Fifty patients who required mandibular reconstruction after segmental mandibulectomy were evaluated retrospectively, 24 virtually planned and 26 conventionally planned. The overall survival of flaps was 92% (46/50). The bony consolidation rate in the virtual group was significantly better than that in the conventional group ( $p=0.002$ ). The difference between the angle of the mandible before and after was highly significant with a median of  $11.5^\circ$  (range  $2^\circ$ - $75^\circ$ ) in the conventional group and  $4.5^\circ$  (range  $0$ - $18^\circ$ ) in the virtual group ( $p=0.0001$ ). Operations were mean (SD) of 34 (21.2) minutes shorter in virtually-planned cases ( $p=0.12$ ). The overall morbidity did not differ significantly between the groups. The use of virtual surgical planning in mandibular reconstruction by fibular free flap is beneficial for optimising accuracy, consolidation of bony segments, and operating time, while increasing the predictability of results for the surgeon. However, additional costs have to be carefully weighed against the benefits.

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## Introduction

Nowadays, mandibular reconstruction with microvascular fibular grafts after segmental mandibulectomy has become standard for the repair of extensive bony defects and composite defects. The reasons for such defects vary from resection of tumours, bony necrosis after radiation, medication with antiresorptive drugs, or post-traumatic bony damage. Even for experienced surgeons, the reconstruction of these defects

can be challenging, particularly in segmented defects that require one or more osteotomies or are combined with soft tissue defects.<sup>1</sup> At the same time, the exact reconstruction of the facial contour and orthognathic planes is crucial for quality of life and function.

To facilitate bony reconstruction, particularly those with more than one segment, virtual surgical planning has become important because it produces guides for resection or cutting, and reconstruction plates or templates. The most common microvascular pedicled transplants used with virtual planning include the fibular, iliac crest, and scapular flaps. As first described in the maxillofacial region by Hidalgo in

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1989,<sup>2</sup> the fibular free flap is an ideal flap for mandibular reconstruction because of the long pedicle, wide diameter of vessels, and ability to include skin and muscle. Multiple teams can also work simultaneously to shorten the operating time.<sup>3,4</sup>

The additional reconstruction of defects of the whole mandible (two bodies and symphysis according to the classification by Urken et al<sup>5</sup>) and the immediate or subsequent insertion of dental implants are possible. Virtual planning is extremely helpful, particularly for this purpose, as it reproduces the occlusal plane or position of a tooth. Most published methods of mandibular reconstruction with fibular flaps involve the insertion of reconstruction plates. However, these plates are often bulky, and removal is challenging. Another disadvantage is that insertion of dental implants may be particularly intricate in some cases because screws interfere with the positioning of the implant. For this reason, one solution might be to use miniplates instead of reconstruction plates, in which case the removal of a single potentially infected or exposed plate and the subsequent insertion of dental implants, would be possible.

We know of no reported significant difference in the morbidity after miniplates and reconstruction plates.<sup>6,7</sup> In the case of miniplates, the contact area between the fragments of fibula should preferably be large enough to avoid load-bearing, for which miniplates are inappropriate. This can be ensured by making exact saw cuts either with cutting guides or free-hand. As free-hand angulation saw cuts are difficult, and because of the lack of studies that compare virtually planned reconstructions of the mandible with conventionally planned ones, our aim in this study was to compare the techniques.

## Patients and Methods

Patients who had mandibular reconstruction with a fibular free flap after segmental mandibulectomy for oral squamous cell carcinoma, osteoradionecrosis, trauma, or osteomyelitis were retrospectively reviewed after the approval of the institutional review board had been obtained. All patients gave signed informed consent. The resections and reconstructions involved a two-team approach by two maxillofacial surgeons at a time in a specialised department of oral and maxillofacial surgery. All patients had high resolution computed tomographic (CT) scan and a CT-angiogram of the lower leg (Brilliance iCT, Philips Medical Systems, The Netherlands). For virtual planning, the data were uploaded to a 3-dimensional planning and printing provider for virtual surgery with ProPlan CMF® software (Materialise, Leuven, Belgium). In a planning session, the resection margins were defined by the surgeon and a clinical engineer within a safety margin of not less than 10 mm in malignant diseases. Cutting guides for the jaw and the fibula were created to transfer the virtual into clinical practice.



Fig. 1. Axial computed tomographic scan of cystic tumour of the mandible.

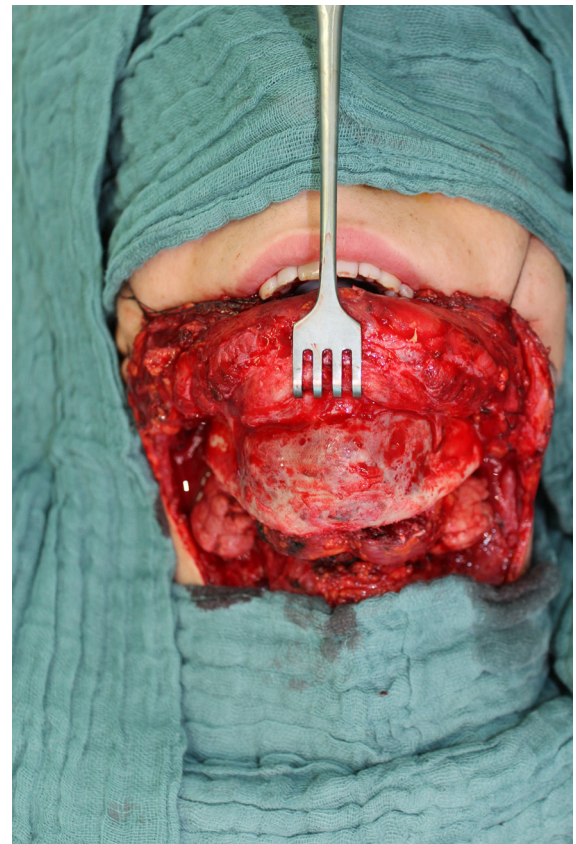


Fig. 2. Site of operation before segmental mandibulectomy.

We used 2.0 mm miniplates (Medartis, Basle, Switzerland) for osteosyntheses of the fibular flaps. Figs. 1–3 illustrate a case treated in this way. For reconstructions without virtual planning, osteotomies and osteosyntheses were made free-hand after the anastomosis had been finished. All arterial anastomoses were end-to-end with the superior

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