Ramus or Chin Grafts for Maxillary Sinus Inlay and Local Onlay Augmentation: Comparison of Donor Site Morbidity and Complications

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ABSTRACT

Background: The placement of endosseous implants in edentulous areas is frequently limited by inadequate bone volume of the residual ridge. Local bone grafts from the mandible are a convenient source of autogenous bone for alveolar reconstruction prior to implant placement.

Purpose: The aim of the present study was to document and compare the morbidity and the frequency of complications occurring at two intraoral donor sites: the mandibular symphysis and the mandibular ramus.

Material and Methods: This study reviewed 53 consecutively treated patients: 29 with autogenous bone grafts from the mandibular symphysis and 24 with mandibular ramus bone grafts. Each patient received a questionnaire 18 months after surgery regarding problems that may have occurred during the postoperative period.

Results: In the patients in whom bone was harvested from the mandibular ramus, there were fewer postoperative symptoms immediately after the operation than with mandibular symphysis harvesting. Twenty-two of the 29 patients with symphysis grafts experienced decreased sensitivity in the skin innervated by the mental nerve 1 month after the operation. Five of the 24 patients with ramus grafts experienced decreased sensitivity in the vestibular mucosa corresponding to the innervation of the buccal nerve.

Eighteen months after the surgery, 15 of the 29 patients in the symphysis group still had some decreased sensitivity and presented with permanent altered sensation. Only one of the patients grafted from the mandibular ramus presented with permanent altered sensation in the posterior vestibular area. No major complication occurred in the donor sites in any of the 53 patients.

Conclusion: The results of this study favored the use of the ascending mandibular ramus as an intraoral donor site for bone grafting.

KEY WORDS: autogenous bone, bone graft, chin, mandibular ramus, mandibular symphysis, maxillary sinus

Implant reconstruction of edentulous patients has been successful and predictable in cases where sufficient bone volume, adequate bone quality, and desired bone location have been satisfactory. However, initial stabilization is often difficult to achieve in the maxillas when the cortical bone is very thin or absent because of severely resorbed alveolar ridges. In the case of pneumatized maxillary sinuses, the total width and height of bone are often inadequate for initial stabilization of the implants.

The use of osseointegrated implants together with autogenous bone grafts was first discussed by Bränenmark and colleagues and is still considered the gold standard for implant rehabilitation. The reconstruction of severely resorbed edentulous maxillae to accommodate endosteal implants has been the subject of many studies. One approach to this clinical problem is to transform part of the maxillary sinus into a bone-filled area prior to the placement of the implants, a procedure first described by Boyne and James.

Many extraoral donor sites for implant reconstruction have been investigated and described in the literature. However, the use of extraoral donor sites
involves extensive surgery and requires hospitalization of the patient. Wood and Moore were the first to discuss procuring autogenous bone from intraoral sites for maxillary grafting. The proximity between donor and recipient sites and the reduced operative and anesthesia times are obvious advantages of using bone grafts from an intraoral site.

Donor site morbidity is one of several important factors that must be considered when harvesting bone. Other factors to take into account are the amount of bone required, the type (cortical or cancellous) of bone needed, the recipient site, and the expected biologic behavior (neovascularization and resorption).

The purpose of this study was to evaluate two intraoral donor sites, the mandibular symphysis and the ascending mandibular ramus, with regard to their morbidity and frequency of complications after performing harvesting procedures.

**MATERIALS AND METHODS**

**Patient Selection**

Fifty-three patients, 28 women and 25 men with a mean age of 48 years (range 22–71 yr), were included in this study. Twenty-seven of the patients underwent maxillary sinus inlay augmentation and 26 had local onlay augmentation. All patients were treated at the Department of Oral and Maxillofacial Surgery, Umeå University, by the same surgeon. All patients needing inlay augmentation presented with severe posterior maxillary alveolar atrophy, diagnosed from preoperative panoramic radiographs and tomograms. Patients subjected to local onlay augmentation presented with insufficient alveolar width.

In the first 29 patients to undergo surgery, the grafts were harvested from the chin; the subsequent 24 patients had grafts harvested from the ramus (Table 1).

