Bone Grafting of Cleft Lip and Palate Patients for Placement of Endosseous Implants

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Objective: **Fixation of a prosthesis or single tooth replacement using osseointegrated implants has the potential to overcome functional and psychological inconveniences that many patients experience from such appliances. However, the dimensions of the recipient site are relatively often inadequate for implant placement. This study assessed grafting of this site with autogenous bone as a solution for the latter problem.**

Methods: **Ten cleft lip and palate patients had bone grafts; six had iliac crest grafts to the maxillary sinus floor (31 implants), and four had chin bone grafts to the local defect in the anterior maxilla (six implants). Implants were inserted during the grafting procedure (one patient) or after 3 months (nine patients).**

Results: **No inflammation of the bone grafts or the maxillary sinus occurred. One implant was lost during the healing phase. Four single tooth restorations, one fixed bridge, and five implant-supported overdentures were made. During the follow-up, which was 47 months (range, 28 to 65 months) in the anterior maxilla group and 56 months (range, 28 to 68 months) in the posterior maxilla group, no loss of implants was observed, and all prosthetic appliances functioned well.**

Conclusions: **It is concluded that bone grafting followed by placement of dental implants can serve as a reliable alternative for conventional prosthetic rehabilitation of cleft patients.**

KEY WORDS: *bone grafting, endosseous implants, prosthesis*

Lack of support of an upper denture and lack of peripheral seal, leading to insufficient retention and stability, are important complicating factors in the prosthetic rehabilitation of edentulous cleft lip and palate (CLP) patients. In dentulous CLP patients, lateral incisors and other teeth often show malformations or are congenitally missing. Depending on the actual dentulous condition, the treatment options mostly applied are orthodontic space closure and conventional prosthodontic rehabilitation with a removable or fixed prosthesis. The orthodontic treatment option may give rise to transversal discrepancy problems and poor esthetics. Fabrication of an appropriate removable or fixed prosthesis is often difficult for esthetic reasons, especially because of the defect of the alveolar ridge. This has resulted in functional and psychological problems for many patients.

Dental implants can be used for fixation of the prosthesis or for single tooth replacement with predictable success. They provide a proper treatment alternative to conservative prosthetics. However, for reliable insertion, the height and width of the alveolar bone at the implantation site must be sufficient. In noncleft patients, augmentation of the local defect to create sufficient bone volume for reliable insertion of an implant has been reported using autogenous bone grafts (Khoury, 1987; Misch et al., 1992; ten Bruggenkate et al., 1992; Lustmann and Lewinstein, 1995; Misch and Misch, 1995; Raghoebar et al., 1996), guided bone regeneration (Rominger and Triplett, 1994; Augthun et al., 1995; Buser et al., 1995), or a combination of these procedures. In the case of an atrophic maxilla total or segmental bone onlays, Le Fort I osteotomy with interpositional bone grafts and grafting of the maxillary sinus with autogenous bone or bone substitutes are accepted treatment options to prepare proper implant sites (Raghoebar et al., 1993; Keller, 1994; Locher and Sailer, 1994; Raghoebar et al.,

