Journal of Cranio-Maxillo-Facial Surgery 42 (2014) e217–e223

Contents lists available at ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

journal homepage: www.jcmfs.com

Early bone resorption of free microvascular reanastomized bone grafts for mandibular reconstruction – A comparison of iliac crest and fibula grafts

Christian Mertens [a,*], Christian Decker [a], Michael Engel [a], Anja Sander [b], Jürgen Hoffmann [a], Kolja Freier [a]

[a] Department of Oral and Maxillofacial Surgery, University Hospital Heidelberg, Im Neuenheimer Feld 400, 69120 Heidelberg, Germany
[b] Institute of Medical Biometry and Informatics, University of Heidelberg, Heidelberg, Germany

ARTICLE INFO

Article history:
Paper received 10 April 2013
Accepted 23 August 2013

Keywords:
Microvascular bone graft
Bone resorption
Free fibular flap
Iliac crest
Mandibular continuity defect
Implant rehabilitation

ABSTRACT

Objectives: Patients with continuous bone defects of the mandible after ablative tumor surgery need bony reconstruction for proper function and aesthetics. Free microvascular reanastomized bone grafts provide a clinically proven option for such patients, yet the optimal source of donor tissue has not yet been established. The aim of this study was to evaluate and compare the bone volume stability of vascularized bone grafts, particularly in the early highly resorptive phase, from the iliac crest (DCIA) and the fibula and to assess the implantologic rehabilitations.

Materials and methods: Thirty-six patients with mandibular continuity defects due to tumor resection were reconstructed by the use of vascularized bone grafts; 21 patients received DCIA flaps and 15 patients received a composite free fibular flap, depending on the size and location of the defect. Bone resorption was assessed using digital panographs. Radiographs were taken immediately after bone reconstruction, 6 months postoperatively, prior to implant surgery, and at prosthetic loading.

Results: After a mean observation period of 6 months, vertical bone resorption was 6.79% for the patients of the iliac crest group (DCIA), 10.20% after 11 months, and 12.58% after 17 months. Fibular grafts showed a bone resorption of 5.30% after a mean observation time of 6 months, 8.26% after 11 months, and 16.95% after 17 months. Eighteen patients received 71 implants for implant-retained dental reconstructions.

Conclusions: Microvascular reanastomized bone grafts represent a reliable treatment option for reconstruction in cases of large defects of the mandible, with low graft resorption in the early healing phase. Additionally, the compared grafts provide sufficient bone volume to permit implant rehabilitation.

1. Introduction

Large bone defects of the mandible and maxilla due to bone atrophy or trauma usually require reconstruction with autologous bone from extraoral donor sites. For such indications, the most common donor site is the iliac crest. Nonvascularized grafts used for this purpose, however, have limitations depending on the defect size, conditions at the recipient sites, and amount of soft tissue available to achieve sufficient graft coverage (Chiapasco et al., 2006b). Furthermore nonvascularized bone grafts, especially from the iliac crest, show high resorption rates (Johansson et al., 2001; Mertens et al., 2013; Vermeeren et al., 1996). The literature reports resorption rates of 49.5% within 6 months of grafting (Johansson et al., 2001).

Free microvascular bone grafts from the iliac crest (DCIA), the fibula and the scapula are frequently described for reconstruction of postoncologic continuity defects of the mandible and maxilla (Chiapasco et al., 2006a; Ferrari et al., 2013; Takushima et al., 2001); however, patients with severe atrophy reconstructed with microvascular bone grafts are described in the literature as well (Chiapasco et al., 2011; Rohner et al., 2002).

The respective grafts must not only meet functional and esthetic requirements of facial reconstruction (Rana et al., 2011), but should also provide for sufficient bone volume to retain dental implants. Because of vascularization of the grafts, bone volume is expected to achieve higher stability and a lower resorption rate as is common for nonvascularized bone grafts (Binger and Hell, 1999; Li et al.,

* Corresponding author. Tel.: +49 6221 56 39705; fax: +49 6221 56 4222.
E-mail address: christian.mertens@med.uni-heidelberg.de (C. Mertens).

1010-5182/$ – see front matter © 2013 European Association for Cranio-Maxillo-Facial Surgery. Published by Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jcms.2013.08.010

2007). Furthermore, vascularized bone shows higher graft survival rates (Rana et al., 2011) and lower infection rates compared with nonvascularized bone or alloplastic materials (Adamo and Szal, 1979; Gadre et al., 2011; Hamaker, 1981).

The aim of this study was to analyze and compare early bone resorption of vascularized bone grafts, either from the DCIA or the fibula. The focus is on the early healing phase, since bone resorption is not a linear process but is most pronounced directly after bone augmentation within the first half year (Verhoeven et al., 1997, 2000).

