

Implant-supported restoration of congenitally missing teeth using cancellous bone block-allografts

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Abstract

Background and objective. Patients with congenitally missing teeth may present with undeveloped alveolar bone morphology, making implant reconstruction a challenge. The aim of the present study was to evaluate the outcome of dental implants after ridge augmentation with cancellous freeze-dried block bone allografts in patients with congenitally missing teeth. **Study design.** Twelve patients with a mean age of 21.4 years, were included. Congenitally missing teeth included maxillary lateral incisors, a maxillary canine, and mandibular central and lateral incisors. A bony deficiency of 3 mm horizontally and 3 mm vertically according to computerized tomography served as inclusion criteria. Twentyone implants were inserted after a healing period of 6 months. Five out of 21 implants were immediately restored. Bone measurements were taken before bone augmentation, during implant placement, and at second-stage surgery. **Results.** Nineteen cancellous allogeneic bone-blocks were used. The mean follow-up time was 30.16 months. Bone block and implant survival rates were 100% and 95.2%, respectively. Mean bone gain was statistically significant ($P < .001$): 5.05 mm horizontally and 2.05 mm vertically. All of the patients received a fixed implant-supported prosthesis. Soft tissue complications occurred in 4 patients (30%). Complications after cementation of the crowns were seen in 1 implant (4.8%). All implants remained clinically osseointegrated at the end of the follow-up examination. There was no crestal bone loss around the implants beyond the first implant thread. **Conclusion.** Cancellous bone block-allografts can be used successfully for implant-supported restorations in patients with congenitally missing teeth.

Introduction

Congenitally missing permanent teeth (hypodontia 1, oligodontia 6, anodontia all teeth) may be seen as part of a syndrome (ectodermal dysplasia) or as a nonsyndromic characteristic.¹⁻³ The prevalence of hypodontia in white populations in North America, Australia, and Europe is estimated to be 5.5%, with a higher incidence in women than in men.^{1,2} Characteristic changes are also growth disturbances of the maxillofacial skeleton and thus the facial appearance.³ For restorative treatment planning, the dentoalveolar features, including occlusal disturbances, delayed eruption, and alterations of tooth morphology, present an exceptional challenge.¹⁻⁶ Tooth absence leads to undeveloped alveolar bone with knife-edge morphology, making implant placement a further challenge. Most of the patients are young with high esthetic demands. Adequate bone and soft tissue volume are therefore mandatory. The young age prevents immediate treatment in many cases. As a result, resorption and atrophy of the alveolar ridge is enhanced, leading to difficulties of implant treatment with a possible contribution to early implant failure.⁴ As a consequence, restorative treatment must be comprehensive, requiring an interdisciplinary approach including orthodontics and preimplant bone grafting techniques in many cases.³⁻⁶ Autogenous bone harvested from either extraoral or intraoral sites is still the "gold standard."⁶ The graft must possess strength and rigidity to allow its fixation in the recipient site and three dimensional stability to withstand muscular forces.⁷ Consequently, an autogenous block graft is often recommended.⁶

Recent studies⁸⁻¹³ suggest that a block allograft in conjunction with a resorbable membrane may be an acceptable alternative to the autogenous block graft. The incentive for using block-allografts in young patients is to avoid donor site morbidity.^{14,15} Otherwise, such patients may deny initial treatment, resulting in an even more compromised alveolar ridge. Information in the literature regarding the results of dental implant treatment in patients with congenitally missing teeth is scarce.⁶ The aim of the present study was to evaluate the outcome of dental implants placed in patients with congenitally missing teeth after ridge augmentation with cancellous freeze-dried block bone allografts.

