Case Report

Use of alveolar distraction osteogenesis for anterior maxillary defect reconstruction

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Abstract:

Alveolar osteogenic distraction (AOD) is a biological process through which new bone formation occurs between bone segments that are gradually separated by incremental traction. This case report described the oral rehabilitation with dental implants of a patient with a vertical bone defect in the maxillary anterior region using the AOD technique. The patient presented with absence of the teeth 22, 21, 11, and 12 associated with a vertical bone defect. The AOD was performed using a supported osteodistractor device surgically installed with subsequent daily activations. After 21 days, the ideal positioning of bone fragment was confirmed and activation was ceased. Five months after the initial surgery, two dental implants were installed in the region of teeth 12 and 22. An FP3 metal–ceramic prosthesis was installed offering satisfactory esthetic results. In conclusion, the use of AOD to increase the alveolar ridge was effective and ensured rehabilitation with dental implants.

Key words:

Alveolar osteogenic distraction, bone regeneration, esthetics

INTRODUCTION

Alveolar osteogenic distraction (AOD) has been considered a promising procedure for bone augmentation. The AOD is a biological process through which new bone formation occurs between the surfaces of vascularized bone segments that are gradually separated by incremental traction.[1] The bone is initially sectioned by osteotomy and the separation process is controlled by an osteodistractor device.[2] In this way, the AOD avoids the morbidity associated with the donor site and provides hard- and soft-tissue predictable gain once the alveolar bone gain occurs simultaneously with soft-tissue increase.[3] Moreover, the AOD is associated with low infection rate, decreased bone resorption, and a short period of bone healing, accelerating the treatment finalization. The new bone structure formed by this technique has the same quality and morphology of the maxilla bone, and the use of the autogenous bone graft is not required.[3]

Clinical studies have demonstrated that the bone formed by the AOD process resists the functional demands, and the survival rates of implants installed in the distracted areas are consistent with those installed in the native bone.[4,5] Furthermore, a more predictable hard- and soft-tissue volume is obtained compared to other methods of vertical bone augmentation, ensuring the installation of longer implants. In addition, there is a lower chance of hard-tissue exposure and graft reabsorption once the mean bone resorption during the AOD consolidation period ranges from "insignificant"[6] to about 30% of bone loss[7] in comparison to the approximately 42% mean bone loss for patients with autogenous block bone graft.[8]

Disadvantages of the AOD approach are related to the difficulty of performing the technique itself and the nonesthetic appearance of the osteodistractor device on the frontal aspect of the maxilla. Complications associated with this procedure have been reported and include basal bone fractures, bone segment fracture, soft-tissue dehiscence, bone exposure, infections, mechanical problems, and several device

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failures.[9] In addition, there is no consensus about some AOD therapeutic aspects including the latency period duration or the amount of overcorrection necessary to compensate for bone resorption during the AOD consolidation period.

Based on the several advantages associated with AOD technique, the purpose of this case report was to describe the oral rehabilitation of a patient with a vertical bone defect in the anterior region of the maxilla using osteogenic bone distraction to increase the tissue volume prior to the installation of dental implants. This case report also proposed an innovative and original dento-supported osteodistractor confectioned with prefabricated teeth with the aim of improving the patient's esthetics during the use of the osteodistractor and increasing patients' acceptance to the treatment.

CASE REPORT

A 42-year-old male patient was admitted for oral rehabilitation with dental implants in the anterior maxillary region. Clinical and radiograph examinations revealed the absence of teeth 22, 21, 11, and 12 with a vertical arch defect that impaired the adequate dental implant placement associated with a high smile line [Figure 1a and b]. Based on that, the osteogenic distraction procedure was proposed to increase bone height in the anterior region of the maxilla in order to assure adequate dental implant placement and an esthetic and functional oral rehabilitation.