**Surgical Techniques**

**Symphysis Graft Harvest.** Prior to the surgical procedure, all patients received 2 g of penicillin V and 600 mg of ibuprofen. Harvesting of the corticocancellous chin graft was performed under local anesthesia with rectal and intravenous diazepam conscious sedation. Lidocaine (2%) with epinephrine (1:80,000) was infiltrated in the mandibular labial vestibule and was also used for mandibular blocks. The mandibular symphysis was then exposed through a two-layer incision made between the deepest part of the vestibule and the lip. Mental nerve foramina were also exposed to increase bone access area when bone was harvested for the purpose of maxillary sinus antral augmentation; for local onlay grafts, the mucosal incision was limited to the area between the canines. An osteotomy was performed using a micromotor oscillating saw with a rectangular blade, creating a unicortical (labial cortex) cut (Figure 1). The cuts were made at least 5 mm inferior to the root tips and 4 mm superior to the mandibular inferior border. The bone transplant was divided in the middle and harvested with an osteotome. It was stored in blood-soaked gauze until particulated with a surgical bone mill. The lingual cortical plate was left intact to avoid alteration of anatomic structures in the floor of the mouth and the inherent risk of bleeding. The residual symphyseal cavity was then packed with a collagenous cotton sponge. The periosteum and muscle attachments were carefully sutured in one layer, and the mucosa was closed as a second layer using resorbable sutures.

**Ascending Ramus Graft Harvest.** All patients received the same type and dosage of antibiotics, sedation, and local anesthesia as in the above technique. The concavity formed by the border between the ascending ramus and the external oblique ridge was identified and used as a donor site. The mental nerves and their foramina were exposed to increase bone access area when bone was harvested for the purpose of maxillary sinus antral augmentation; for local onlay grafts, the mucosal incision was limited to the area between the canines. An osteotomy was performed using a micromotor oscillating saw with a rectangular blade, creating a unicortical (labial cortex) cut (Figure 1). The cuts were made at least 5 mm inferior to the root tips and 4 mm superior to the mandibular inferior border. The bone transplant was divided in the middle and harvested with an osteotome. It was stored in blood-soaked gauze until particulated with a surgical bone mill. The lingual cortical plate was left intact to avoid alteration of anatomic structures in the floor of the mouth and the inherent risk of bleeding. The residual symphyseal cavity was then packed with a collagenous cotton sponge. The periosteum and muscle attachments were carefully sutured in one layer, and the mucosa was closed as a second layer using resorbable sutures.

**Figure 1** Mandibular symphysis (chin) donor area.

<table>
<thead>
<tr>
<th>Type of Graft</th>
<th>Donor Site</th>
<th>Total No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sympyysis</td>
<td>Ramus</td>
</tr>
<tr>
<td>Inlay</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Onlay</td>
<td>17</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>24</td>
</tr>
</tbody>
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as a starting point for the mucosal incision. The incision was made medial to the external oblique ridge in an anterior direction and terminated in the first molar area to avoid interference with the mental nerve branches. The external oblique ridge was dissected free and a ramus retractor was placed on the ridge; by pulling the retractor, the overlying soft tissue was pushed along the ascending ramus until the insertion of the temporal muscle fibers was identified. A ramus clamp was secured over the coronoid process. The lateral surface of the mandibular ramus was exposed by blunt dissection, and the periosteum was kept out of the way with a toe-out retractor.

The exposed bone area was then evaluated in terms of the amount needed. The margins of the block of bone to be harvested were outlined by holes drilled through the cortex with a small round bur (Figure 2).

The superior/sagittal osteotomy was performed with a microreciprocating saw, medial to the oblique ridge. Just the tip of the saw was used to avoid interference with underlying anatomic structures. Size requirements of the bone graft and the anatomy of the inferior alveolar canal determined the anterior extension (Figure 3).

The posterior vertical osteotomy was then performed with the same saw. The anterior vertical osteotomy was performed with a thin fissure bur, just cutting through the cortex until the cancellous bone was identified by marrow bleeding. The inferior osteotomy was not made completely through the cortex. With a large round bur and a long shaft in a straight handpiece, a groove was created to undermine the lateral cortex so that a fracture would occur at a particular level. This level was able to be modified to predetermine the size of the corticocancellous bone graft (see Figure 3).

After completing all osteotomies, the lateral mandibular bone was fractured off with the aid of one flexible and one stiff straight chisel. The bone block was carefully lifted to ensure that the inferior alveolar nerve was not trapped within the graft.

The harvested bone was stored in blood-soaked gauze until particulated with a surgical bone mill. The donor area was filled with a collagen cotton sponge for local hemostasis and closed with a running suture through the mucosa.

