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# Horizontal alveolar transport distraction osteogenesis followed by implant placement

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*S. Uckan, G. Senol, E. Ogut, G. Muftuoglu: Horizontal alveolar transport distraction osteogenesis followed by implant placement. Int. J. Oral Maxillofac. Surg. 2019; 48: 824–829.* 

*Abstract.* Alveolar transport distraction osteogenesis (ATDO) is an alternative treatment method to vertical alveolar distraction osteogenesis in cases of large bony defects, especially when the bone is limited in size. ATDO was performed in 10 patients with 12 defects. The mean age of the patients was 39.1 years. The average bone length gain was 18.2 mm. Implants were inserted following a 3-month consolidation period. Three patients needed additional bone grafting for horizontal widening. Final prosthetic rehabilitation was performed at least 3 months following implant insertion. The mean follow-up period was 63 months and the survival rate of the 25 implants placed was 92%. All failures ($n = 2$) occurred during the early healing period. Although the results are not totally predictable, it can be concluded that ATDO can be effective in the reconstruction of the alveolar crest prior to implant placement.

Key words: transport alveolar distraction; distraction osteogenesis; dental implant.

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Dentoalveolar bone defects in the maxillofacial region, which usually result from trauma, atrophy, infection, or congenital conditions, can lead to aesthetic and functional problems. In the restoration of such defects, the missing bone and soft tissues should be replaced prior to the placement of implants. The goals of reconstruction are to provide the proper morphology and relationship with the opposite jaw, to restore hard and soft tissue continuity, and to obtain adequate height and width of the bone to allow for occlusal rehabilitation[1]. Various surgical techniques have been described to repair alveolar defects, including autogenous bone grafting, guided bone regeneration, alveolar distraction osteogenesis, and free flap microsurgery.

Vertical bone augmentation is one of the challenging issues in alveolar reconstruction. Intraoral bone grafting is usually the treatment of choice for small defects, as graft material can be obtained easily from the neighbouring areas, despite the fact that their size will be limited[2]. When large amounts of bone are necessary, the iliac crest is usually the preferred donor site. Although autogenous bone grafting is still the gold standard, donor site morbidity and the unpredictable resorption rate of the graft are the known drawbacks. In addition, graft failure due to inadequate mucosal coverage is possible[3,4]. Free flap reconstruction is a technique for cases of large defects; however, this technique is complex and costly, and an experienced microsurgery team is needed[5,6].

Distraction osteogenesis is a biological process of regenerating new bone and attached gingiva by stretching bone fragments separated by osteotomies[7]. Distraction osteogenesis is advantageous when compared to traditional bone grafting techniques in terms of elongation of the hard and soft tissues simultaneously, lower morbidity and resorption rates, earlier implant placement, lack of the need

 

for a donor site, and decreased hospital stay[2,4,8–10].

Vertical alveolar distraction osteogenesis (VADO) has been used successfully to increase the height of alveoli. However, VADO is not recommended for wide defects because of the unavailability of large amounts of bone over the anatomical structures. Alveolar transport distraction osteogenesis (ATDO) is an alternative to the vertical distraction technique[11,12].

Transport distraction osteogenesis (TDO) was first used for mandibular reconstruction[13,14]. Liou et al. then applied this technique to maxillary alveolar defects in cleft patients[15]. Cheung et al. performed unilateral posterior maxillectomy and immediate reconstruction by TDO in 14 monkeys using a custom-made distractor[16]. Two molar teeth were also carried with a bone segment. Subsequent radiographic and histological studies proved the feasibility of TDO in jaw reconstruction[16,17]. The use of TDO in the repair of large mandibular resection defects is well documented in the literature[18]. In addition to discontinuity defects, it can also be used for isolated alveolar reconstruction. The technique is similar to VADO except that the distractor is placed in a horizontal plain rather than in a vertical plain.

This is a relatively new technique, and the indications, technical aspects, complications, and implant survival and success rates have not yet been fully elucidated[11,12,19–24]. The aim of this study was to investigate the implant survival rate following horizontal ATDO and to assess the indications, complications, and success of this method of distraction.