MATERIALS AND METHODS

The study group comprised 12 patients (10 women and 2 men), with an age range of 18-35 years (mean age 21.4 years). Missing teeth included 11 maxillary lateral incisors, 1 maxillary canine, 8 mandibular lateral incisors, and 1 mandibular central incisor. A total of 19 freeze-dried cancellous bone block-allografts (5 patients were grafted with 1 block and 7 patients with 2 blocks) and 21 dental implants (17 Seven-MIS Implant Technologies [Bar Lev Industries, Misgav, Israel] and 4 Osseotite-3i/Implant Innovations [Biomet, Palm Beach Gardens, FL] were used. Implants were placed after a healing period of 6 months. Five implants were immediately loaded, and 16 implants were allowed to heal for an additional 6 months. All implants were restored with fixed cement-retained restorations. Patients were selected after a meticulous evaluation of their medical histories and dental examinations that included panoramic, orthoradial periapical radiographs, and dental computerized tomography (CT) scans. Patients presenting with a history of congenitally missing teeth and a bony deficiency of 3 mm horizontally and 3 mm vertically according to CT para-axial reconstruction thereby met the inclusion criteria. Postoperative panoramic and orthoradial periapical radiographs were taken to compare with the preoperative ones. All procedures were fully explained to the patients, and the Ethics Committee of the Tel Aviv University approved the study protocol. A staged approach was planned to reduce potential complications (wound dehiscence, block graft fracture, implant loss) that have been associated with simultaneous grafting and implant placement.⁹ One hour before surgery, oral antibiotics of 1000 mg amoxicillin (Moxypen Forte; Teva Pharmaceutical, Petach Tikva, Israel) and 600 mg Etodolac (Etopan; Taro Pharmaceutical Industries, Haifa Bay, Israel) were administered. Antiseptic mouthwash, 0.2% chlorhexidine gluconate (Tarodent; Taro Pharmaceutical Industries), was used immediately before surgery. Under local anesthesia (infiltration using 2% lidocaine with 1:100,000 epinephrine), surgery commenced at the recipient site to confirm the shape and size of the defect as previously seen on the CT para-axial reconstruction. The prepared allograft was rehydrated with a solution of sterile saline for 45 minutes. Freeze-dried cancellous block allograft (ReadiGraft, Canblock 1.5; LifeNet, Virginia Beach, VA) was shaped with a fissure bur in a high-speed handpiece with copious irrigation. The end point was a block graft that closely approximated the recipient bed and provided adequate width and height to accomplish the restorative treatment plan. It was then thoroughly rinsed with sterile saline solution to remove residual bone particles. A midcrestal incision based on the missing teeth was made. The incision was extended intrasulcularly around the cervical margins of the adjacent teeth. Two vertical releasing incisions were made on the labial aspect, away from the recipient site to include the papilla. The buccal aspect of the alveolar ridge was then exposed to allow 3-dimensional visualization of the defect (Fig. 1). Several modalities can be applied to ensure the broadest communication possible between grafted bone and the bone marrow cavity. The most frequent technique used was multiple perforations made through the cortical plate with a round bur. The