Initially, elastic separators were used around the supporting teeth and the orthodontic bands were placed. The maxillary impressions with alginate (Orthoprint-Zhermack Inc., River Edge, New Jersey, USA) were made to cast acquisition that received the transfer bands. Then, an original dento-supported osteodistractor was confectioned with prefabricated teeth (Trilux-VIPI ind. Pirassununga, SP, Brazil) and an artificial gingiva was fixed to the osteodistractor rod in the anterior maxillary region due to the patient's esthetic requirement [Figure 2].

For the osteodistractor surgical installation, a single dose of antibiotics (amoxicillin – 2 g) associated with a steroidal anti-inflammatory agent (dexamethasone – 4 mg) was prophylactically administered 1 h prior to surgery. Intra- and extraoral asepsis were made with 0.12% and 2% chlorhexidine gluconate, respectively. Local anesthesia was induced using a 4% articaine solution with epinephrine 1:100.000 (Nova DFL, Rio de Janeiro, Brazil). Intraoral linear incision with 15C Scalpel Blade was performed on the vestibular region 1 mm above the mucogingival line. Then, two vertical incisions rising from the first incision were carried out over the mesial region of the both canine roots. A conservative subperiosteal dissection was performed to expose the bone ridge only in the osteotomy region, preserving the soft tissue on the palatal and bone crest areas. The maintenance of the mucoperiosteal tissue adhered to the palatal bone and the bone ridge is fundamental for the bone fragment blood nutrition.[10] Osteotomy was performed using a piezoelectric ultrasonic device (CVDentus®, São José dos Campos, SP, Brazil) and a 700-carbide drill at 1200 rpm coupled with a surgical straight handpiece. The osteotomy was made in trapezoidal shape, with the base oriented to the ridge crest [Figure 3]. The vestibular and palatine cortices were completely ruptured, and the bone fragment remained adhered only to the palatal mucosa and to the mucosa of the ridge crest region. The trapezoidal shape is necessary to guarantee fragment movement during the osteodistractor activation.[11] After the osteotomies, two mini-implants (1.5 mm × 8 mm; SIN Implant Systems-São Paulo, SP, Brazil) were placed at the center of each side of the bone fragment [Figure 4].

After confirmation of the bone fragment's total mobility, a 0.25-mm orthodontic wire was tied in both mini-implants to fix the osteodistractor to the bone fragment. A simple suture with 4–0 silk (Ethicon®, Johnson and Johnson Medical Limited, New Brunswick, NJ, USA) was made with small fenestrations in the flap to ensure wire access [Figure 5]. The osteodistractor was placed immediately after the surgical procedure using glass ionomer for band cementation (Vidrion C-SS White, Rio de Janeiro, Brazil). The activation of the device started after a 7-day latency period from the surgical procedure with subsequent activations of ¼th turn (0.25 mm) two times a day (morning and night), corresponding to an opening of 0.5 mm/day. The course of the bone fragment movement was followed by periapical radiographs [Figure 6a] and measurements in millimeters with Castroviejo compass [Figure 6b]. Two fixed structures on each side of the osteodistractor were predetermined to guarantee the accuracy of the Castroviejo compass measurements. During the period of osteogenic distraction, the patient was followed up every 3 days by the orthodontist and the incisors of the osteodistractor artificial teeth were periodically trimmed, preventing any contact with the opposing teeth [Figure 7]. After 21 days of activation, the ideal positioning of the bone fragment was confirmed by clinical and radiographic evaluations and the fragment movement was concluded [Figure 8].

