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Alveolar Distraction Osteogenesis of the Severely Atrophic Anterior Maxilla: Surgical and Prosthetic Challenges

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Abstract

Significant maxillary anterior osseous defects are considered contraindications for fixed partial dentures. This clinical report discusses the surgical and restorative treatment protocol of a patient who sustained trauma to the premaxilla and was treated by distraction osteogenesis to provide an adequate restorative platform for an implant-retained fixed prosthesis.

History

Distraction osteogenesis (DO) is rooted in the 1940s and 1950s in Siberia with Dr. Ilizarov, a Russian orthopedic surgeon. Considered the father of DO, he treated World War II amputees with a revolutionary surgical technique that could "lengthen limbs." After performing a corticotomy in long bones, he would apply a four-ring distractor that could be activated several times a day after an initial healing interval of 5 to 7 days. The callus formed in the center of the corticotomy would then slowly be placed under the traction of the distractor, resulting in new bone formation (osteogenesis) over several weeks. In 1992, McCarthy et al[1] used this concept to treat hemifacial microsomia by distracting the mandible. In 1996, Block et al[2] subsequently described the first alveolar distraction in dogs, while Chin and Toth applied it to humans the same year.

Indications for DO

The main indication for alveolar distraction is vertical augmentation of the ridge with or without soft-tissue deficiency. Compared to guided bone regeneration and onlay bone grafting, DO has proven to predictably gain more than 5 mm of alveolar height.[3,4,11] In addition to vertical bony growth, the mucosa also develops with a predictable increase of vestibular height. This technique may either be used to optimize esthetics in the anterior areas or to increase bony volume prior to implant placement in the posterior. Severe traumatic defects often result in complex multidimensional dento-alveolar and mucosal deficiencies best treated with a combination of DO and onlay bone grafting. In extremely atrophic areas, there may be minimal bone available to distract, requiring an onlay bone graft to be performed first. After 4 months of healing, the grafted area can then be vertically distracted. In cases where there is mild-to-moderate horizontal atrophy, the DO can be performed first, followed by an onlay bone graft.

Clinical report

A 34-year-old male patient was first evaluated in the emergency department for maxillofacial injuries he sustained at work while operating heavy machinery. His medical history included an allergy to Penicillin and a history of tobacco use (one pack per day for the last 10 years). The upper anterior alveolus and teeth no. 7 through 12 were severely fractured and luxated, necessitating their extraction. After an initial healing period, he presented 12 weeks later for an evaluation, with the chief concern being replacement of the lost teeth. On examination, he had severe horizontal and vertical maxillary anterior alveolar deficiency (Fig 1), confirmed on a computed tomography (CT) scan reformatted with Simplant software (Materialise Dental, Leuven, Belgium) (Fig 2). The prosthetic options consisted of a fixed or removable prosthesis. After carefully reviewing alternatives, complications, and benefits for each option, the patient opted for an implant-retained fixed prosthesis.

Based on our clinical exam, wax-up, and CT scan, it was determined that the patient's anterior maxilla needed to first be reconstructed with DO to gain vertical height, followed by

onlay bone grafting to restore the deficient width. The patient underwent an anterior maxillary osteotomy with the placement of an alveolar distractor under general anesthesia. A Modus bidirectional distractor (Medartis, Basel City, Switzerland) with two independent central pins yielding vertical distraction of 0.25 mm per turn and a buccal tilt of 10° per turn was used. Through a vestibular incision, the distractor was first placed on the buccal alveolus and temporarily fixated before planning the osteotomies. Then, a horizontal and two divergent vertical osteotomies were carried out with sagittal and reciprocating saws under heavy normal saline irrigation with care to preserve the palatal pedicle prior to refixating the distractor (Fig 3).

After a latency period of 8 days, we began the distraction process at a rate of 0.5 mm/day. During a period of 36 days, the alveolus was vertically distracted a total of 10 mm; however, the activation was interrupted and decreased several times due to partial soft tissue dehiscence around the device (Fig 4). Ultimately, the dehiscence was primarily closed with nonresorbable sutures. In addition, the buccal segment was laterally tilted a total of 30°, split into three activations, spread 1 week apart.

During the activation period, it was also noted that the central pin, pulled lingually by the thick palatal tissue, impinged on the incisal surface of the lower anterior teeth. To remediate this situation, an acrylic occlusal splint was inserted on the maxillary arch accommodating the distractor to open the occlusal vertical dimension (OVD). Our patient was instructed to wear the splint continuously. Once the activation period was stopped, the pin was sectioned with a handpiece, and the occlusal splint removed.