## Materials and methods

ATDO was performed in 10 patients (four male, six female) with 12 alveolar defects. The mean age of the patients was 39.1 years. The defects were due to cleft lip and palate ($n = 3$), benign tumour resection ($n = 3$), traumatic injury ($n = 3$), and severe atrophy ($n = 3$). The defects were located in the anterior mandible ($n = 1$), posterior mandible ($n = 4$), anterior maxilla ($n = 5$), and posterior maxilla ($n = 2$).

Patients referred for implantation were included in this study. The inclusion criteria were the presence of a severe vertical alveolar bone defect, good oral hygiene, and age over 18 years. The exclusion criteria were a history of radiation or chemotherapy in the head and neck region, uncontrolled systemic disease, and a malignant tumour resection.

The procedures were performed by the same oral and maxillofacial surgeon under general anaesthesia with nasotracheal intubation, or under local anaesthesia and sedation. An intraoral horizontal incision was made on the buccal side of the defect and if necessary some relaxing incisions were also performed. Mucoperiosteal flaps that were as small as possible were elevated, in an attempt to preserve the blood supply coming from the lingual/palatal and crestal soft tissues. Following the insertion of vertical alveolar distractors (DePuy Synthes, Switzerland) at the preplanned sites on the bone, osteotomy lines were marked (Fig. 1). The distractors were then removed and vertical–horizontal osteotomies were performed under irrigation with the use of an oscillating saw; a thin osteotome was used to finalize the osteotomy. The distractors were then screwed back into their previous position and activated–deactivated to check that the device was working. The incisions were closed with 4–0 resorbable sutures. Amoxicillin with clavulanic acid (1 g twice daily) was given to all patients for 5 days postoperatively.

*Fig. 1.* An intraoral alveolar distraction device (DePuy Synthes, Switzerland). This device was used horizontally.

The distractors were activated at a rate of 0.5 mm twice a day, starting 5 days after the surgery. The activation was continued until the desired length was achieved (Fig. 2). After a 3-month consolidation period, the distractors were removed and implants were placed in the new bone (Fig. 3). The implants were loaded with screw-retained crowns at least 3 months after placement (Fig. 4).

Radiographic examination (panoramic or cone beam computed tomography (CBCT)) was performed preoperatively, immediately after surgery, and after implant insertion (Fig. 5).

## Results

The mean length of bone gained was 18.2 mm (range 10–26 mm). The whole treatment period ranged from 16 to 22

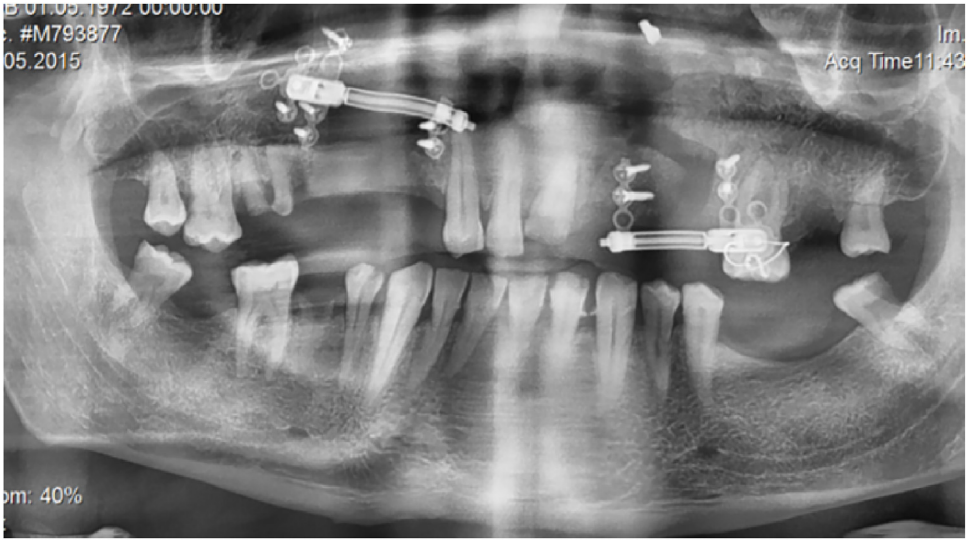


*Fig. 2.* Panoramic view of a patient at the end of the bilateral distraction.