After the consolidation period, corresponding to 4 months following complete activation, the dental implant placement was planned using a panoramic radiograph [Figure 9]. Then, the same preoperative protocol described above was followed, the osteodistractor was removed, and local anesthesia was induced using a 4% articaine solution with epinephrine 1:100.000 (Nova DFL, Rio de Janeiro, Brazil). A linear incision was performed on the ridge crest using a 15C Scalpel Blade, followed by full-thickness mucoperiosteal flap. The mini-implants were removed and two external hexagon implants (3.3 mm × 13 mm; Neodent-Curitiba, PR, Brazil) were placed in the 12 and 22 tooth regions, following the fabrication instructions [Figure 10]. The dental implants were installed in a more palatal position due to the atrophic aspect of the maxilla. The insertion torque for both dental implants was 40 N and 45 N, respectively. Simple suture was performed with 4–0 silk (Ethicon®, Johnson and Johnson Medical Limited, New Brunswick, NJ, USA).

The sutures were removed after 10 days and a temporary removable partial denture was installed for patient function during the osseointegration period. After the osseointegration of implants [Figure 11] and installation of healing abutments, implants were molded to provide temporary restorations. At the end of the interim stage, new implant molding was performed using the open-cast technique, and an FP3 (Misch Prosthodontic classification) metal–ceramic prosthesis in feldspar porcelain was made with satisfactory esthetic results after 3 months of follow-up [Figure 12a and b].

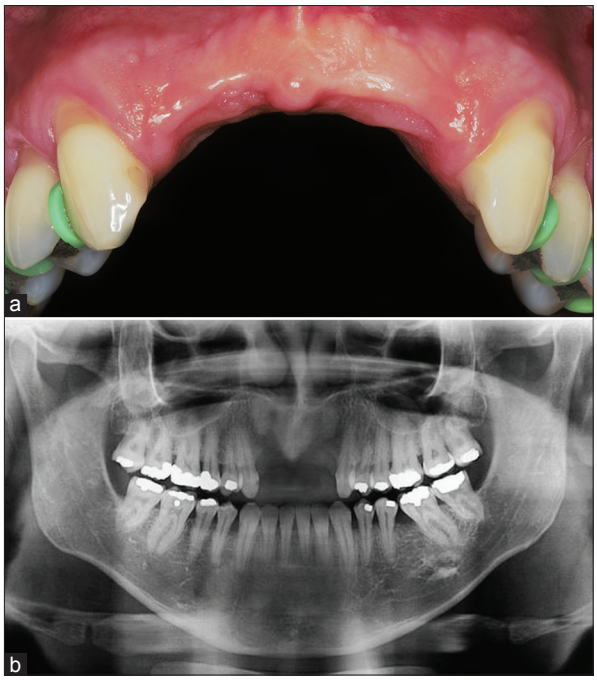

Figure 1: (a) Initial intraoral image demonstrating the absence of dental teeth 22, 21, 11, and 12 associated with a vertical bone defect. (b) Initial panoramic radiograph before the alveolar osteogenic distraction demonstrating the vertical bone defect in the maxillary anterior region

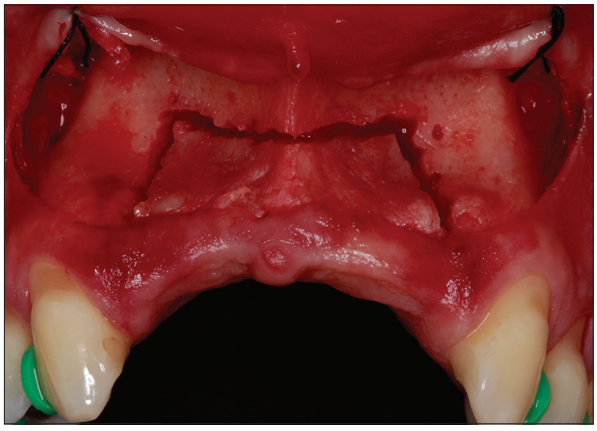

Figure 3: Osteotomy in a trapezoidal shape, with the base oriented to the ridge crest

Figure 5: Orthodontic wire in both mini-implants to fix the osteodistractor to the bone fragment

Figure 2: Dento-supported osteodistractor device with prefabricated teeth and artificial gingiva fixed to osteodistractor rod