Three months after removing the distractor, the patient was taken to the operating room for the placement of an onlay bone graft of the anterior maxilla using his anterior iliac crest as the donor site (Fig 5). Particulate cancellous bone chips were packed around the blocks and covered by a membrane. Then, a tension-free watertight closure was performed after releasing the flap and scoring the periosteum. A small bony dehiscence was noted 5 weeks later on the buccal aspect. It subsequently sequestered, and no treatment was needed.

After 5 months of graft maturation, a Simplant reformatted CT scan of the maxilla was repeated to plan placement of the implants. Despite marked graft resorption in some areas, it was determined that there was enough vertical and horizontal alveolar bone for fixture placement (Figs 6, 7). Implants (Nobel Replace Select tapered, Nobel Biocare, Zurich, Switzerland) in the area of no. 7 (3.5 × 16 mm), no. 8 (3.5 × 13 mm), no. 9 (3.5 × 10 mm), no. 11 (3.5 × 16 mm), and no. 12 (3.5 × 13 mm) were placed (Fig 8). Although no implant threads were exposed, several buccal areas were noted to be very thin, prompting the need for localized guided tissue generation with Puros (RTI Biologics, Alachua, FL) covered with a Bio-Gide membrane (Osteohealth, Shirley, NY).

After a total of 6 months of integration, the implants were uncovered, and healing abutments placed. All implants were noted to be stable when manually torqued at 35 Ncm before abutments were placed.

The prosthodontic reconstructive phase of care consisted of a reevaluation of the implant fixture positions and axial inclinations, as well as the interarch distance and centric relation position of the mandible. The posterior maxillary teeth manifested neither mobility nor periodontal pocketing and were devoid of any significant restorative procedures. An Angle Class I molar relationship was present, and the centric relation and maximum intercuspation positions were coincident.

Closed tray impression copings were placed, radiographed, and stabilized with carbide burs luted to the copings with Triad Gel (Dentsply International, York, PA). The fixture level full-arch impression was made using polyvinyl siloxane (PVS) (Honigum, DMG, Hamburg, Germany). A facebow record facilitated the mounting of the maxillary cast to an arcon articulator (Teledyne Combi, Whip Mix, Louisville, KY). A wax interocclusal record was used to articulate the mandibular cast at the same vertical dimension. A diagnostic full-contour wax-up with labial flange incorporating temporary abutments was fabricated. The try-in allowed for evaluation and correction of lip support and incisal edge position in three planes. With the patient's approval of the esthetic arrangement of the teeth and flange-contour, the wax-up was transferred back to the master cast, and a labial and lingual PVS lab putty (Sil-Tech Ivoclar, Buffalo, NY) index was made.

Although the anterior ridge height and width had been significantly enhanced, a labial flange on the fixed prosthesis was necessary to create a confluence from the natural dentition to the prosthetic replacement. Furthermore, to facilitate retrievability and removal during periodic prophylaxis, a screw-retained restoration was fabricated.

The framework was waxed in two segments, and at the try-in appointment, after radiographic verification of fit, the segments were luted with GC Pattern resin (GC America, Alsip, IL). The implant fixture in the area of the left central incisor (no. 9) was palatal to the arch (Fig 9). Porcelain was baked to the metal substructure in the area of the teeth. The labial and proximal soft tissue contours were reestablished with a resin flange (Figs 10, 11). When reviewing tooth contours and shade, the patient brought photographs of himself prior to the accident but requested that the shade of the prosthetic teeth be lighter and more vibrant than his adjacent or opposing teeth.

The implant-retained fixed partial prosthesis was equilibrated in all excursions, ensuring an atraumatic mutually protected occlusal scheme. The prosthesis was repolished, and the set-screws were tightened to 20 Ncm. The screw access holes were sealed with pellets of cotton and Tempit L/C (Centrix Corp., Shelton, CT). The patient has been followed for 6 months with no clinical complications (Fig 12). Radiographs of these implants will be taken every 18 months for the next 5 years to monitor bone resorption.