Maxillary Sinus Augmentation Graft. The sinus area was prepared following the technique previously described by Wood and Moore. After infiltration of the area with local anesthesia, an incision was made along the horizontal portion of the palatal vault to avoid exposure of the grafted area in the event of wound dehiscence. The lateral wall of the maxillary sinus was then exposed, and a bone window was outlined with a round bur. Care was taken not to lacerate the sinus membrane. The outlined portion of the lateral wall was then removed. The sinus membrane was carefully elevated through the osseous cut using a sinus elevator. The maxillary sinus was divided into two com-
partments, the superior portion of the maxillary sinus and the recipient site. The harvested corticocancellous bone was particulated and then packed, filling the entire compartment.

**Maxillary Local Onlay Graft.** The recipient area was prepared by flattening the surface and perforating the cortical bone to enhance the local vascularization. The harvested corticocancellous bone block was trimmed to fit to the recipient site and was fixed to the underlying bone with one or two titanium screws. A lag screw technique was used with 2 mm by 11 to 15 mm screws to ensure bicortical stability in the residual alveolar crest.

The graft was extensively perforated with a thin twist drill to enhance the blood supply. Excessive periosteal cuts were made to ensure there would be sufficient length of the mucosal flap to avoid pressure on the grafts, ischemia in the flap, and the risk of wound dehiscence.

**Implant Surgery**

Six months after the grafting procedure the patients were scheduled for implant surgery. Bränemark® Standard or Mark II titanium implants (Nobel Biocare AB, Gothenburg, Sweden) with a turned surface were used without pretapping, according to a standard protocol.

**Questionnaire**

All 53 patients were asked to participate in a retrospective clinical study. A questionnaire with 20 questions was created and sent to the patients. The questionnaire was designed to assess patient perception of recovery in different areas: pain, oral function, and other signs and symptoms. Pain was measured in intensity and duration and was contrasted with the type and frequency of analgesics required. Questions regarding oral function pertained to speaking, chewing, opening the mouth, eating, and drinking. Other signs and symptoms included the presence of sensory impairment and its distribution and description. The presence of swelling, bleeding, bruising, and possible infections was also noted. In the final questions, patients were asked if the treatment had met their preoperative expectations and whether they would consider undergoing the same treatment again, if necessary.

The questions were set in both multiple choice and verbal formats and were separated in three groups, referring to the period immediately, 1 month, and 18 months after the operation.

To estimate convergent validity, answers referring to the days immediately following the operation were compared with information collected from the patient charts at the time of suture removal 2 weeks postoperatively.

Those patients who did not answer the questionnaire at the first request were sent a second questionnaire 3 weeks later. Those who did not answer the second questionnaire were contacted by telephone. All 53 patients eventually completed the questionnaire.

**RESULTS**

For the period immediately after the operation (0–2 wk), a variety of answers concerning pain were noted. Intensity and duration of pain seemed to be more pronounced in those patients receiving grafts from the chin area; in addition, their need for analgesics was higher (Figure 4). Functional limitations in speaking, eating, and drinking were experienced equally by both groups, but mouth opening and chewing were reported to be more difficult for patients receiving grafts from the ramus. Swelling was

![Figure 4](image-url)
an expected complication that most patients experienced. Bleeding, bruising, and bad taste/breath had a negligible incidence in both groups. Altered sensation was reported much more frequently (22 of 29 patients) in patients receiving grafts from the chin area than in patients who received a ramus graft (5 of 24) (Figure 5). No infections occurred in either group.

At 1 month after the operation, none of the 53 patients reported persistent pain. There were no reports of symptoms other than the persistence of altered sensation in the 27 patients who had reported paresthesia during suture removal. Twenty-two patients in the "symphysis group" experienced altered sensation in the mental and lower lip area, and five patients in the "ramus group" experienced altered sensation localized in the region of the buccal nerve terminal branch. Oral function was affected minimally or not at all in the treated patients.

At 18 months after the operation, oral function was completely reestablished in all patients. Altered sensation was considered permanent in 15 of the patients in the symphysis group and in 1 of the ramus group patients (see Figure 5).

Ten of 29 symphysis group patients reported changes in the chin contour; however, this could not be verified by clinical examination. There were no complaints of contour change from the patients whose bone had been harvested from the ramus.

In patients grafted with an inlay sinus augmentation, two to three titanium implants were placed successfully in each sinus graft. In those patients receiving an onlay graft, the required number of implants were able to be inserted. Upon comparison of the two donor site groups, no significant difference in implant failure was noted. Results of implant success and clinical follow-up will be published at a later time.

Of the 53 patients receiving grafts, 48 felt that the treatment had met their pretreatment expectations, and 50 stated that they would consider undergoing the same process again, if necessary.