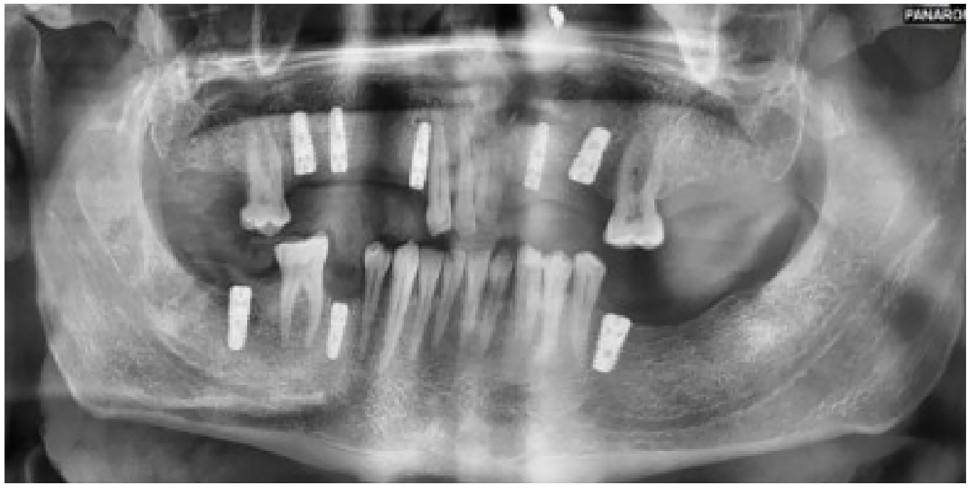

*Fig. 3*. Panoramic view of a patient after implant placement.

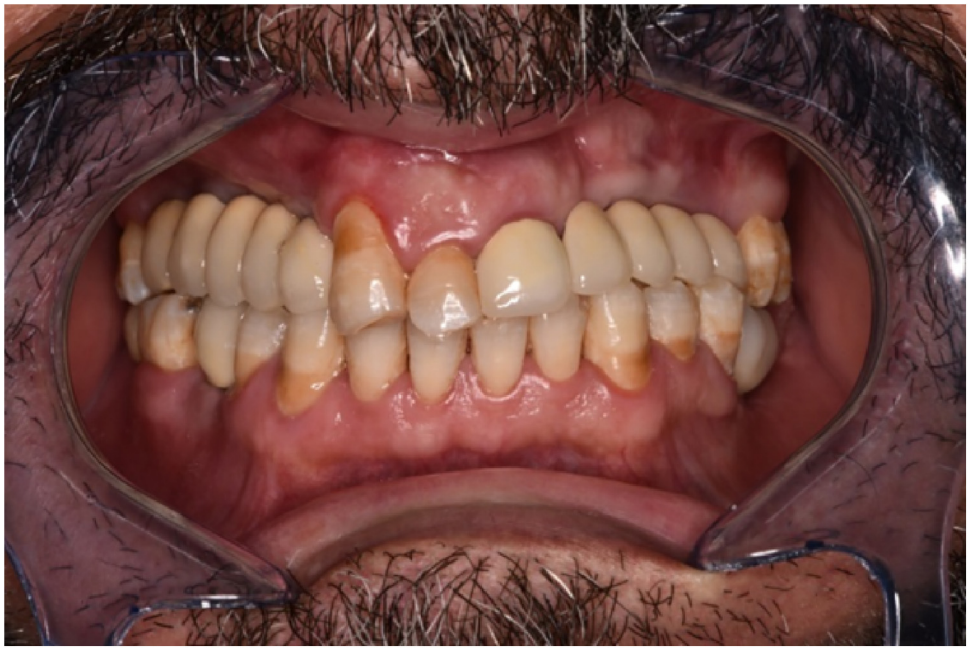

*Fig. 4*. The temporary prosthesis.

months. One or two teeth were moved with the transported segments in all patients. The teeth on the transported segment were extracted after the consolidation period due to periodontal or restorative status. At the end of the consolidation period, 17 implants were placed in the regenerated bone of the distracted segment in seven patients. The remaining three patients needed additional intraoral bone grafting due to insufficient horizontal bone volume. The implants of these patients were inserted 5 months after onlay bone grafting.

Overall, 25 implants were placed in the 10 patients. The lengths of the implants were between 11.5 mm and 13 mm and diameters ranged from 3.5 mm to 4 mm. The survival rate of implants was 92% after 63 months of follow-up (range 18–108 months). Within 3 months of implantation, two implants were removed due to mobility.