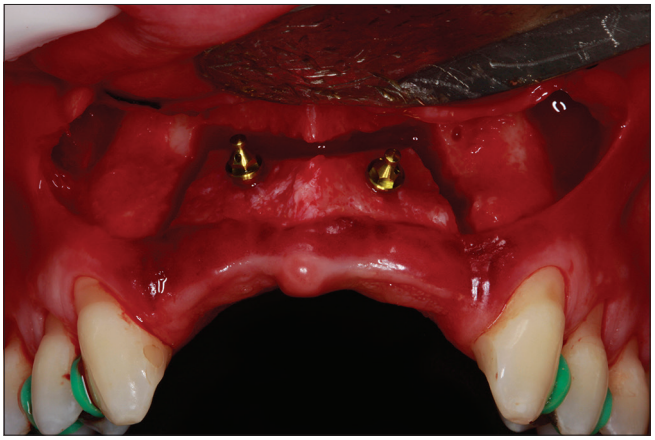

Figure 4: Two mini-implants placed at the center of each side of the bone fragment

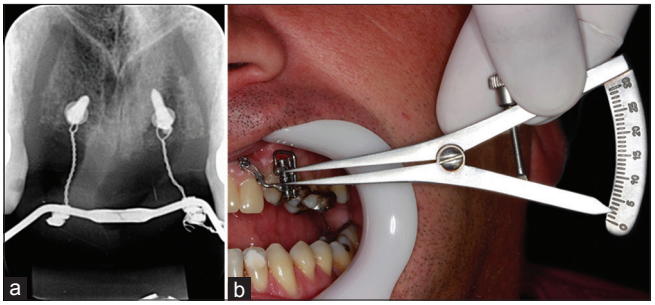

Figure 6: (a) The course of the bone fragment movement followed by periapical radiographs after 7 days of the alveolar osteogenic distraction surgery. (b) The course of the bone fragment movement measured in millimeters with Castroviejo compass

DISCUSSION

Despite the efficacy of autogenous bone grafts for vertical bone defect reconstruction, a 25%–42% of bone resorption could be observed in these grafts, associated with a mean vertical bone gain limited to 5 mm in partially edentulous patients.[8] On the other hand, an average vertical gain of up to 12 mm could be obtained with the AOD technique.[12] Based on that, the AOD technique was chosen in this case report to guarantee simultaneous hard- and soft-tissue augmentation, with smaller resorption in the postoperative period, lower surgical morbidity, and complication risks. The disadvantages described in literature associated with the osteodistractor

Figure 7: Intraoral frontal view of the osteodistractor device, with the incisor teeth periodically trimmed

Figure 8: Final tissue volume obtained after 21 days of osteodistractor activation

Figure 9: Panoramic radiograph after 4 months of the alveolar osteogenic distraction surgery confirming the bone gain obtained

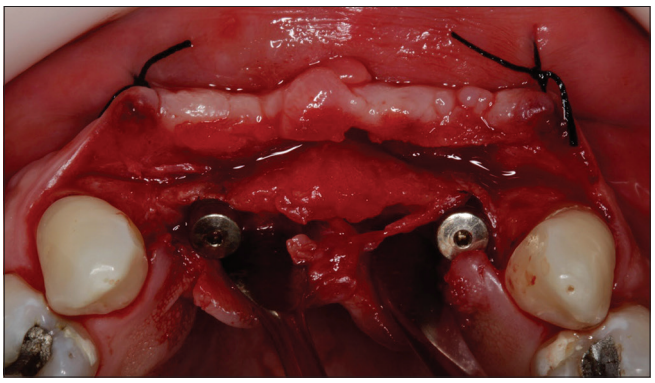

Figure 10: Two external hexagon implants (3.3 mm × 13 mm) placed in the 12 and 22 tooth regions

