Use of the sandwich osteotomy plus an interpositional allograft for vertical augmentation of the alveolar ridge

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SUMMARY. Introduction: Vertical augmentation of the alveolar ridge is necessary for extensive resorption of the alveolar ridge. Aim: To evaluate treatment outcome after alveolar ridge augmentation by a sandwich osteotomy combined with an interpositional allograft. Patients and Methods: The deficient alveolar ridges were augmented by a sandwich osteotomy combined with bovine collagen matrix as an interpositional allograft placed between the basal bone and the osteotomized fragment without fixation. Standardized lateral cephalographs were taken of nine patients, before surgery, immediately postoperatively and 3 months after augmentation to evaluate the level of augmentation, bone loss and stability of the osteotomized fragment. Results: The augmentation ranged between 8.4 and 11.0 mm (mean 9.8 mm). Bone resorption in the crestal bone height ranged from 1.5 to 3.0 mm (mean 2.1 mm) after 3 months. Bone resorption in thickness of the osteotomized fragment ranged from 0.3 to 2.0 mm (mean 1.0 mm). Conclusion: Although there was some resorption of the superior and anterior parts of the reconstructed alveolar process, it was concluded that this procedure of augmentation is safe. © 2003 European Association for Cranio-Maxillofacial Surgery.

Keywords: Sandwich osteotomy; Allograft; Ridge augmentation

INTRODUCTION

Vertical augmentation of the alveolar ridge is necessary for patients with extensive resorption of the alveolar ridge in order to make aesthetic and prosthetic rehabilitation and enable implant insertion. Horizontal osteotomy with the interposition of bone in the form of a ‘sandwich’ to augment the alveolar ridge has been described before (Schettler, 1976; Stoelinga et al., 1978; Stellingsma et al., 1998). This offers the advantage of guaranteeing a greater vascular supply to the inlay graft. It allows optimum use of the basal bone, which is less prone to resorption (Zins et al., 1984; Stellingsma et al., 1998). However, this technique involves donor site morbidity (Misch and Misch, 1995; Misch, 1996), as autogenous bone is used as the interpositional material. The following report describes the treatment outcome after alveolar ridge augmentation by a sandwich osteotomy combined with an interpositional allograft.

PATIENTS AND METHODS

Nine consecutive patients (six men and three women) aged between 16 and 51 years (mean 34 years) were enrolled in this study. All patients were referred to us for treatment of an atrophic mandible. Seven patients had local alveolar ridge defects following fractures and two had defects following the traumatic loss of a single tooth (Table 1). All patients were treated by a segmental mandibular sandwich osteotomy combined with an interpositional allograft. An horizontal incision was made approximately 5 mm above the mucogingival reflection in the labiobuccal gingiva in the edentulous area. A flap was raised without detaching the lingual mucoperiosteum to expose the anterior wall of the atrophic mandible. Subsequently, on each side vertical cuts were made in the upper third of the mandibular bone with a fissure bur. These cuts were connected horizontally with an oscillating saw. The osteotomy lines were inclined slightly downward towards the lingual soft tissues. The segment was moved superiorly after all bone cuts were completed. Care was taken to maintain the soft-tissue pedicle on the lingual surface. A bovine collagen matrix (Osteovit, Braun Melsungen, Melsungen, Germany) was placed as an interpositional graft, without fixation, between the residual basal bone and the mobile

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Table 1 – Patient data

<table>
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<th>Patient number</th>
<th>Location of defect*</th>
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<tr>
<td>1</td>
<td>31</td>
<td>9.5 mm</td>
</tr>
<tr>
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</tr>
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</tr>
<tr>
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<td>41</td>
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</tr>
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<tr>
<td>9</td>
<td>31,32,41,42,43</td>
<td>9.6 mm</td>
</tr>
</tbody>
</table>