Discussion

As with any patient requiring dental implants to replace missing teeth, careful examination and treatment planning are critical. In extensive defects, a CT scan with a barium-coated radiographic guide may be used to evaluate ridge morphology, the vector of distraction, and the location of osteotomies in relation to neighboring roots, maxillary sinus, nasal cavity, inferior alveolar nerve, and inferior mandibular border. The segment being distracted should be at least 4-mm in height to prevent its resorption during the distraction phase. In the mandible, more

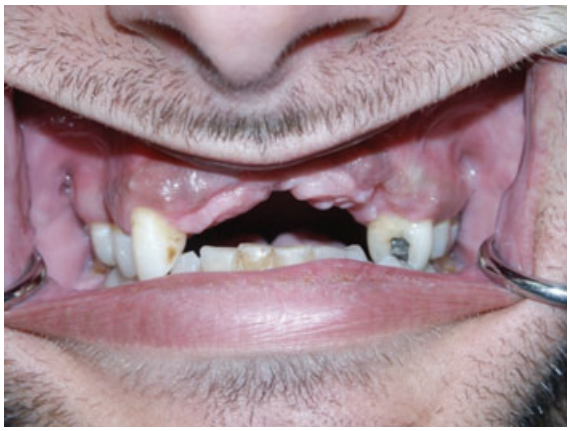

Figure 1 Vertical alveolar ridge defect.

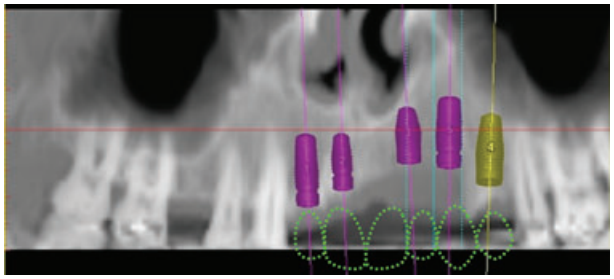

Figure 2 A panoramic reconstructed view of a CT scan. Note the apical position of the implants and the anticipated restorations. An unfavorable implant-to-crown ratio can be appreciated.

than 9 mm of intact residual inferior border is necessary to prevent fractures.[5–9] To prevent damaging the adjacent teeth, the osteotomies are made 2 mm from the roots.

Careful assessment of occlusion is also critical to avoid interferences with the central pin protruding in the vestibule. When distracting the anterior maxilla, the pin may sometimes be camouflaged by a temporary prosthesis. Patient compliance is essential since the patient is responsible for activating the

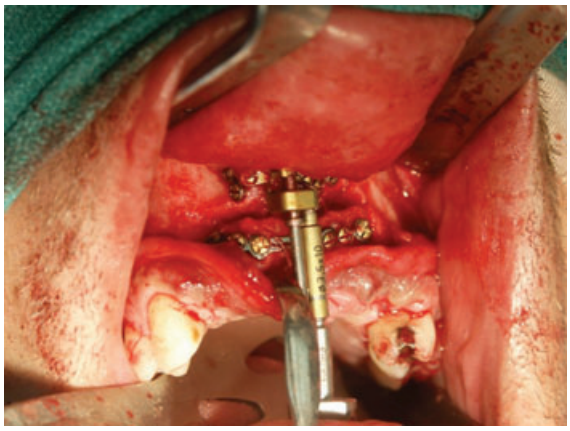

Figure 3 Osteotomies and the placement of the distractor.

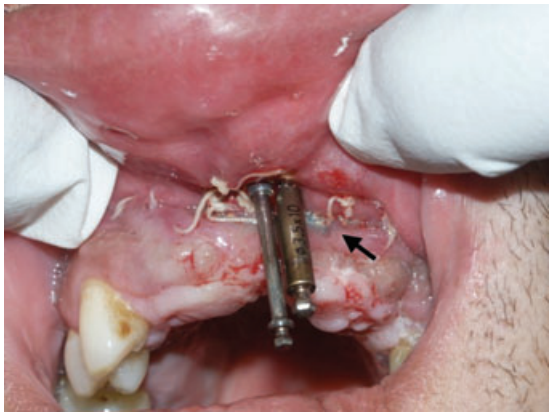

Figure 4 Intraoral photograph taken 13 days postoperatively, demonstrating a soft tissue dehiscence around the device (black arrow).

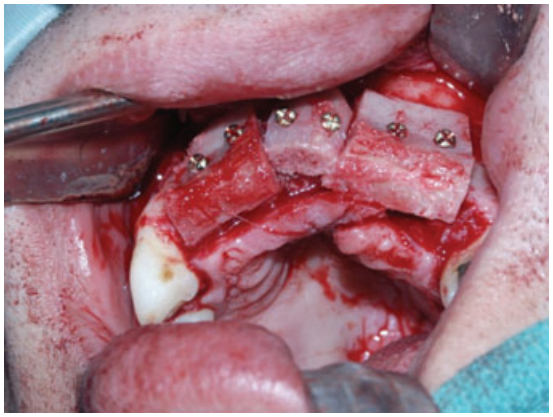

Figure 5 Anterior iliac crest bone graft to the maxilla. The blocks were subsequently rounded, and cancellous bone was added.