**DISCUSSION**

Of the 27 patients who complained of altered sensation 1 month after surgery, 22 belonged to the symphysis donor site group and 5 to the ramus donor site group.

Eighteen months after the bone reconstructive surgery, the oral function was completely reestablished with the exception of persistent altered sensation in 16 patients, who are considered to have permanent impaired nerve function. Fifteen of these patients were from the symphysis group, and the impaired nerve function was related to the mental nerve branches. One patient from the ramus group complained of impaired nerve function in the vestibular area, corresponding to the premolar and molar areas on the harvested site, which is the location of the terminal branches of the buccal nerve. This nerve complication may have been caused by the retraction of the soft tissue over the ascending ramus of the mandible. Anatomic variations of the buccal nerve have been reported and might explain the impaired function of the buccal nerve after surgery.20

Inspired by the publication of Wood and Moore,19 we began performing augmentation of the maxillary sinus and local onlay grafting with autogenous mandibular bone from the chin.21,22 Some patients complained of stiffness and limited mobilization of the vestibulum in the anterior mandibular area during the postoperative period.
period. Some also complained of numbness in the anterior mandibular incisors and canines and decreased sensitivity in the innervation area of the terminal mental nerve branches. For these reasons we began investigating other possible intraoral bone harvesting areas that would be more predictable in the postoperative period. Because of our extensive experience with mandibular ramus surgery in orthognathic corrections, we identified this as our target area. Our first experience was promising; there were few complaints from the patients in the postoperative period. However, the bone volume was initially less than that harvested from the mandibular symphysis. We modified the technique, mainly by increasing the access of the inferior mandibular body area, by using a long-shafted round bur to create a groove instead of an inferior border osteotomy. In this way, the accessible bone for harvest was increased to a volume much more than that possible from the mandibular symphysis. This is a striking difference from the results obtained in a study by Misch, who found that the available amount of bone volume was higher in the mandibular symphysis than in the ramus. The inconsistent findings must be owing to differences in the surgical techniques used.

Bone harvesting from intraoral sites (both the chin and the mandibular ramus) for maxillary sinus augmentation has been investigated prior to now. However, these investigations focused more on the augmentation of the maxillary sinus than on donor site morbidity. In a retrospective study, Raghoebar and colleagues found that after 3 years of harvesting bone from the chin, half of the 20 patients reported decreased sensitivity in the donor area. In a prospective study evaluating objective and subjective superficial sensory function in the postoperative 12 months, Nkenke and colleagues concluded that patients have to be informed extensively about disturbances of the inferior alveolar nerve function, which can last >12 months when bone has been harvested from the chin.

In the present study, two patients had bilateral maxillary sinus floor augmentation with bone from one ramus only, and another patient had a combination sinus inlay/local onlay graft. Currently, a bilateral maxillary sinus inlay graft is routinely taken from one ramus only, without an increase in donor site morbidity or complication rates (Figure 6).

This is considerably different from the harvesting of the symphysis area. First, it is difficult to obtain enough bone from the mandibular symphysis area to use for a bilateral maxillary sinus augmentation. Second, when harvesting bone from the symphysis, the amount of bone obtained is directly proportional to the occurrence and persistence of morbidity and complications, whereas the volume of bone harvested from the mandibular ramus does not seem to be related to the morbidity or complications experienced (Table 2).

**CONCLUSION**

Although the accessibility of the mandibular symphysis area seems to be better than that of the mandibular ramus, a greater amount of bone with higher density and more cortical content can be harvested with less morbidity and fewer complications from the ramus.
TABLE 2 Altered Sensitivity Related to Symphysis and Ramus Harvesting for Local Onlay Grafts (Minor) and Maxillary Sinus Inlay Grafts (Major)*

<table>
<thead>
<tr>
<th>Type of Graft</th>
<th>Symphysis (%)</th>
<th>Ramus (%)</th>
<th>Permanent</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>At 1 Mo</td>
<td></td>
<td>At 1 Mo</td>
</tr>
<tr>
<td>Inlay</td>
<td>12/12 (100.0)</td>
<td>3/13 (23.0)</td>
<td>8/12 (66.7)</td>
</tr>
<tr>
<td>Onlay</td>
<td>10/17 (58.8)</td>
<td>2/11 (18.1)</td>
<td>7/17 (41.2)</td>
</tr>
<tr>
<td>Total</td>
<td>22/29 (75.9)</td>
<td>5/24 (20.8)</td>
<td>15/29 (51.7)</td>
</tr>
</tbody>
</table>

*Numbers represent those affected out of total in group receiving graft harvested from the mandibular ramus.

REFERENCES