*Fédération Dentaire Internationale tooth numbering system.
The mucosa was meticulously closed with 3.0 Vicryl mattress sutures. Clinical examination was carried out 1 week, 1 month, and 3 months after augmentation including visual examination of the soft tissues for signs of inflammation or suture breakdown and a qualitative evaluation of the oral vestibule. Sensory changes of the lip and chin were evaluated by touching the skin with a cotton pellet. To evaluate postsurgical changes of both the osteotomized fragment and the interpositional allograft, standardized lateral cephalographs were taken from each patient prior to surgery, immediately and 3 months after augmentation. The outline of the mandible was traced from each cephalometric radiograph. The following points were identified on the radiographs: the top of the osteotomized fragment, the most anteroinferior point of the osteotomized fragment, the most posteroinferior point of the osteotomized fragment, the most anterosuperior point of the allograft, and the most anteroinferior point of the graft. The following parameters were measured (Fig. 2): the height of the osteotomized fragment (shortest distance between the top of the osteotomized fragment and the base of the fragment); the width of the osteotomized fragment (distance between the most anteroinferior and posteroinferior points of the fragment); and the height of the graft (distance between the most anterosuperior and anteroinferior points of the graft). The stability of both the osteotomized fragment and the graft was assessed by evaluating the changes in those parameters. The Wilcoxon signed rank test for paired samples was used to calculate statistical differences between immediately and 3 months after ridge augmentation.

RESULTS

The postoperative course was uneventful in seven of the nine patients. In the remaining two patients, a small dehiscence of the mucosa was observed at the marginal ridge of the mobilized fragment. This defect healed uneventfully after local debridement under local anaesthesia. In four out of the nine patients the alveolar mucosa on the labiobuccal vestibule had moved upward together with the mobilized segment resulting in a shallow vestibule. However, the mucosa on the lingual side over the augmentation site appeared unaffected in all patients. No patient suffered from hypoaesthesia in the region supplied by the mental nerve.

The augmentation achieved for each patient is listed in Table 1. The augmentation ranged from 8.4 to 11.0 mm (mean 9.8 mm). Bone resorption and stability of the osteotomized fragment is listed in Table 2. Immediately after augmentation, the height of the osteotomized fragment ranged from 11.2 to 15.1 mm (mean 12.5 mm), and the thickness of the fragment ranged from 9.2 to 14.1 mm (mean 12.4 mm). Three months after augmentation, the height of the fragment ranged from 9.1 to 12.8 mm (mean 10.4 mm), and the thickness of the fragment ranged from 8.2 to 13.5 mm (mean 11.4 mm). Statistically significant differences were detected from immediately postoperatively and 3 months after augmentation, indicating that there was bone resorption during the observation period. In all patients, bone resorption involved the superior–anteroinferior site of the fragment (Fig. 3). As for the interpositional allograft, the height of the graft ranged from 8.4 to 11.0 mm (mean 9.8 mm). There was no difference in height of the allograft from immediately postoperatively up to 3 months after ridge augmentation, indicating that there was no resorption of the interpositional graft during the observation period. There were no changes in the basal bone in any patient. Radiolucency was still noted in the augmentation gap 3 months after augmentation. However, its radiopacity had increased gradually when compared with the findings made 4 weeks after augmentation.
DISCUSSION

Panoramic radiographs were used to assess the level of bone loss in previous follow-up studies evaluating the postoperative healing after vertical augmentation of the deficient alveolar ridge (Stoelinga et al., 1978; Stellingsma et al., 1998), even though it may be impossible to measure the level of bone loss with panoramic radiographs due to its lack of sharpness and image distortion (Geertman et al., 1996). In this study, cephalometric radiographs were used to assess the amount of postoperative bone loss at the augmentation sites. It has been shown that errors in cephalometric measurements are very small when using a superimposition technique (Houston et al., 1978; Rondhal et al., 1988). In this study, the contours of the basal bone and of the fragment were well defined, hence, it was possible to superimpose the tracings of the mandible precisely.