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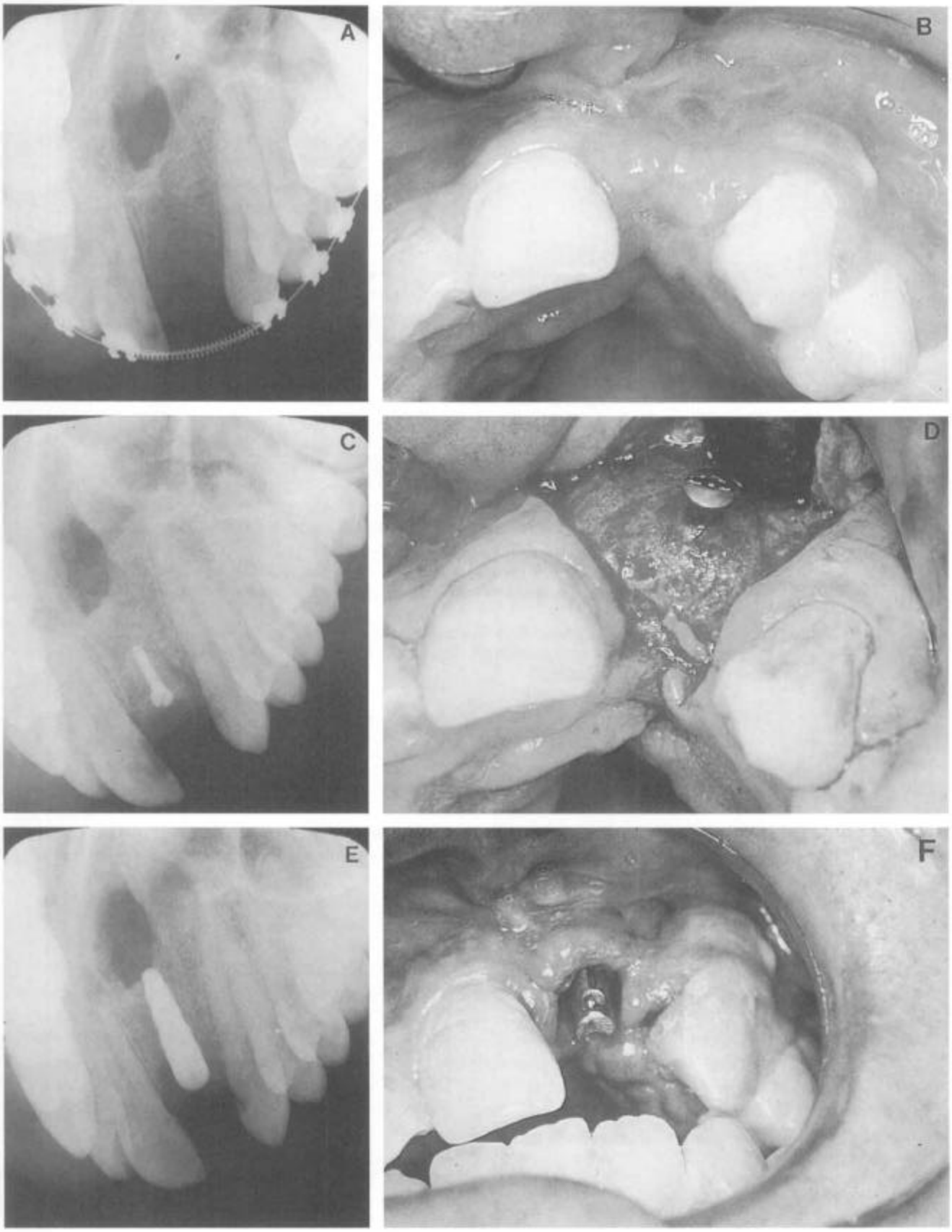
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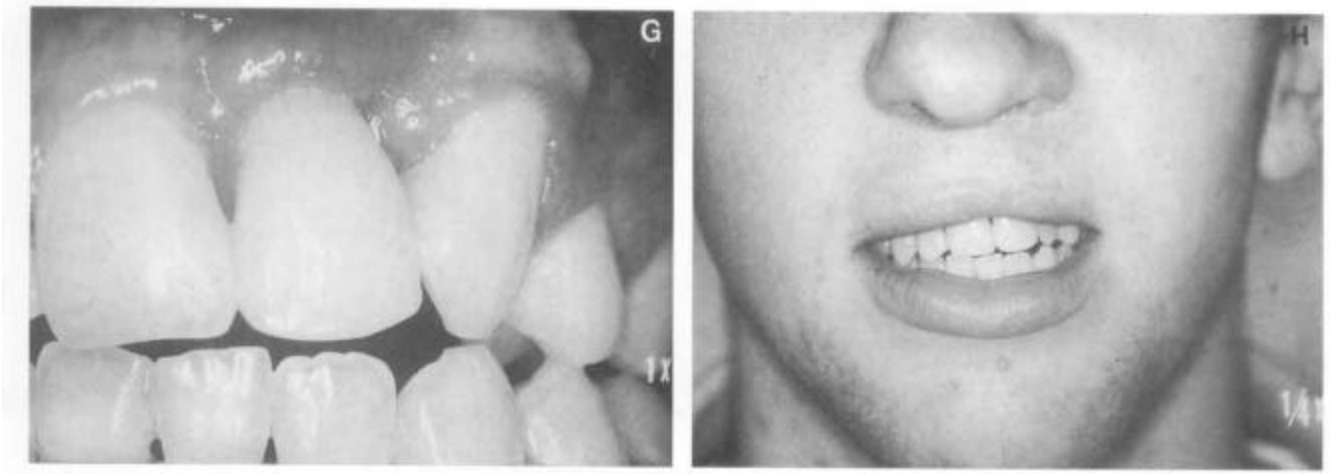