cancellous block-graft was refined to fit into the defect. Once the graft was seated and stable, it was fixed with 1.6 10 mm bone screws (OsteoMed Corp., Addison, TX; Fig. 2) A high-speed water-cooled large round bur was used to round the sharp cortical edges and shape it to completely conform to the defect site. Measurements of the initial augmentation ridge width and height were taken with periodontal probes scaled in millimeters to assess bone gain. Height was assessed relative to a line joining the cemento-enamel junction of adjacent teeth. Deficiencies at the edges of the graft were filled with particulate bovine bone mineral (BioOss; Geistlich Biomaterials, Wolhusen, Switzerland). A resorbable membrane (Ossix; OraPharma, Warminster, PA) was used. Periosteal releasing incisions were made. The midcrestal incision was initially closed using interrupted or horizontal mattress sutures as needed. The interdental papillae and the vertical incisions were secured with interrupted sutures. Oral amoxicillin (Moxypen Forte) 500 mg, 3 times daily, and Etodolac (Etopan) 600 mg, twice daily, were prescribed for 5 days after surgery. As an antiseptic solution, 0.2% chlorhexidine gluconate mouthwash (Tarodent) was used for 45 seconds, 3 times a day, for 2 weeks. Provisional restorations were modified to prevent the application of any pressure to the healing tissues. All provisional restorations were fitted and delivered to the patient immediately after surgery. The grafted sites were allowed to heal for 6 months. The patients were seen weekly during the first month after surgery and monthly thereafter until second-stage surgery. Periapical radiographs were taken immediately after surgery and before implant placement. The clinical evaluation included a thorough search for soft tissue dehiscence and an overall view of the grafted ridge contour. Access to the augmented ridge was obtained after 6 months via an incision similar to the one used during graft placement. The augmented site was evaluated. Surgical exposure of the augmentation site revealed well integrated block grafts that were incorporated into the surrounding bone. The fixation screws were removed. Measurements of postaugmentation ridge width and height were taken to assess bone gain. Width gain was assessed by subtracting postaugmentation ridge width from initial ridge width. Height gain was assessed by subtracting postaugmentation height from initial height, relative to a line joining the cemento-enamel junction of adjacent teeth. Implants were placed (Fig. 3). Implants were either nonfunctionally immediately loaded (nonocclusal contacts present) or exposed 6 months later. For all of the nonfunctionally immediately loading cases, the provisional acrylic crowns were prefabricated in the laboratory before surgery. The occlusion was adjusted and finalized without contacts in protrusive excursions or intercuspal position. The temporary acrylic fixed restorations were adjusted over temporary abutments. In cases with 2-stage healing period, the soft tissues were allowed to mature for 3 weeks after implant exposure. Cement-retained restorations were then fabricated. In cases that were immediately loaded, 6 months after implant placement, radiographs of the implant sites were taken. The implants were restored with cement-retained fixed ceramic prostheses. (Fig. 4) Temporary cement (Temp Bond; Kerr Italia, Salerno, Italy) was used to enable future maintenance and follow-up. Clinical and radiographic examinations were carried out at the time of restoration, every 6 months during the first year, and once a year thereafter (Fig. 5). Two-tailed Student t test served for statistical analysis to compare bone gain.

RESULTS

Nineteen ridges of 12 patients were grafted. Twentyone implants were placed in the augmented sites. Of the grafts, 79% were used to gain width and 21% to gain both height and width. Bone gain was statistically significant ($P < .001$). Bone gain in the horizontal dimension (4-6 mm, mean 5 0.5 mm) exceeded bone gain in the vertical dimension (0-3 mm, mean 2 0.5 mm; Table I). Soft tissue breakdown occurred in 4 patients (30%). All cases were characterized by incision line opening

followed by membrane and graft exposure. Necrotic soft tissue was removed, and the bone was leveled with the soft tissue by the aid of a high-speed bur. Chlorhexidine gel was applied twice daily to the exposed area, resulting in wound healing within 4-6 weeks. Block graft survival rate was 100%. One out of the 5 immediately loaded implants failed (80% survival rate). The survival rates of implants placed after cancellous block-allograft augmentation in patients with congenitally missing teeth was 95.2% (2-stage implants 100% and immediately loaded implants 80%). All of the patients received a fixed implant-supported prosthesis. Complications after cementation of the crowns were seen in 1 implant (4.8%). One patient presented with a fistula in the marginal gingival after cementation of the crown, which closed spontaneously after curettage in the gingival sulcus. Patients showed good oral hygiene in general, and soft tissue pathology was rarely detected. Bleeding on probing was noted in 3 (3.6%) of 84 sites recorded. A sulcus depth 4 mm was recorded. The mean follow-up time was 30 16 months (range 13-60 months). All implants remained clinically osseointegrated at the end of the follow-up examination. There was no crestal bone loss around the implants beyond the first implant thread.

