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# Survival of dental implants placed in vascularised fibula free flaps after jaw reconstruction☆

Sameh Attia [a,*], Joerg Wiltfang [b], Jörn Pons-Kühnemann [c], Jan-Falco Wilbrand [a], Philipp Streckbein [a], Christopher Kähling [a], Hans-Peter Howaldt [a], Heidrun Schaaf [d]

[a] University Hospital Giessen, Dept. for Oral and Maxillofacial Surgery, (Head: Prof. Dr. Dr. Hans-Peter Howaldt), Klinikstr. 33, 35392, Giessen, Germany
[b] University Hospital Kiel, Dept. for Oral and Maxillofacial Surgery, (Head: Prof. Dr. Dr. Joerg Wiltfang), Arnold-Heller-Straße 16, 24105, Kiel, Germany
[c] Institut for Medical Informatics, Medical Statistics Rudolf-Buchheim-Str. 6, 35392, Giessen, Germany
[d] Private Practise MKG am Theater, Neuenweg16, 35390, Giessen, Germany

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ABSTRACT

*Purpose:* Ablative oncological surgery to treat head-and-neck cancer often triggers a requirement for jaw reconstruction. Modern surgical procedures using free microvascular flaps afford acceptable outcomes in terms of restoration of bony and soft tissue defects. A fibula free flap is often the preferred flap, as the bone length is considerable and a two-surgeon approach is possible. Dental implants play important roles in functional rehabilitation. Our aim was to evaluate the survival of dental implants placed in reconstructed areas after transfer of fibula tissue to the jaw.
*Materials and methods:* We retrospectively studied 34 patients who underwent ablative tumour surgery and jaw reconstruction using osteocutaneous fibula free flaps and who then received dental implants. We evaluated implant survival and success, survival of the fibula flap, and clinical and radiographic data.
*Results:* We included 34 patients, 23 of whom were diagnosed with squamous cell carcinoma. In total, 134 dental implants were inserted in transferred fibula bone. The cumulative implant survival rate was 81%. The survival rate of the 34 fibula flaps transplanted after surgical reconstruction was 97%.
*Conclusion:* The insertion of endosseous implants after jaw reconstruction using vascularised fibula tissue yields successful dental rehabilitation in patients with oral cancers.


## 1. Introduction

Ablative surgery with and without radiation is the current standard therapy for oral cancer (Roumanas et al., 2006). Surgical removal of a tumour may generate a series of problems, such as disfigurement of the facial contours; large oro-nasal communications; and impaired speech, chewing, swallowing, and saliva retention. The loss of teeth and jaw bone can significantly impair mastication (Chiapasco et al., 2006).

Rehabilitation of cancer patients using conventional complete or partial dentures may be difficult or impossible even when the mandibular or maxillary reconstruction is ideal; the dentures are unstable in the compromised oral environment (Barber et al., 1995). Osseointegrated dental implants have been used increasingly frequently to rehabilitate patients with head-and-neck cancers (Al Mardini, 2009). Such implants enhance rehabilitative quality by enabling patients to function with implant-supported prostheses (Barber et al., 1995). Some studies recommend that 6–12 months should elapse prior to dental implant insertion (Zlotolow et al., 1992). Before implantation, it is essential to explore whether the soft tissue and bone requirements are acceptable. Healthy, well-vascularised soft tissue must overlie the bone to be implanted. The bone requirements are much more rigorous: the minimum vertical bone height is 10 mm, and the minimum horizontal width 3.75 mm (Frodel et al., 1993). An appropriately positioned fibula free flap affords an excellent foundation for insertion of osseointegrated dental implants (Zlotolow et al., 1992). The skin of the fibula free flap is sometimes very thick and exhibits considerable mobility; such peri-implant soft tissue is suboptimal, and peri-

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* Corresponding author. University Hospital Giessen, Dept. for Oral and Maxillofacial Surgery, Klinikstr. 33, 35392, Giessen, Germany.
*E-mail address:* sameh.attia@dentist.med.uni-giessen.de (S. Attia).

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implantitis may develop. Transplanted fibula tissue includes considerable soft tissue (muscle cuffs and/or vascular pedicles).

If the peri-implant tissue around the fibula transplant lacks keratinised gingiva, soft tissue adjustment is necessary. Vestibuloplasty in combination with placement of a free palatal gingival graft is the procedure of choice. This can be performed during second-stage re-opening of the dental implants with insertion of gingival formers (Wei et al., 1997). The most common definitive prostheses are implant-tissue–supported overdentures, or implant-fixed or implant-detachable prostheses. Removable dentures are preferred for optimal oral hygiene. The aim of our present study was to evaluate the survival rates of dental implants inserted into free fibula flaps.