FIGURE 1 Continued.

1997). These studies have shown that in both dentulous and edentulous noncleft patients, bone grafting followed by implant placement is a reliable, clinically worthwhile treatment option to solve the functional and psychological inconvenience these patients experience from prosthetic appliances. The aim of this study was to evaluate the results of bone grafting and implant placement in CLP patients.

Materials and Methods

Anterior Maxilla

In four CLP patients (mean age, 18 years; range, 17 to 24) with agenesis of an incisor and insufficient height and width of the alveolar crest at the site of the alveolar cleft, the implant site had to be grafted to enable reliable placement of an endosseous implant. A secondary alveolar cleft bone graft had been performed at an earlier age (mean age, 11 years; range, 9 to 12), but the diastema had not been closed orthodontically (Fig. 1A and 1B).

Bone grafting was performed under local anesthesia. A full-thickness flap was raised, and the surface of the bone was freed from periosteal fibers and scar tissue. Monocortical grafts from the mandibular symphysis were placed on the outer cortex of the alveolar defect. The gaps between the bone graft and the alveolar crest were filled with cancellous bone particles. In three patients, the bone graft was fixed to the alveolar crest with titanium screws (Fig. 1C and 1D). Perioperative broad-spectrum antibiotics were used and continued for 1 week. Three months after grafting, the grafted area was exposed. The screws were removed, and four endosseous implants (three self-tapping Brånemark implants, Nobelbiocare, Götenburg, Sweden; one Frialit-2 implant, Friatec AG, Mannheim, Germany) were inserted (Fig. 1E). One of these three patients received two implants. In the fourth patient, the available bone volume was considered enough to achieve primary stability of the implants. Therefore, two self-tapping Brånemark implants were inserted immediately after beginning the grafting procedure. In all patients, abutment connection was performed after a healing period of 6 months (Fig. 1F). In all cases, single tooth restorations were made (Fig. 1G and 1H).

Posterior Maxilla

In six CLP patients (mean age, 45 years; range, 30 to 55) in whom the posterior maxillary alveolar crest was insufficient for reliable dental implant placement, the maxillary sinus floor was augmented. Five patients were edentulous in the maxilla. One patient was partially edentulous.

In all cases, iliac crest bone grafts, harvested under general anesthesia, were used. A full-thickness flap was raised to expose the alveolar crest and the lateral aspect of the maxilla. The lateral wall of the maxillary sinus was fenestrated with a round bur at high speed. Subsequently, the sinus membrane was raised, and the mobilized part of the lateral sinus wall, together with the raised sinus membrane, was rotated medially and upward. In all cases, a two-stage procedure (first stage, bone grafting; second stage, implant placement) had to be chosen, because the floor of the maxillary sinus was too thin to

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FIGURE 1 Example of a 17-year-old male who underwent anterior alveolar ridge augmentation and single tooth replacement with an endosseous implant. A: Occlusal radiograph showing the situation 6 years after grafting of the alveolar cleft in the mixed dentition. The diastema caused by absence of the central and lateral incisor has been reduced orthodontically. Note the characteristic concave resorption pattern of the alveolar ridge. B: Clinical situation after removal of the orthodontic appliance. C: Occlusal radiograph taken after alveolar ridge augmentation and widening with a chin bone graft fixed with a titanium screw. D: Clinical view during surgical exposure after 3 months for removal of the screw and insertion of an endosseous implant. E: Occlusal radiograph showing a Frialit-2 type endosseous implant 6 months after insertion. F: Clinical situation 4 weeks after abutment connection. G: Close view of final rehabilitation after cementation of a crown. H: Extraoral view of end-result.