DISCUSSION

There is little information available regarding restorative treatment outcome in patients with congenitally missing teeth. The emergence of a large variety of augmentation techniques has created new options for the oral rehabilitation of such patients. Today, the aim of the prosthodontist is to providing these patients with a fixed partial restoration without any damage to the natural teeth.^{4,6,16,17} However, functional and esthetic demands were provided by the use of autogenous boneblocks with donor site morbidity and discomfort to the patient. Such morbidity cannot be regarded as negligible. Each intra- or extraoral donor site has its own inherent problems and potential complications, including up to 43% of some paresthesia and incomplete bony regeneration.^{14,15} As a result, implementation of an implant-supported restoration was not always feasible in patients with congenitally missing teeth, owing to lack of patient willingness to undergo complex harvesting procedures. The functional and esthetic demands in the present study were provided by the aid of cancellous blockallograft without donor site morbidity and discomfort to the patient. Several advantages of the described technique should be emphasized. The area, size, and contour of the bone regeneration is dictated by the size and shape of the undeveloped alveolar ridge. The cancellous block-allograft can be modified to comply with the desired height and width of the new generated bone. In contrast, the contour and size of the autogenously harvested block grafts are very difficult to control, because of the inherent shape of the cortical bone graft itself, which must be reshaped to fit the contours and curves of the anterior maxilla. Another major drawback for using autogenous bone blocks is their inability to maintain long-term 3-dimensional stability. Resorption rates of 0%-25% at the time of implant placement and up to 60% at abutment connection were documented with the use of autogenous block grafts.¹⁸ Thus, many clinicians and patients are confronted with the dilemma of whether the risk (morbidity)/benefit of autogenous bone block harvesting is worth taking. With cancellous block-allografts, resorption rates were 10% at the time of implant placement and 14% at second-stage surgery.¹¹ This demonstrates the potential of cancellous block-allografts to minimize bone resorption and allow a long-term stable result compared with autogenous block-grafts. Future long-term studies are needed for the validation of the present data. In the present study, the considerations of risk(morbidity)/benefit were in favor of grafting, because the parameter of risk and morbidity was minimized. Treatment of patients with congenitally missing teeth is generally multidisciplinary, invasive, and expensive. Therefore, data regarding the outcome of treatment are essential. Implant survival is an important tool in measuring

the efficacy of treatment. In the present study, the mean follow-up period was

3 years. Bone block and implant survival rates were 100% and 95.2%, respectively. Some earlier reports on the use of implant treatment in patients with congenitally missing teeth have produced conflicting results, ranging from 35.7% to 96.6%.^{4,6,16,17} It is tempting to compare the implant survival rate observed in the present study with that found in single implants placed in “regular” partially edentulous subjects. A recent systematic review calculated an implant survival rate of 95.5%.¹⁹ The overall implant survival rate in the present study is more favorable than those described in the literature for patients with congenitally missing teeth and is similar to those for patients with noncongenitally missing teeth. This can be attributed to bone grafting with cancellous bone-block allografts resulting in noncompromised bone volume and quality and contributing to high implant survival rates as reported in other studies using block-allografts.⁸⁻¹³ The incidence of soft tissue complications in the present study was relatively high (30%). The congenital absence of teeth results in undeveloped hard tissue. A bone grafting and implant treatment approach cannot be considered at young age, leading to further atrophy of the alveolar process with time. This may explain the high incidence of soft tissue complications as due to the inherent biologic compromises of the alveolar bone. Such a speculation awaits future evidence. Other explanations for soft tissue breakdown, such as flap design, soft tissue release, or avoidance of bone overcontouring, also should be considered in the future. The surgeon, the prosthodontist, and the patient must be aware of such potential complications. These patients require a close follow-up, and treatment should be initiated as soon as a complication is noticed. The prosthetic complications were negligible, owing to a prosthetically derived implant position, made possible by the use of the cancellous bone block-allograft. In conclusion, to improve the standard of care for patients with congenitally missing teeth, prospective studies are needed to evaluate the outcome of various implantsupported restorative treatment modalities. Within the limits of the present study, the data indicate that cancellous block-allograft can be used successfully for implantsupported restoration in patients with congenitally missing teeth.

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Table

Direction	n	Range	Mean	SD
Horizontal	19	4-6	5	0.5
Vertical	4	0-3	2	0.5

Table I: . Bone gain characteristics (mm)