## 2. Materials and methods

### 2.1. Patients and procedures

We included patients undergoing mandibular or maxillary resection and reconstruction that involved the use of microvascular fibula flaps followed by the insertion of dental implants. The inclusion criteria were tumour resection involving the jaw that was followed by immediate reconstruction using free fibula flaps and then dental implantation after 5 months. The exclusion criteria were the absence of dental implantation, jaw reconstruction using other types of flaps (e.g., iliac crest or radial forearm flaps), or cancer recurrence prior to dental implantation. All patients were treated at the Departments of Maxillofacial Surgery and Prosthetic Dentistry of the University Hospital Giessen between January 1, 2000, and December 31, 2011. We retrospectively collected data on the following: patient age; sex; indications for surgery; defect location; implant type, number, location, and status; and prosthetic rehabilitation provided. Selected patients were invited to clinical follow-up sessions and were radiologically evaluated. Jaw defects were defined as mandibular (Iizuka et al., 2005) or maxillary (Brown et al., 2000). The principal outcome was implant survival. The criteria for implant success were those of Albrektsson et al. (1986): absence of persistent pain, peri-implant infection, mobility, and continuous peri-implant radiolucency; and peri-implant bone resorption >1.5 mm in the first year and <0.2 mm annually in the following years.

Clinical assessments included dental status, oral condition, extent of prosthetic rehabilitation, postoperative complications, implant survival, and fibula transplant survival. All clinical examinations were performed by a single physician using a standardised method. Probe depth, bleeding evident on probing, and Periotest (PT) (Siemens, Bensheim, Germany) data were recorded. Probe depths (in millimeters) were measured at four sites around each implant using a World Health Organization (WHO) periodontal probe. The maximum depths were recorded. Every implant was examined in terms of plaque status. The bleeding scores were as follows: 0, no bleeding; 1, bleeding after 1–15 s; 2, immediate weak bleeding; 3, bleeding of the interdental papilla; and, 4, rapid heavy bleeding. Osseointegration of the dental implants and fibula bone was also assessed. Implant mobility was recorded using a digital scale and quantitated using the PT, which also measured occlusal loads. The scale ranges from −08 to +50. One or two measures are required at each follow-up examination. These values usually decrease in the first year by 1–2 units, which is attributable to ossification of the surrounding bone.

Panoramic radiography was used to measure bone loss. The orthopantomograph was taken directly after implant insertion, and this was compared with a radiograph taken a minimum of 1 year later. The distances between the bone level and the implant shoulder in both radiographs were recorded; the difference was the extent of bone loss, calculated with the aid of Sidexis XG software (Sirona Dental Systems GmbH, Bensheim, Germany). Implant failure was defined as implant removal caused by failure of osseointegration or peri-implantitis. The annual success rates of implantation were also recorded.

Histological diagnosis of tumour biopsy samples was followed by panoramic x-rays, computer tomography, and photographic documentation. The surgical protocols included neck dissection and en bloc tumour resection. The resulting defects were reconstructed using microvascular fibula free flaps. One surgical team performed tumour resection and neck dissection, and a second surgical team raised the fibula flap. If necessary, the fibula was remodelled into the shape of the reconstructed defect. Osteosynthesis was achieved by placing adjustable locking plates. Each fibula graft was placed with the posterior aspect and the nutrient artery orientated caudally; the pedicle thus entered the lower aspect of the neo-jaw. After waiting for 6 months to ensure that no sign of recurrence was evident, the dental implants were inserted. After 5 months of healing time, the implants were exposed using healing abutments. Vestibuloplasty using a free mucosal graft from the palate was performed to create a vestibule with attached gingiva. All patients were then referred to our Department of Prosthetic Dentistry to commence prosthetic procedures.

This study was approved by the Research Ethics Committee of the Faculty of Medicine of the Justus-Liebig-University Giessen (approval no. 25/10) and was supported by an organisation (a registered society) promoting cancer research in Giessen.

### 2.2. Statistical analysis

Implant survival rates were subjected to Kaplan–Meier analysis, which was performed in collaboration with the Institute of Medical Informatics of the Justus Liebig University, Giessen, using SPSS software (SPSS Inc., Chicago, IL, USA). Other parameters were evaluated with the aid of impDAT-Dental Software (Kea Software GmbH, Poecking, Germany).

## 3. Results

We included 34 patients treated from January 1, 2000, to December 31, 2011 (11 females and 23 males) with a mean age of 53.47 years (range 17–79 years) at the time of ablative surgery. Most patients ($n = 26$) were 50–79 years of age. Tumour resection was the principal cause of maxillary and mandibulary defects. Squamous cell carcinoma, or recurrence thereof, was diagnosed in 23 patients. Ameloblastoma affected three patients, and osteomyelitis affected two. One patient each had the following: mucoepidermoid carcinoma, adenoid cystic carcinoma, adenoid squamous cell carcinoma, keratocystic odontogenic tumour, hemangiopericytoma, and osteofibroma. More tumours were removed from lower than from upper jaws. Six patients had maxillary and 28 had mandibular defects; the Iizuka classifications for mandibular defects and the Brown classifications for maxillary defects are listed for all patients in Table 1.

### 3.1. Analysis of dental implants

In total, 228 dental implants were inserted after jaw reconstruction using fibula flaps; 134 implants were inserted in these flaps, 53 were inserted in native jaw bone, and 41 were inserted in the opposite jaw. We evaluated only follow-up data on the 134 fibula flap implants. Two implants were retained as sleeping implants because of prosthetic considerations. Two were not examined because the patients were lost to follow-up. Three different implant types were placed in transplanted fibulae: 66 Xive