Alveolar distraction osteogenesis versus autogenous onlay bone graft for vertical augmentation of severely atrophied alveolar ridges after 12 years of long-term follow-up

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Objective. The aim of this study was to evaluate alveolar distraction osteogenesis (ADO) and autogenous onlay bone graft (AOBG) procedures by comparing their long-term results and their ability to correct severe vertical alveolar defects for further rehabilitation.

Study Design. Fourteen patients treated with ADO and 28 patients treated with AOBG were included in this study. Radiographic measurements of alveolar bone heights over time and the implant survival and success were compared for the 2 groups.

Results. The vertical bone gain was 8.4 ± 2.6 mm for ADO and 6.5 ± 2.3 mm for AOBG. After a mean follow-up period of 7.1 years, there was no significant difference between the 2 groups regarding alveolar bone heights over time and implant survival and success ($P > .05$). The cumulative survival and success rates were 97.3%, 92.7% in the ADO group and 94.1%, 90.2% in the AOBG group, respectively.

Conclusion. Both ADO and AOBG may be reliable and effective for ridge augmentation procedures of severe vertical alveolar bone defects and subsequent dental rehabilitation using implants. (Oral Surg Oral Med Oral Pathol Oral Radiol 2013;116:540-549)

Dental implants have evolved to become a reliable and predictable restorative procedure for partial or complete edentulism.[1] However, vertical alveolar bone deficiency carries a major risk of difficulty in placement of implants and may also be a factor in creating esthetic and functional problems associated with increasing crown-to-implant ratio of the prosthesis. Various surgical techniques have been developed to address these problems, including guided bone regeneration (GBR), maxillary sinus bone graft, autogenous particulate or block bone graft, and distraction osteogenesis.

GBR is a well-known treatment modality used to overcome vertical or horizontal alveolar bone deficiency.[2] However, augmentation of vertical defects using GBR is limited to 5 mm, presenting higher risks of membrane exposure, wound infections, and other complications with greater amounts of vertical augmentation.[3] Maxillary sinus bone grafting is performed to supplement the posterior maxillary area when bone height is insufficient for implant placement. However, this procedure cannot overcome the crown-to-implant ratio problem, and the prognosis of grafts is rendered questionable because of sinus pneumatization.[4]

Autogenous onlay bone graft (AOBG) is a surgical procedure often selected to treat severe vertical alveolar bone deficiency, especially when the alveolar ridge is less than 5 mm high or less than 4 mm wide.[5] Several studies have reported acceptable success and survival rates of dental implants using AOBG.[6,7] The reported vertical bone gain after AOBG is 4 to 10 mm, which is sufficient for placement of an average-length implant,[8,9] and compared to particulate grafts, these cortico-cancellous block grafts show excellent capability in maintaining bone volume.[10]

Since McCarthy et al.[11] first used distraction osteogenesis in the craniofacial area, alveolar distraction osteogenesis (ADO) has been used to reconstruct vertically atrophied alveolar ridges.[12] ADO allows the correction of vertical bone defects measuring up to 15 mm and is suitable for augmentation of extended defects.[13] Moreover, ADO promotes neohistogenesis of soft tissue along with augmentation of hard tissue,[13]

Statement of Clinical Relevance

There have been few comparative studies of alveolar distraction and autogenous onlay bone grafts with adequate long-term follow-up. The aim of this study was to evaluate their abilities to correct severe vertical alveolar defects in advance of further rehabilitation using dental implants.

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and the bone regenerated using ADO is a type of pedicle graft showing lower infection rates and greater stability over the long term.[14]

Only a few studies with adequate follow-up have directly evaluated the long-term stability of augmented bone and changes in vertical bone grafts.[7,15,16] To date, there is insufficient evidence regarding the long-term stability of bone grafts. Moreover, although numerous studies have presented satisfactory results of bone augmentation using both ADO and AOBG,[14,17-20] considerable controversy still exists regarding the choice of the more reliable technique because of the lack of long-term studies comparing the 2 procedures. The aim of this retrospective study was to compare the long-term results, up to a maximum period of 12 years, of ADO and AOBG procedures and to evaluate their abilities to correct severe vertical alveolar defects before further rehabilitation using dental implants.