Vertical augmentation of the deficient alveolar ridge has been achieved by onlay grafts, interpositional grafts or distraction osteogenesis (Becker et al., 1996; Feichtinger et al., 2003). Onlay augmentation methods using autogenous free bone grafts to restore the vertical dimension of the alveolar ridge have shown high resorption rates of up to 50% (Von Arx et al., 1996). Augmentation procedures using interposed bone have been evaluated over many years and appear to be reliable (Stoelinga et al., 1978; Stellingsma et al., 1998). The data in the present study verify that the interpositional graft method reduces the amount of bone loss. Resorption of the superior–anterior parts of the fragment was observed in all patients. The level of bone height loss ranged from 1.5 mm (18%) to 3.0 mm (28%) within 3 months following augmentation, and in terms of fragment thickness loss from 0.3 to 2.0 mm. It appears that some resorption of the fragment cannot be avoided, possibly as a result of the poor blood supply to the fragment due to elevation of the mucoperiosteal flap, and to the osteotomy of the remaining alveolar bone. It is important to elevate the periosteum as little as possible when using this technique. In addition, augmentation should be slightly exaggerated to compensate for resorption. The resorption rates observed in this study are similar to those reported in studies where distraction osteosynthesis was performed. Augmentation using distraction osteogenesis have shown that 0.9–3.0 mm of resorption in the crestal bone height occurs (Block et al., 1996; Oda et al., 1999; Urbani et al., 1999; Jensen et al., 2002; Raghoebar et al., 2002). Distraction osteogenesis has several advantages: no need for bone harvesting; avoidance of donor site morbidity; vital bone in the distraction area; and gain of soft tissue. However, the failure of augmentation due to infection was a major disadvantage (Oda et al., 1999, 2000). Distraction osteogenesis has some more disadvantages: The need for absolute compliance of the patient and his/her family is of utmost importance (for daily rotation of the distraction screws), also, close and frequent follow-up is necessary. Thus a major advantage of

<table>
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<th>Patient number</th>
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<tbody>
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<td>Immediately after augmentation</td>
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<td>Immediately after augmentation</td>
<td>3 months after augmentation</td>
</tr>
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<td>Mean ± SD</td>
<td>12.5 ± 1.2</td>
<td>10.4 ± 1.1*</td>
<td>12.4 ± 1.5</td>
<td>11.4 ± 1.6*</td>
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</table>

*Values are given in mm, p < 0.01.
interpositional graft methods over distraction osteogenesis is the reduced need for compliance. A further advantage of interpositional grafting is that less infection is likely as well as the patient being able to wear a mandibular prosthesis. In our cases, where a dehiscence of the mucosa was observed, the mucosa healed uneventfully after local debridement, and the graft materials were never lost. This appeared to be due to the graft materials being placed beneath the vascularized bony fragment. However, the disadvantage of this method is that there is a possibility of a shallow vestibule. Four out of the nine patients had reduced lower sulcus depth following augmentation, requiring a later vestibuloplasty.

In this study, the mobilized fragment was not fixed using osteosynthesis or by implants. The bovine collagen matrix was placed beneath the fragment and maintained its position. There was a concern that this would be insufficient to achieve stability of the fragment, but this was not the case. Cephalometric evaluation confirmed that the position of the fragment did not change after alveolar augmentation. This stability was attributed to the fact that bovine collagen matrix has excellent mechanical properties for stabilizing the fragment. Its rigidity prevents collapse and its stability prevents a graft displacement. Therefore, mechanical graft stability, an essential prerequisite for graft integration, was guaranteed. The matrix could easily be adapted to the augmented space, as it can be shaped and trimmed as necessary.

This study encourages further investigation of the sandwich osteotomy plus interpositional allograft for augmentation of the alveolar ridge. Since the findings relate to a small number of patients, further studies with a larger number as well as the morphofunctional analyses of biopsies may be necessary to determine the ultimate treatment of choice for vertical augmentation of the alveolar ridge.

CONCLUSION

Although the operative procedure of a sandwich osteotomy combined with interpositional allografts leads to some resorption of the superior and anterior parts of the alveolar fragment, it was concluded that this method is safe.

Acknowledgements

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