Infection or device failure did not occur in any of the patients. In one patient, the distracted segment tilted in a lingual direction; the segment was aligned manually and fixed to its correct position with a plate. The direction of the vector was out of arch in one patient. The distractor was removed and aligned again and the procedure was completed as planned preoperatively.

## Discussion

ATDO provides a valuable alternative to grafting techniques. The goal of this method is to restore alveolar bone continuity and provide sufficient keratinized tissue coverage through the use of residual bone, avoiding donor site morbidity. Regenerated bone produced by this method is ideal for dental rehabilitation[23].

VADO has also been used effectively for the correction of vertical alveolar defects[1,2,4]. However, if the residual bone height and width are limited, the placement of alveolar distractors without damaging the anatomical structures will be

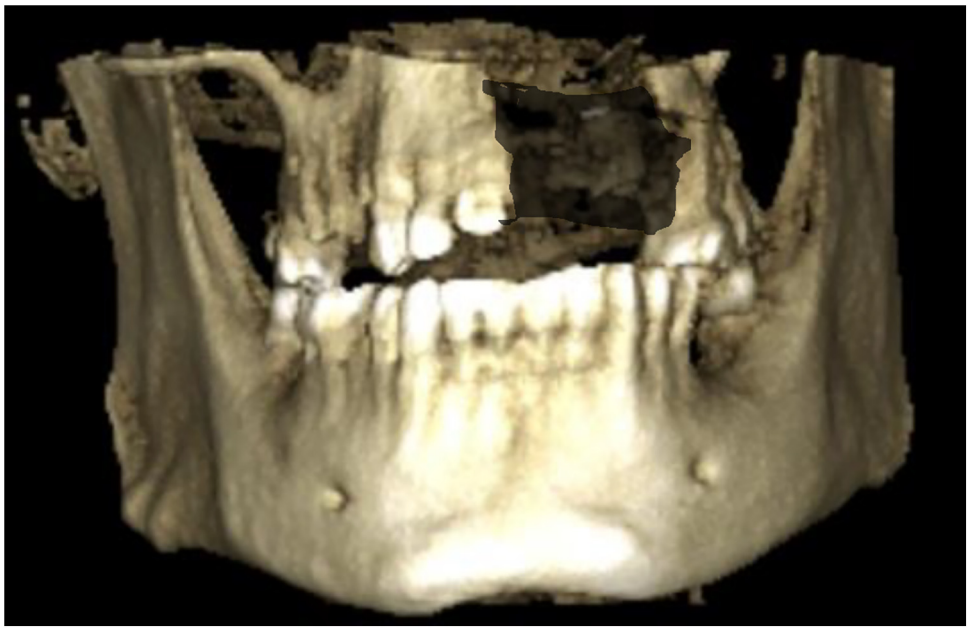

*Fig. 5*. Three-dimensional computed tomography scan revealing a wide alveolar defect from the right central tooth to the left first molar caused by a bomb blast injury.

difficult or even impossible[12]. In these cases, VADO could be performed 6 months following bone grafting. This is time-consuming and, in addition, the risk of donor site morbidity is high[25].

In order to be able to maintain bone length and slow down the resorption at the edge of the transported segment during ATDO, the distraction rate should be less than 1 mm a day. In VADO, there are three osteotomized active surfaces, but in ATDO there are only one or two osteotomized active bony surfaces (Fig. 6). This is why a slow distraction rate should be considered, without a risk of early consolidation.

Teeth and implants can be moved by ATDO. Teeth carried by the transported segment may require prosthetic rehabilitation to imitate the correct morphology or may require extraction. With the preservation of the periosteum of the alveolar segment, the blood supply remains sufficient to maintain the vitality of the transported teeth and bone. In a case report, Kondoh et al. repaired an alveolar defect after marginal mandibulectomy using the same procedure and named it 'sliding transport distraction osteogenesis'[26]. In their patient, an unerupted tooth moved with the transported segment and it erupted spontaneously during the consolidation period at the new location. In this study, all teeth were extracted due to the previous periodontal and restorative status (eight defects) or bone resorption at the end of the transported segment (four defects).