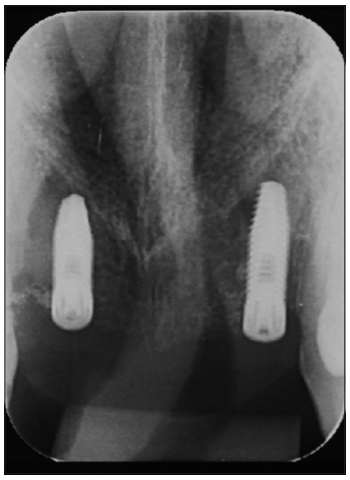

Figure 11: Periapical radiography of implants after 6 months of osseointegration

Figure 12: Final treatment aspect obtained after the metal–ceramic prosthesis installation after 3 months of follow-up. (a) Intraoral, (b) Extraoral

device in relation to esthetics, costs, and the occurrence of mechanical failures were not observed in this case report.[13] The construction of the device including artificial teeth favored the partial restoration of function and esthetics during the treatment phases. In addition, the device was produced in the prosthesis laboratory, reducing the costs associated with the osteodistractor manufacturing.

On the other hand, the AOD guarantees only the correction of vertical bone defects. However, the bone augmentation

obtained using the AOD technique in this case report was enough to allow the dental implant placement in a more palatal position. This technique enables rehabilitating atrophic patients with similar success rates, soft-tissue conditions, and peri-implant bone loss, which was observed in well-centered implants placed in nonatrophic ridges.[14] In addition to that, dental implants with 3.3 mm in diameter were chosen in this case since literature indicates the use of smaller diameter implants in the anterior maxilla to optimize esthetic results. The use of implants that are <4 mm in diameter maintains a generous amount of buccal bone and guarantees an ideal prosthetic emergency profile, enhancing esthetics.[15]

Soft-tissue complications, including dehiscence[7] and failure to increase the gingival tissue height,[16] have been frequently mentioned in the studies evaluating AOD clinical results. According to Ettl *et al*., (2010),[13] this failure in mucosal extension could be associated with the horizontal vestibular incision made in the alveolar ridge associated with two vertical incisions that can induce scarring and inhibit the formation of a suitable gingival band. In the present case report, the access to bone structures was performed with a linear incision 1 mm above the mucogingival line associated with a conservative subperiosteal dissection only in the osteotomies region, preserving the soft tissue on the palate and on the bone crest area, thus preventing the occurrence of dehiscence.

Another complication described in the literature is the distracted bone fragment fracture or resorption. This complication has been related with the length of distracted bone fragment that must be at least 5 mm high.[17] Small bone segments are associated with increased bone resorption and complication rates due to dense screw fixation and poor vascularization.[17] In this case report, the osteotomy was made in a trapezoidal nonretentive format, with the base facing the ridge crest. The trapezoidal nonretentive format prevents fractures and ensures the efficiency of the movement during the osteodistractor activation.[11]

Periods of consolidation prior to implant installation are necessary to ensure complete maturation of the bone tissue formed between the basal bone and the bone fragment. A histological study conducted by Marchetti *et al*.[18] compared the aspect of the bone tissue formed after periods of consolidation of 70 and 180 days. At 70 days, biopsies showed a vital lamellar bone with many Haversian canals and osteons. Similarly, the biopsies performed at 180 days after the end of distraction demonstrated that the amount of bone tissue apposition did not differ from that observed at 70 days; however, the bone was more compact and mature, with well-organized osteons. Therefore, in the present case report, the placement of implants was performed 4 months after consolidation to ensure complete bone maturation prior to implant installation.

CONCLUSION

The use of AOD technique to increase the alveolar ridge in the atrophic maxilla was effective for bone and soft-tissue augmentation, ensuring the dental implant installation in a correct position with lower surgical morbidity, low risk of infection, and lower resorption compared to other surgical techniques.

Acknowledgement

The authors dedicate this case report to the memory of Professor Elcio Marcantonio PhD whose inspiration and guidance led us to master the use of the presented technique.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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