FIGURE 2 Example of the procedure of augmentation of the maxillary sinus floor. A: Diagram showing the principle of rotation of the lateral sinus wall into the maxillary sinus and placement of a cortico-cancellous bone block harvested from the iliac crest. The remaining space is filled with cancellous bone particles. B: Perioperative view showing the subsequent widening of the posterior alveolar ridge with an additional monocorticocancellous bone block fixed with titanium screws. The implants are inserted during a second-stage procedure after 3 months.

provide primary stability for endosseous implants. A monocortical iliac bone block was placed in the sinus with the cortical layer cranially and was not fixed. The remaining space between the iliac bone block and the alveolar crest was filled with cancellous bone (Fig. 2A). After grafting, the height of the maxillary alveolar crest was at least 13 mm. In addition, monocorticocancellous bone blocks were placed buccally to widen the alveolar crest to at least 7 mm. These iliac grafts were fixed with titanium screws. Cancellous bone particles were used to fill the gaps between the bone graft and the alveolar crest (Fig. 2B). Broad-spectrum antibiotics were started perioperatively and continued for 1 week. Four weeks following the operation, the edentulous patients were allowed to wear relined dentures, after selective relieving of the dentures in the operated areas. After 3 months, the grafted area was exposed, the screws were removed, and endosseous implants (31 self-tapping Brånemark implants, Nobelbiocare, Götenburg, Sweden) were inserted (Fig. 3A through 3C).

The abutment connection was performed after a healing period of 6 months (Fig. 3C). Five patients were rehabilitated with removable overdentures (Fig. 3D), and one patient was rehabilitated with a fixed bridge.

Evaluation

Complications during surgery and the postoperative healing period, such as loss of implants and resorption of the grafts, were recorded at regular intervals during the follow-up. Radiological evaluation to detect marginal peri-implant bone loss was carried out independently by two observers who were not informed about the clinical findings during the evaluation, using intraoral and panoramic radiographs taken immediately after the prosthetic procedure and at yearly intervals thereafter. Bone loss was scored as 0 (no apparent bone loss or bone level exceeding three-fourths of the implant length), 1 (bone level not exceeding three-fourths of the implant length but exceeding half of the implant length), 2 (bone level not exceeding half of the implant length but exceeding one-fourth of the implant length), or 3 (bone level not exceeding one-fourth of the implant length). For calibration, a training session was organized prior to the experiment using images of implant patients not included in the experimental series.

Results

Anterior Maxilla

One implant was lost during the healing phase of the patient in whom two implants were placed during the grafting procedure. The implant was not replaced, because a proper prosthetic appliance could be fabricated using the other implant. All other cases healed uneventfully, and no complications were observed at the donor sites.

The mean follow-up period after implantation was 47 months (range, 28 to 65 months). All implants were in function and appeared to be osseointegrated.

Radiological evaluation indicated slight bone loss at the level of the marginal alveolar crest around one implant during the first year of function (score, 0). The bone loss did not exceed one-fourth of the implant length and did not progress. In the other cases, no bone loss around the implants was observed. In all cases, there was complete agreement between both observers.

The satisfaction with the prosthetic appliance was good in all four patients.

