The potential of the horizontal ramus of the mandible as a donor site for block and particular grafts in pre-implant surgery


Abstract. The results on 32 consecutive patients, who underwent bone grafting prior to implant surgery, are presented. The grafts were taken from the horizontal part of the mandible, including the full height of the buccal cortico-cancellous plate and were used to reconstruct alveolar defects or to augment sinus floors. 3–5 months postoperatively, 99 implants were inserted in 43 onlay grafts and in 17 sinus floor augmentations. The follow-up ranged from 2–6 years post implant insertion. Parameters examined included: healing of donor site and bone grafts, implant survival, peri-implant condition, donor site morbidity and patient satisfaction. This study indicates that with one full height ramus graft, alveolar defects comprising a bicuspid–molar area, can be augmented. The grafted volume is also sufficient to augment one sinus floor. The implant survival rate (99%) compares well with studies using iliac crest or skull bone. Postoperative complaints were minimal, resulting in extremely high patient satisfaction (97%).

Keywords: bone grafts; implant surgery; mandible; horizontal ramus; donor site.

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Bone grafts are often used in reconstructive oral and maxillofacial surgery. The choice of donor site largely depends on the amount of bone required. When relatively large areas need to be bridged or defects filled, grafts are mainly taken from the anterior or posterior iliac crest. In pre-implant surgery, small grafts are often needed. Grafts from the mandible are often recommended, mainly from the symphyseal area, the trigonum or the ascending ramus. The advantages of grafts taken from intraoral sites are that morbidity is usually minimal and distant donor sites can be avoided. The drawback is the limited amount of bone available.

Misch described a harvesting technique in which the graft was taken from the horizontal part of the mandible in the area of the oblique ridge. Although readily available using only local anesthesia, this method barely allows enough bone to be harvested for the most common procedures, such as sinus floor augmentation or onlay grafting for narrow ridges. Claervo and Lundgren described a variation of the technique that included an extension of the graft taken from the ramus (Fig. 1).
A technique to harvest larger mandibular bone blocks was introduced by Vincente and Stoelinga.\textsuperscript{20} They suggested including the full height of the horizontal part of the mandible (Figs. 1–3). In this study, comprising 32 patients, the versatility of the harvesting technique is reported including its advantages and disadvantages.

**Material & methods**

**Patient selection**

32 consecutive patients (20 females; 12 males) aged 18–74 years (mean 49.2 years) underwent the procedure either at one site or bilaterally (Table 1). 5 patients smoked 10–20 cigarettes per day and one patient suffered from diabetes type II. Patients who had undergone radiation therapy or received chemotherapy were excluded from the study. The bone was harvested to provide sufficient bone volume to facilitate implant insertion at a second stage. All patients received $2 \times 10^6$ units of penicillin intravenously 30 min before surgery.

**Surgical technique**

Harvesting horizontal ramus grafts may be performed under local or general anesthesia. The procedure begins with an incision along the oblique ridge similar to that used for a sagittal split osteotomy. The horizontal ramus is exposed on the buccal side, stretching from the angle to the mental foramen. Two vertical bone cuts are made through the cortex using a Lindenmann burr, one just posterior to the mental foramen and one as far posterior as needed (Figs. 1 and 2). The latter may run obliquely to extend the amount of bone that needs to be harvested. Subsequently, these vertical cuts are connected by two horizontal cuts. The superior cut can easily be performed using a Lindenmann burr at a level just above the oblique ridge. The inferior cut is made below the mandibular canal at the lower border. Two techniques have been applied to carry out this inferior cut. In the first 20 patients, only a round burr was used. In the subsequent patients, the inferior groove was accentuated, using an ultrasound-driven surgical instrument (Piezzo Surgery\textsuperscript{1}). This made it easier to separate the buccal plate with a chisel. Typically, its inner side often contains some cancellous bone. While mobilizing the fragment, the inferior alveolar nerve may become visible or completely exposed (Fig. 3). The donor site is primarily closed using $3 \times 0$ Vicryl\textsuperscript{1} sutures.

The grafts were stored in 0.9% saline and were either shaped into the desired format to fit the ridge to be augmented or were ground to augment the floor of the sinus. When used as block grafts, the grafts were fixed with at least two 1.5 mm microscrews (Fig. 4). In all sinus floor augmentations the bone particles were mixed with hydroxyapatite or tricalcium phosphate in a ratio of approximately 4:1.