Additionally, the microvascular bone grafts were evaluated with respect to their dimension and checked for suitability to retain dental implants. In patients having received consecutive implants, the parameters of implant survival and soft tissue condition were evaluated and assessed.

2. Material and methods

2.1. Patients

All patients in this retrospective cohort study were recruited from the Department of Oral and Maxillofacial Surgery of the University Hospital Heidelberg, Germany. All patients having received reanastomized microvascular bone transplants between September 2010 and December 2011 were checked for eligibility. Of these 54 treated patients (19 female, 35 male), 33 grafts were taken from the DCIA, 18 from the fibula and 3 from the scapula.

Only patient groups large enough to permit statistical application were included; hence, the scapula graft population was excluded from the present study. Patients requiring surgical reduction of graft height and double-barrel fibula flaps were also excluded.

Thus, 36 patients (21 having grafts from the DCIA and 15 with grafts from the fibula) were evaluated in this study of bone graft resorption (Table 1).

Seventeen females and 19 males underwent ablative surgery due to malignant (DCIA, 14; fibula, 14) or benign entities (DCIA, 7; fibula, 1). Nine patients with malignancies in the DCIA group and 8 in the fibula group received adjuvant or neoadjuvant radiochemotherapy. Twenty-two procedures were primary reconstructions (DCIA, 12; fibula, 10) and 14, secondary reconstructions (DCIA, 9; fibula, 5).

The study was conducted in accordance with the principles of the Declaration of Helsinki. The Ethics Committee for clinical studies of the Medical Faculty of the Heidelberg University had reviewed and approved the study protocol.

Table 1
Patients' characteristics.

	Iliac crest ($N = 21$)	Fibula ($N = 16$)	Total ($N = 36$)
Male	12	7	19
Female	9	8	17
Tumor type			
Malignant	14	14	28
Benign	7	1	8
Radiotherapy	9	8	17
Reconstruction			
Primary	12	10	22
Secondary	9	5	14
Patients with			
Opposing dentition	19	10	29
Remaining teeth in mandible	19	12	31
Osteosynthesis			
Load bearing	14	8	22
Load sharing	7	7	14

2.2. Bone grafting

Panoramic radiography and computed tomography (CT) were carried out before bone reconstruction. All bone-grafting procedures were performed under general anesthesia.

All mandibular defects were classified according to the HCL method described by Jewer et al. (1989). In this classification, *H* implies the lateral segment including the condyle, *C* represents a defect of the entire central segment with both mandibular canines, and *L*, the lateral segment not including the condyle. Combinations are possible in this classification. Horizontal and vertical defect dimensions were measured in digital panoramic radiographs.

For exact positioning of the graft, the DICOM data preoperatively obtained prior to bone resection was used to fabricate a rapid prototyping model of the mandible. This model was then used to create a prebend osteosynthesis plate to allow graft fixation in an optimum anatomical position during reconstructive surgery (Lethaus et al., 2012).

2.3. Radiographic follow-up

To quantify bone resorption, digital panoramic radiographs (Orthophos XG Plus, Sirona Dental Systems GmbH, Bensheim, Germany) were used for evaluation. The radiographs were taken at the following times: the first evaluation before bone grafting, the second after bone reconstruction surgery, the next prior to and directly after implant surgery, at prosthetic loading, and then at yearly intervals thereafter. If further radiographs existed, the last one was used for the final evaluation. To evaluate early resorption, postoperative reconstruction heights were measured radiographically and compared with the reconstruction heights at the time of follow-up.

For optimum comparability of the measurements, a line approximating the center of three consecutive reconstruction plate screw holes was drawn to allow for the creation of a perpendicular central line permitting bone height measurements at a standard magnification of $\times 1.25$ at a specific location. Measurements were performed in patients with a reconstruction plate in situ as well as in patients who had their reconstruction plates removed, as long as the screw holes were still clearly visible in the radiographs. If the screw holes were no longer noticeable, no further measurements were taken of that particular patient.

To eliminate the risk of bias, all radiographic measurements were performed by the same, independent, blinded examiner (observer blind) who had not been actively involved in the treatment of the patients concerned. For calibration and evaluation of examiner reliability, the radiographs were measured twice on two different days and a mean value was calculated. If the two measurements varied by more than 0.3 mm, a third measurement was performed.

2.4. Implant treatment

Six months after performing reconstructive surgery, the osteosynthesis plate and screws were removed if the general and oncologic situations permitted. For a subgroup of patients desiring implant-retained prosthetic rehabilitation, the planning process was then initiated, using three-dimensional planning software (SimPlant, Materialise Dental, Leuven, Belgium). For those patients not treated with dental implants, the last available CT taken as postoncolgic follow-up was analyzed for the suitability of the graft to retain dental implants, using the same software. The number and location of the inserted implants depended on the bone condition and the prosthetic treatment concept. Implant surgery was performed using a stereolithographic surgical guide. All