Posterior Maxilla

In two of the 12 sinuses (17%) that were grafted, the sinus membrane was perforated during the operation. No loss of

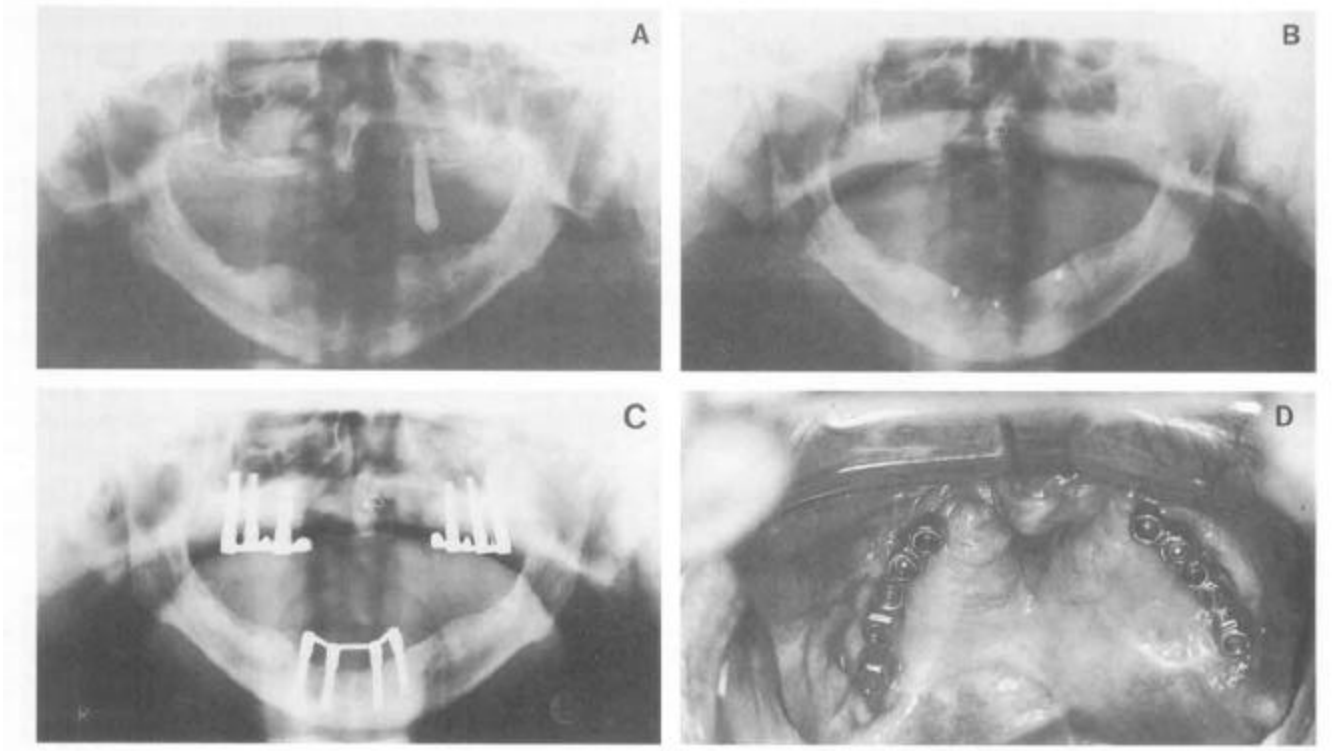

FIGURE 3 Example of an edentulous 44-year-old male who underwent bilateral augmentation of the maxillary sinus floor and augmentation of the inferior alveolar ridge followed by placement of endosseous implants and rehabilitation with implant-supported overdentures. A: Panoramic radiograph showing the preoperative situation with atrophy of the maxilla. B: Radiograph showing the situation 3 months after bilateral augmentation of the maxillary sinus floor and of the interforaminal inferior alveolar ridge. The bone grafts were harvested from the posterior iliac crest. C: Three months after bone grafting, 10 endosseous implants (Brånemark implants, Nobelbiocare, Götenburg, Sweden) were inserted in the grafted areas. After 6 months, abutments and suprastructures were connected. This is shown on the radiograph. D: Intraoral view of the suprastructures in the maxilla prior to rehabilitation with implant-supported overdentures.

bone particles through the nose or other complications were observed, and none of the patients showed symptoms of sinusitis. Signs of inflammation or wound dehiscence were not observed at the donor or recipient sites.