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**Fig. 1.** 3 published methods of bone grafting in the retromolar region.

**Fig. 2.** Clinical pictures before (a) and after (b) the use of a chisel to mobilize the buccal plate.
Implants

After 3–5 months the grafted areas were exposed and the microscrews removed, under local anesthesia in most cases. Two-phase implants were used in all cases, including 68 ITI-Straumann (Straumann, Basel, Switzerland), 16 Branemark Mk III TiU (Branemark, Gothenburg, Sweden), 14 Frialit and 1 IMZ (Dentsply Friadent, Mannheim, Germany). 99 implants were inserted (Table 1). The implants were exposed 3 months later and abutments placed. The prosthetic devices varied from removable dentures to fixed crowns and bridges and were made by specialist dentists.

Follow up

At the last examination, at least 2 years after implant insertion, the implant status was examined using the Mombelli Bleeding Index (mBI). Pocket scores as well as the presence of peri-implant mucositis were also monitored (Table 2). The two-point discrimination test was used to examine nerve-paresthesias (Table 1).

The patients filled out a questionnaire in which they graded pain, complaints (difficulties during chewing, drinking and speaking) and discomfort (postoperative bleeding and swelling), using a visual analogue scale (VAS) (Table 3).

Orthopantomograms were taken for each patient, preoperatively, immediately postoperatively, after 6 months and at the last follow-up. These radiographs were used for measuring bone loss around the implants according to the method proposed by de Wijs et al.22

Results

Of 32 patients, 27 returned the questionnaire and were seen for their last follow-up (84% response). Of the 5 non-respondents, 1 patient died, the other 4 were tracked and interviewed by phone. Their particulars are also presented in Table 1.

43 buccal plates were harvested. In 6 patients the inferior alveolar nerve became visible. In one patient the nerve was positioned in the buccal plate and needed to be mobilized using a freer. Only these 6 patients, reported mild, temporary paresthesia of the mental area. The discomfort and paresthesia appeared to be mild and lasted from 2 weeks to several months. One year postoperatively the paresthesia in all patients had disappeared (Table 1).

In all but one patient, the grafts healed with no clinical sign of inflammation. In the one patient, who underwent a sinus floor augmentation, wound dehiscence occurred at the recipient site combined with the loss of some bone sequesters. In another patient an abscess occurred at the donor site that responded well after incision and drainage.

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**Fig. 3.** After mobilizing the buccal fragment the inferior alveolar nerve may become visible (left). Showing the amount of bone that needed to be harvested (a) after removing the buccal fragment the inferior alveolar nerve (see white arrows) may become visible (b) Harvested bone fragments from the left and right mandibular ramus (c) Cone Beam CT image after the removal of the buccal fragment showing the intact mandibular canal.
The average VAS score (Table 3) shows that 97% patients were satisfied with the treatment and preoperative information; only 2 patients indicated that the treatment had not met their expectations. This was demonstrated in the returned VAS and appeared to be related to temporary hypoesthesia of the inferior alveolar nerve in one case, while the other patient had infection at the donor site.

The follow-up data for the 27 patients are summarized in Tables 1–3. All implants were in place in the 27 patients examined. In one patient, one implant appeared not to be integrated in bone after 3 months. It was immediately replaced in a different location, where it healed without problems. In the four patients, who did not return for the last examination, all implants were still in place, as indicated by telephone.

Peri-implant conditions appeared to be healthy in most cases (Table 2), only 8 implants had a pocket of more than 5 mm (8%). No patients with overt signs of peri-implantitis were observed. Radiographic measurements on the last follow-up orthopantomograms revealed, that marginal bone loss was seen around only 2 implants (Table 2).

The results of this follow-up study revealed a high degree of patient satisfaction (97%) and survival rate of the implants (99%) at a mean survival time of 51.7 months. Statistical evaluation was hampered by the small number of patients in the study. Most variables seemed not to be suitable for any clinical relevancy. As a result, no statistically supported conclusions could be drawn.