device two to three times per day by turning the pin clockwise. If this is not performed for a few days, there may be a risk for premature consolidation of the segments. Multiple follow-up appointments are recommended during the distraction phase to

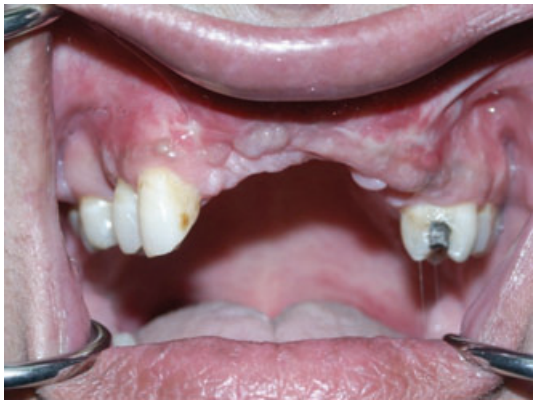

Figure 6 Morphology of the ridge 5 months after bone grafting. Note the improved vertical dimension of the alveolus (refer to Fig 1).

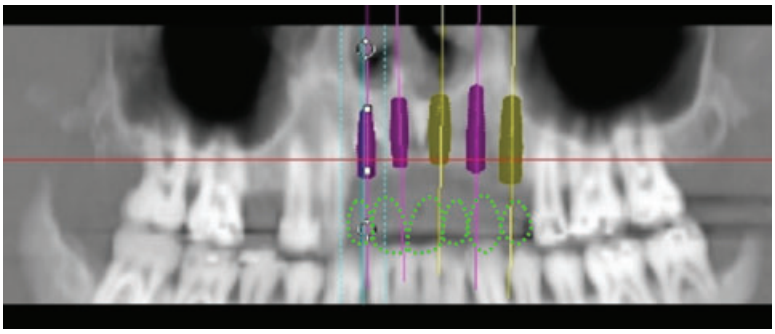

Figure 7 A panoramic reconstructed view of a CT scan taken 5 months after bone graft of the maxilla. Note the improved apico-coronal position of the implants and the anticipated restorations. An enhanced implant-to-crown ratio can be appreciated (refer to Fig 2).

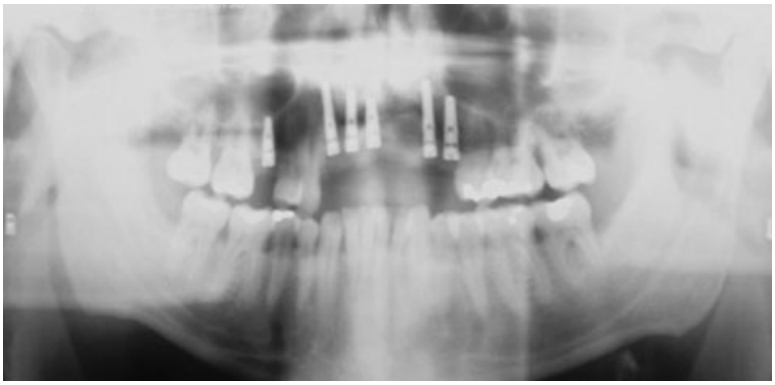

Figure 8 Panoramic radiograph depicting position of implants.

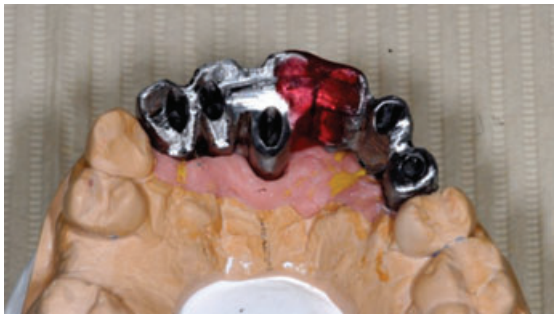

Figure 9 Cast metal substructure fabricated in two sections, luted with GC resin. Note the fixture in the no. 9 position is offset lingually.

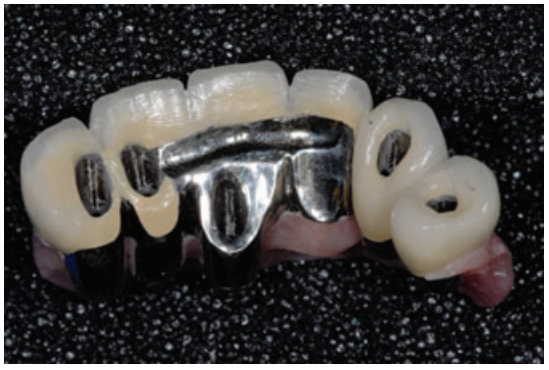

Figure 11 Lingual view of the implant-retained fixed bridge with metal incisal stops.

