

Clinical Paper
Pre-Implant Surgery

Reconstruction of the extremely atrophied mandible with iliac crest onlay grafts followed by two endosteal implants: a retrospective study with long-term follow-up

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G. C. Boven, H. J. A. Meijer, A. Vissink, G. M. Raghoobar: Reconstruction of the extremely atrophied mandible with iliac crest onlay grafts followed by two endosteal implants: a retrospective study with long-term follow-up. *Int. J. Oral Maxillofac. Surg.* 2014; 43: 626–632. © 2013 International Association of Oral and Maxillofacial Surgeons. Published by Elsevier Ltd. All rights reserved.

Abstract. Treatment outcomes of implant-retained lower dentures on two endosseous implants placed in severely atrophied mandibles after reconstruction with iliac crest onlay grafts were assessed in a retrospective observational study. All consecutive patients treated between 2000 and 2007 were recalled in 2012 ($n = 40$). Survival of the implants, the condition of hard and soft peri-implant tissues, and patient satisfaction were scored. One implant was lost after 5.5 years. The mean mandibular symphysis height was 8.9 ± 2.2 , 16.4 ± 2.7 , 15.7 ± 2.7 , and 15.4 ± 2.5 mm at intake, after augmentation, after implantation, and at the last recall visit, respectively. Mean radiographic peri-implant bone loss was 0.6 ± 0.7 mm. Mean clinical index scores were very low. Patient satisfaction was high. Surgical complications related to the donor site were seroma ($n = 1$), haematoma ($n = 2$), and sensory disturbance of the lateral femoral cutaneous nerve ($n = 1$); all had resolved before placement of the implants. Eleven patients reported postsurgical sensory disturbances of the mental nerve, of whom five still experienced some sensory disturbance at the last recall visit. Augmentation of the extremely resorbed mandible with an iliac crest onlay graft followed by placement of two implants 4 months later provides a solid basis for a bar-retained overdenture with favourable clinical and radiographic results.

Key words: edentulous mandible; atrophied mandible; overdenture; retrospective study; dental implant; endosseous implant; bone augmentation; iliac crest; autogenous bone; bone resorption.

Accepted for publication 5 November 2013
Available online 9 January 2014

Currently, dental implants serving as a basis for removable and fixed prostheses are considered a significant tool to reduce problems related to lack of retention of a mandibular denture. In many cases dental implants can be placed without much effort, but in the extremely resorbed mandible, the placement of dental implants still poses a challenge.^{1,2} It has been reported that in extremely resorbed edentulous mandibles, the placement of four 6-mm dental implants provides a solid basis for a bar-retained mandibular overdenture.³ In more extreme cases, reliable implant placement is not possible and an appropriate treatment is to augment the mandible prior to placement of endosseous implants.² Common techniques to augment a mandible are onlay grafts and interpositional grafts.⁴ When applying an interposition technique, materials such as hydroxyapatite can serve as an alternative to autogenous materials (bone, cartilage), either in combination with autogenous bone or even as the only material applied.⁵⁻⁷ For onlay grafts, only autogenous bone has been used as a grafting material to date.

Depending on clinical circumstances, endosseous implants can be inserted during the same session as reconstruction of the resorbed mandible (simultaneous procedure), or after incorporation of the graft (delayed procedure, commonly after 3-4 months).⁸ A major advantage of the simultaneous procedure is that the graft and the implant can be incorporated at the same time, thus eliminating the need for a second operation. An important drawback of this approach is that the positioning and angulation of the implants is more complicated, making it less desirable from a prosthetic point of view.⁹ Another major drawback is the unpredictable resorption of the peri-implant bone in the grafted area.¹⁰⁻¹³ Verhoeven et al.¹⁴ showed that up to 50% of the grafted bone, including the area where the implants were placed, was resorbed within 10 years. Also, van der Meij et al.¹⁵ noted a clinically relevant resorption of the iliac crest onlay graft when applied simultaneously with the two implants (mean follow-up 4.3 years, 15% bone resorption). Therefore, it has been advised that implants be placed 4-6 months after grafting (delayed procedure), as then most of the loss of vertical bone height due to remodeling has already taken place and thus the extent of peri-implant bone loss will be significantly lower.^{9,15,16}

Hypothetically the mandible with a bone onlay graft will resorb to a level comparable to a mandible without implants and an onlay graft.