The mean follow-up period after implantation was 56 months (range, 28 to 68 months). All implants were still in function and appeared to be osseointegrated. The peri-implant soft tissue appeared healthy and without signs of inflammation.

Radiological evaluation indicated slight bone loss at the level of the marginal alveolar crest (score, 0) around eight implants during the first year of function. The bone loss seemed to progress in only one patient (three implants) after the first year (score, 1). In the other cases, no significant bone loss around implants was observed. In all cases, there was complete agreement between both observers.

The satisfaction with the prosthetic appliance was good in all six patients.

Discussion

As in noncleft patients, the bone grafting procedures of the anterior maxillary alveolar defects and of the atrophic maxillae appear to be a reliable treatment modality. They have the potential to reduce the functional, esthetic, and psychological problems patients may have with conventional prosthetic appliances.

In the anterior maxilla, onlay bone grafting is performed not only to achieve sufficient osseous support for functionally loaded dental implants, but also to achieve an appropriate vertical level of the alveolar bone height to avoid prosthetic and/or esthetic problems associated with long abutments (Schliephake et al., 1994). It is considered a disadvantage that this onlay bone grafting is, in fact, a second bone graft operation for most patients. The reason for this is that implants should ideally be placed after termination of growth. The first bone graft is performed as a secondary alveolar cleft grafting procedure around the age of 10 years in the mixed dentition. Until the patient reaches the age sufficient for implant placement in the cleft area, resorption in height and width of this first bone graft occurs, making an extra grafting procedure necessary. Takahashi et al. (1997) reported this resorption to be correlated with the duration between bone grafting and implant placement. An extra chin bone onlay graft prior to implant placement due to insufficient bone volume was also often needed in their patients.

Perforation of the sinus membrane was the most commonly observed complication. As reported elsewhere, a small perforation of the sinus membrane does not complicate healing (Jen-

sen et al., 1994; Timmenga et al., 1997). An advantage of the cortical bone plate on top of the graft just below the sinus membrane is that this bone plate will prevent spread of bone fragments into the maxillary sinus in case a perforation was not closed off by folding of the membrane. A second advantage of a bone graft with a cortical bone plate is that the bone graft can be fixed when the implants are inserted simultaneously in a one-stage procedure, providing optimal stability for both the bone grafts and the implants. In the cleft patients included in this study, this was impossible because of insufficient height and width of the preexisting maxillary bone.

The use of mandibular bone grafts is increasing (Jensen et al., 1990; Hirsch and Ericsson, 1991; Jensen et al., 1994). Because of the dense cortical structure, resorption of these bone grafts is less when compared to iliac crest, tibial, or rib bone grafts (Koole et al., 1989; Borstlap et al., 1990; Sindet-Pedersen and Enemark, 1990). Other advantages of intraorally harvested bone grafts are the use of local anesthesia instead of general anesthesia, a relatively short operation time, no need to stay in hospital postoperatively, less donor site morbidity, and lower costs (Jensen et al., 1990; Hirsch and Ericsson, 1991; Misch et al., 1992). A disadvantage is that intraoral donor sites offer smaller volumes of bone than the iliac crest. Iliac crest grafts therefore still have clinical value and had to be used in all our cases of augmentation of the maxillary sinus, while the volume of intraoral grafts was sufficient in all defects of the anterior maxilla.

From this study, it is concluded that augmentation of the maxilla with autogenous bone grafts followed by placement of endosseous implants can serve as a reliable alternative for conventional prosthetic rehabilitation in CLP patients. The use of dental implants for tooth replacement is also an alternative for orthodontic space closure in cleft patients with missing incisors. Further studies are needed to evaluate the long-term results of the described methods with regard to implant stability, revascularization and resorption of bone grafts, and the long-term prognosis of the various bone augmentation techniques.

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