Some authors have performed bone transport using an ordinary or modified orthodontic appliance. Although these devices have advantages such as easy construction and lower cost, changes in inclination or mobility of the anchorage teeth are associated disadvantages[20–23,27]. In a case report, a cleft distractor was used for the restoration of a posterior mandibular defect because of its flexibility and the long legs of the distractor, which helped the patient to turn the rod with ease[12]. Unidirectional intraosseous vertical alveolar distractors were used in the patients included in the present study.

Satisfactory results of ATDO and the successful placement of implants in regenerated bone have been reported previously[12,19,22,23,28,29]; however, it appears that no study has evaluated the success or survival rates of implants. The survival rate at 63 months of the 25 implants inserted was 92%, which is comparable to the results of Uckan et al., in which the success rate was 91.4% using VADO[8].

Vector control during distraction of the transported segment, especially in curvilinear defects, is considered one of the most critical issues of ATDO. An arch form is needed for reconstruction of an alveolus, but the vector of the transport distraction device is straight only. However lingual and palatal tissues always pull the segment into the arch position and

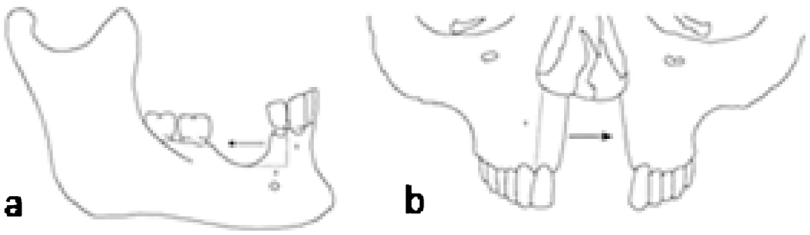


*Fig. 6*. (a) In alveolar transport distraction osteogenesis, there are most often two osteotomized active bone surfaces (there is less bone contact than in vertical alveolar distraction osteogenesis). (b) In some cases there is only one active bone surface, representing the least bone contact.

intercuspid contact stabilizes this vector. Some authors have dealt with this problem using various appliances or methods[19,28]. Otherwise a second osteotomy has to be performed and a new distraction vector formed after the consolidation period. Bilateral ATDO is preferred in wide alveolar defects and clefts, in order to provide a particular bone shape and shorten the duration of distraction. Bilateral alveolar distractors were applied in two patients in the present study (one cleft patient and one traumatic injury patient).

A gap may occur between the transport segment and basal segment or docking site and this may result in the need for secondary grafting. This gap possibly occurs due to intervening soft tissue or resorption at the advancing edge of the transported bone[30]. Some authors have removed soft tissue and used bone grafts (docking site surgery)[24,28,31], and some have developed compression forces to achieve fusion with the residual bone[32,33]. Docking site surgery was not performed in the present study.

Deviation of the transported segment in the lingual or palatal direction due to muscle tension and thick or inelastic mucosa can be corrected during the consolidation period. Case reports have shown the resolution of this problem through several methods[34,35]. Basa et al. suggested a horseshoe-shaped acrylic splint that could be fabricated and secured on the lingual side to prevent medial displacement[12]. In the present study, the distracted segment tilted lingually in one patient; this segment was aligned manually and fixed in its correct position with a miniplate.

This study is subject to several limitations, such as a small sample size and a heterogeneous group of patients. Despite this, and although there are some case reports in the literature, it appears that this study reports the largest series of patients treated with this technique to date and is unique in reporting implant survival following ATDO.

It can be concluded that ATDO is an effective and reliable method for the restoration of wide alveolar defects. It is recommended for large alveolar defects, for defects that cannot be closed by grafting methods, and for patients who do not accept extraoral bone grafting. A substantial amount of hard and soft tissue regeneration, followed by implant placement and acceptable aesthetic–functional prosthetic restoration can be achieved using this method. However the necessity for patient compliance, device cost, tilting of the bone segment, tooth loss, and insufficient final bone width are the disadvantages of ATDO[19,24]. Proper patient selection is critical for the success of ATDO. In conclusion, ATDO appears to be effective for the reconstruction of the alveolar crest prior to implant placement.

## Funding

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## Competing interests

There is no conflict of interest.

## Ethical approval

The Non-interventional Research Ethics Committee of Istanbul Medipol University approved the study (reference number L 10840098-604.0101-E.2604).

## Patient consent

Not required.

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