No studies have yet been published on the long-term treatment outcomes of onlay grafting of the severely resorbed mandible to facilitate implant placement. Therefore, a retrospective observational study was performed to assess the treatment outcomes of lower dentures on two endosteal implants placed in the severely atrophied mandible reconstructed with bone grafts from the iliac crest (delayed approach). The study was done in consecutive patients with a follow-up of at least 5 years.

Materials and methods

Patient selection

All consecutive patients treated between 2000 and 2007 with an iliac crest bone onlay graft and insertion of two implants in the extremely atrophied mandible, with a delayed procedure, were invited by letter to attend the clinic between September 2012 and November 2012 for a recall visit. Patients with a history of radiotherapy to the head and neck region, or a history of pre-prosthetic surgery or previous oral implantology, were excluded from the study.

Forty patients agreed to participate in the study (for details see section "Results"). The institutional review board approved the study. Written informed consent was obtained from all patients. The mean follow-up after fabrication of the prosthetic construction was 6.6 ± 1.2 years (range 5-9 years, median 6.0 years). Surgery and prosthodontics were performed within the same clinic.

Treatment procedure

Panoramic radiographs of one of the patients are shown in Fig. 1. Fig. 2 illustrates the grafting procedure. All patients were treated by the same surgeon (GMR). Immediately preoperatively, broad-spectrum antibiotics (3 g amoxicillin) and 0.5 mg/kg dexamethasone were given intravenously. Under general anaesthesia, a block of corticocancellous bone was harvested, and some additional cancellous bone was taken in a standard fashion from the medial surface of the anterior ilium.¹⁷ Next to this, a low vestibular incision was made. A mucoperiosteal flap was raised towards the top of the alveolar ridge. After identifying the mental foramen on both sides, the flap was raised further to create a sub-periosteal tunnel distal to the mental foramen. Care was taken to avoid the mental nerve, and for this reason the tunnel was placed slightly to the lingual

surface of the mandible. Subsequently, the iliac bone graft was cut with a saw. The resulting corticocancellous bone block was fitted as an interforaminal onlay graft and fixed with two screws (1.5-mm diameter; Martin Medizin Technik, Tuttlingen, Germany; Fig. 1B) to the mandible (Fig. 2A). After grafting, the height of the mandible in the interforaminal area had to be at least 12 mm. The remaining cancellous bone was milled and used to fill the created sub-periosteal tunnel distal to the mental foramen. In this way, a smooth border was created between the grafted interforaminal area and the areas distal to the mental foramen (Fig. 1B). The mucoperiosteal flap was closed, after mobilization, in two layers with 3-0 polyglactin sutures. Postoperatively the patients were instructed to use 0.2% chlorhexidine mouth rinse (1 min, five times daily) for 2 weeks.

Four weeks after surgery, the dental prosthesis was corrected and the patient was allowed to wear it again. After an uncompromised healing period of 4 months, the grafted area was exposed under local anaesthesia and the screws used for fixation of the onlay graft were removed. Subsequently, two endosseous Straumann standard implants (Institute Straumann AG, Basel, Switzerland) with a diameter of 4.1 mm and a length of at least 10 mm were inserted in a one-stage procedure (Fig. 1C).

Two weeks after implant placement, the patient was allowed to wear the dentures again after relieving the denture in the area of the implants and relining it with a resilient material (Soft Liner; GC Corporation, Tokyo, Japan). The patient was given oral hygiene instructions. After a 3-month osseointegration period, a mandibular overdenture retained by a milled titanium bar (Fig. 2B), with gold retention clips attached to it, was made (Fig. 1D). All patients were on a recall schedule of at least once a year after treatment.

Data collection

Outcome measures were implant survival, change in height of the mandible, change in the peri-implant bone level, condition of the soft tissue (plaque index, presence of calculus, gingival index, sulcus bleeding index, and pocket probing depth), and patient satisfaction. Panoramic radiographs were taken for all patients at the recall visit. The other radiographs and data on complications during surgery, postoperative healing (inflammation, wound dehiscence, sequestration and loss of bone particles, and sensory disturbances of the

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