MATERIALS AND METHODS

Study design and sample

This retrospective study included patients who were treated by AOBG or ADO between January 1995 and December 2005 at the Department of Oral and Maxillofacial Surgery, Ewha Medical Center, Seoul, Korea. Out of 65 patients (16 for ADO and 49 for AOBG), patients were selected who had (1) physically healthy condition; (2) severe vertical alveolar defects of partial or completely edentulous areas; (3) a condition predisposed to an unfavorable crown-to-implant ratio; and (4) radiographic examinations at specific times (at least 3 times: at bone augmentation surgery, at implantation, and at prosthetic loading). The exclusion criteria were severe liver or renal disease, diabetes mellitus, history of radiotherapy or chemotherapy related to cancer, heavy smoking (more than 10 cigarettes per day), alcoholism, poor oral health, and poor compliance. Patients who had received previous autogenous bone grafts or allografts after tumor resection were also excluded. Ultimately, 14 patients for the ADO group and 28 patients for the AOBG group met the criteria and were included in this study.

All surgical procedures, including implant placement, were performed by a single surgeon. The study protocol and access to the patient records were approved by the Institutional Review Board of the Ewha Medical Center, Seoul, Korea (12-30A-29).

Surgical procedures

Both procedures were conducted with patients under general nasotracheal anesthesia or local anesthesia with intravenous sedation.

ADO procedure. In the ADO group, intraoral subperiosteal distraction devices (Track 1.5, Gebrüder Martin, Tuttlingen, Germany; 10 mm, 15 mm) were used for the distraction procedure. After vestibular incision, a full-thickness flap was elevated and subperiosteal dissection was performed to access the osteotomy site. First, the distraction device was adapted to the operative site; subsequently, the device was pre-fixed by 2 titanium screws on each side. The path of the distraction device's rod was directed toward the buccal vestibule of the opposing arch or in a more buccal direction to prevent lingual tilting of the transport segment during distraction. After the osteotomy line was traced, a trapezoidal osteotomy was conducted using a reciprocating and oscillating saw rather than a fissure bur. Here, special precaution was taken to preserve the lingual flap for adequate blood supply. After the osteotomy, the distractor was fixed using 1.5-mm screws, and the mobility and path of the transport bone segment were confirmed through the activation of the distractor's rod. After activation to test the function, the device was returned to its initial position. After a latency period of approximately 1 week after surgery (mean, 6.2 days; range, 5-7 days), distraction was initiated at a daily rate of 1 mm (2 activations of 0.5 mm) according to the manufacturer's recommendation. After the desired level of transportation of the segment was achieved, the distraction device was kept in place for consolidation for an average of 3.7 months (range, 3.1-8.4 months). Implants were placed at the time of removal of the distraction device. After an average of 4.9 months (range, 3-7 months), second-stage surgery was performed (Figure 1).

AOBG procedure. In the AOBG group, the autogenous onlay bone grafts were harvested from the mandibular ramus. After a vestibular incision, a full-thickness flap was elevated on the site of the vertical bone defect, and the necessary amount of bone graft was measured. Osteotomy at the donor site on the mandibular ramus was performed using a reciprocating saw and an oscillating saw, and bone cutting was limited to the cortical bone to prevent injury to the inferior alveolar nerve. The cortical bone block harvested from the mandibular ramus was adapted to the recipient site, trimmed, and then fixed with 1.2-mm titanium screws. Autogenous bone particulates that were harvested along with the bone block from the mandibular ramus were grafted surrounding the onlay block bone. Within an average of 6.2 months (range, 5-8 months) after graft placement, the implants were inserted with simultaneous removal of the titanium screws. After an average of 3.9 months (range, 3-8 months), the second-stage implant surgery was conducted.

Radiographic analysis

Panoramic radiographs were obtained as follows: (1) before and after bone augmentation procedures; (2)