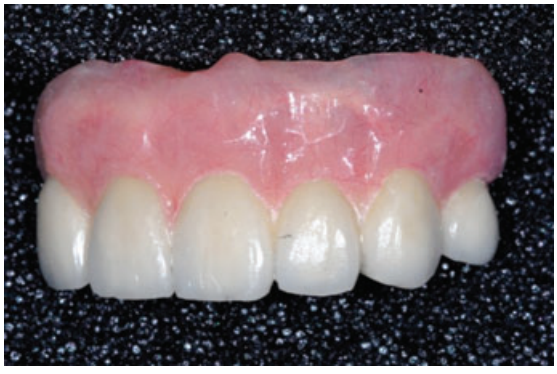

Figure 10 Porcelain baked to the tooth contours and soft tissue developed with a resin flange.

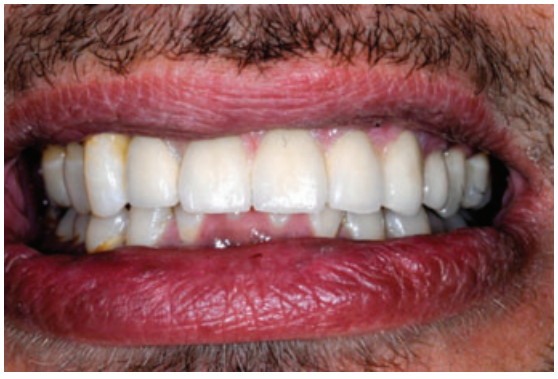

Figure 12 Frontal view of definitive prosthesis 6 months post insertion

monitor the progress and treat occasional dehiscences of the devices or correct vector discrepancy.

In the case presented, we obtained approximately 5 mm of vertical augmentation and 3 mm of horizontal increase in the area of no. 7 through 12, as confirmed on the preimplant placement scans (Fig 7). The discrepancy between the initial amount of alveolus distracted (10 mm) and noted 5 months postgrafting (5 mm) is due to the prolonged treatment interval between the removal of the distractor and the placement of implants (9.5 months). In situations where no secondary grafting is needed, implants are usually placed at the time of distractor removal, thus minimizing the risks of resorption. Clinically, this bone loss translated into slight increase in crown-to-implant ratio.

Despite the great predictability of alveolar DO,[12-15] a high rate of surgical complications has been reported. In a comprehensive analysis of 37 patients with 45 ridge deficiencies, Enislidis et al[10] described a complication rate of 75.7%. The majority of these complications were categorized as "minor," and included soft tissue dehiscences (37.8% of distracted sites), tilting of the segments, or occlusal interferences that did not impact adversely on implant survival (95.7%); however, "major" complications (21.6%) were reported as well, such as fracture of basal bone or the transport segment, breakage of the distractor, and severe mechanical problems, all resulting in treatment discontinuation.

In the clinical report presented, the patient experienced multiple minor complications during this multidisciplinary treatment plan. The soft tissue dehiscence we experienced during the distraction period caused a total delay of more than 2 weeks and an additional surgical procedure to primarily close the site. Careful incision planning and good homecare can help prevent this complication. Unfortunately, the patient dehisced once again, 5 weeks postonlay bone grafting, resulting in partial loss of the graft and, ultimately, resulting in the palatal positioning of the fixtures.

Occlusal interferences by the central pin impinging on the lower incisors were also encountered in this case. To prevent excess trauma to the device, an acrylic-occlusal splint was fabricated and inserted to slightly increase the OVD. Once the distraction phase was completed, the central pin was sectioned, relieving the occlusion. This minor complication is best avoided by careful preoperative planning, the use of articulated models, and precise placement of the device.[5] Orthodontic treatment and tilting of the segment can be achieved to relieve the occlusal interferences caused by a malposed distractor central pin.[10]

Conclusion

This case illustrates the multidimensional alveolar deficit frequently encountered after trauma and the different treatment modalities required to provide adequate site development for an implant-retained restoration. The vertical deficiency was first addressed with alveolar DO, followed by onlay bone grafting to correct the compromised width. Proper treatment planning, in conjunction with careful surgical technique and precise prosthetic rehabilitation are keys to minimizing complications and assuring long-term treatment success. DO is a viable treatment modality to expand the height of the residual ridge. This procedure does have several clinically limiting conditions and is not suitable for all patients. Careful consideration must be given to achieve proper lip support and lingual tooth morphology to ensure acceptable esthetics and anterior guidance.

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