**Discussion**

The bone grafts taken from the horizontal part of the mandible appeared to be functioning well, providing sufficient volume to insert implants in a selected patient group. Bilateral grafts appeared to be sufficient for both sinus floor augmentation and onlay grafting of maxillary or mandibular atrophic processes (Fig. 4). This technique is also suitable to augment a narrow mandibular alveolar ridge, for instance after tooth loss because of trauma. The limitation is the available height of the horizontal ramus of the mandible. Other donor sites are indicated when the whole mandible is atrophic or when relatively large areas are to be augmented.

The unwanted side effects, in particular paresthesia of the inferior alveolar nerve, appeared to be limited and temporary. It is recommended that the buccal fragment be mobilized with great care to avoid serious nerve damage. In case the nerve appears to be caught in the buccal fragment, it might be advisable to stop the procedure and fix the fragment back in its original position. All patients were forewarned that in case this happened, the surgeon would take the anterior iliac crest as a donor site. The authors have experienced one such case. Modern 3D imaging techniques can accurately depict the course of the inferior alveolar nerve, which may avoid these unwanted occurrences (Fig. 3).
The advantages of mandibular bone grafts over other distant bone grafts are obvious. They also apply to the use of calvarial bone grafts, promoted by various authors.4,16,19 The advantage of the horizontal ramus over the chin as a donor site is that there is more bone available. The morbidity of bone grafts from the chin includes limited mobility of the vestibulum in the symphyseal area, numbness of the mandibular incisors and decreased sensitivity of the chin.1 Authors report persistent sensitivity disturbances from 20 to 50% in the chin area of the patients treated.3,6,10,15,17

Table 2. Scores for Modified Bleeding Index (mBI), Modified Plaque Index (mPlI) and marginal bone loss.

<table>
<thead>
<tr>
<th></th>
<th>Modified Plaque index (mPlI)</th>
<th>Modified Bleeding index (mBI)</th>
<th>Marginal bone loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score</td>
<td>Score 0: no plaque</td>
<td>Score 0: no bleeding</td>
<td>Score 0: less than 1/4 from implant length</td>
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<tr>
<td></td>
<td>Score 1: plaque detection with probing instr.</td>
<td>Score 1: isolated light bleeding</td>
<td>Score 1: between 1/4 en 1/2 from implant length</td>
</tr>
<tr>
<td></td>
<td>Score 2: visual detection of plaque</td>
<td>Score 2: a visible bleeding line</td>
<td>Score 2: between 1/2 en 3/4 from implant length</td>
</tr>
<tr>
<td></td>
<td>Score 3: large amount of plaque</td>
<td>Score 3: large amount of bleeding</td>
<td>Score 3: more than 3/4 from implant length</td>
</tr>
</tbody>
</table>

Table 3. Averages and standard deviations from the Visual Analogue Scale (VAS) scores.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. dev.</th>
</tr>
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<tbody>
<tr>
<td>pain</td>
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<td>2.88</td>
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<tr>
<td>complaints</td>
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<td>4.48</td>
<td>3.18</td>
</tr>
<tr>
<td>discomfort</td>
<td>27</td>
<td>4.51</td>
<td>3.14</td>
</tr>
<tr>
<td>Treatment Satisfaction (%)</td>
<td>27</td>
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<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td>93</td>
<td>7</td>
</tr>
</tbody>
</table>

Pain: 0 = no pain; 10 = intense pain; Complaints (problems with chewing/drinking/speaking): 0 = no complaints; 10 = many complaints; Discomfort (bleeding, swelling): 0 = no complaints; 10 = many complaints. Treatment satisfaction shows the percentage of satisfied and dissatisfied patients. Legend: Visual Analogue Score (VAS) comprising 27 patients, including the Mean and Standard deviation (Std. Dev.) The Treatment Satisfaction shows the percentage of (dis)satisfied patients.

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The implant survival rate reported in the present study compares well with those reported in studies using anterior iliac crest bone grafts: 83–99%1,8,18 and calvarial bone grafts: ±95%.5,16 There appeared to be no differences in implant survival between the 5 smoking and 27 non-smoking patients, although in one patient (nr 7) two pockets of more than 5 mm were measured (Table 1).

In conclusion, the current study clearly shows the benefits of the horizontal ramus area as a donor site. A randomized double blind study is necessary to define whether these benefits are significant compared with other donor sites. Ethical reasons may prevent such a study.

References


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