Immediate Loading of Dental Implants Placed in Distracted Bone: A Case Report

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A 40-year-old female patient presented for rehabilitation of an edentulous mandible with endosseous implants. Radiologic examination showed evidence of moderate atrophy in the intraforaminal area and an even more pronounced level of bone resorption in the posterior mandible. The patient desired a fixed rehabilitation with re-establishment of the posterior occlusal plane. From an esthetic standpoint, it was necessary to provide a restoration with crowns the same height as the original teeth while avoiding an unfavorable biomechanical situation. Vertical distraction of the complete mandible was performed using a Martin distractor according to the Hoffmeister technique. At the end of the period of activation and consolidation, the distractor was removed and 8 Frialit-2 Synchro-type implants were placed in predetermined sites and immediately loaded with a cemented transitional prosthesis. Ten months later the definitive restoration was delivered. The absence of any pathologic symptoms or negative radiologic findings 12 months after the surgery suggests a satisfactory result in the short term.
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Distraction osteogenesis (DO) is a surgical method of bone elongation—growing bone between bone segments separated by incremental traction.[1,2] A corticotomy is performed on endochondral bone, followed by a gradual distraction of the developing callus.[3] It was used experimentally in dogs by Snyder and colleagues[4] in 1973 and in a clinical case by McCarthy and associates[5] in 1992—the first clinical case of mandibular lengthening by gradual distraction using an intraoral device reported in the English literature. Since then there has been an increase in the possible applications of this procedure in the craniomaxillofacial region.[2] Theoretically, every bone segment in the head can be distracted.[2] In the last 2 decades, this technique has been used to lengthen or repair continuity defects in the mandible, maxilla, and craniofacial bones in the treatment of conditions such as hemifacial microsomia, micrognathia, craniosynostosis, and maxillary and mandibular hypoplasia.[1,2,6–14] More recently, this method has been reported in the treatment of bone defects in orthognathic, traumatic and tumor surgery.[2]

The value of DO is related to its simplicity and relatively low morbidity compared with other surgical techniques.[2] In addition to reducing disability, DO can reduce the number of procedures a patient undergoes and the duration of treatment.[13] In DO, new bone is formed without the use of bone grafts.[13] Bone formation starts when force is applied to the healing callus that is formed between the sectioned bone segments.[1] The gradual traction on living tissues stimulates and maintains the regeneration and differentiation of precursor cells.[2,15] DO has been shown to be an effective technique for widening and

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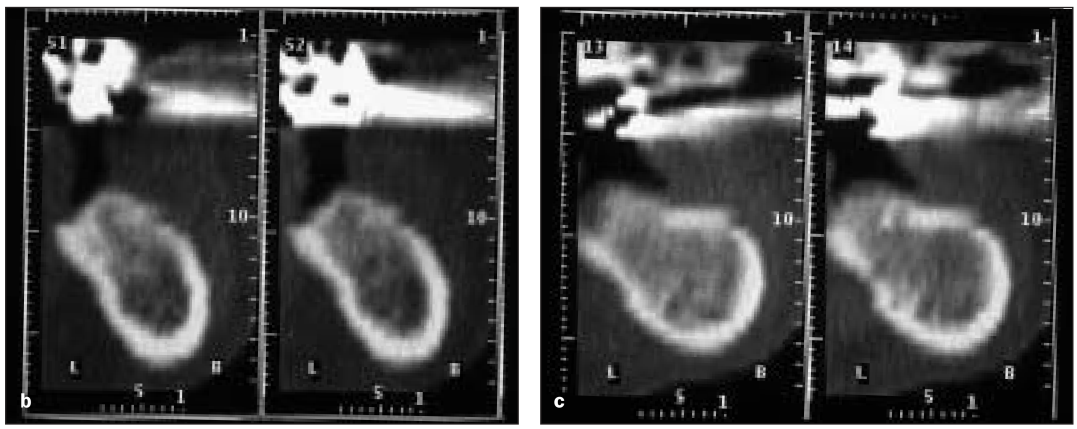

Figs 1a to 1c *(a)* Preoperative panoramic radiograph showing complete edentulism in the mandible and relevant atrophy of the alveolar ridge. Investigation of the sagittal sections from the computerized tomography scan *(b, c)* clearly indicates that the available bone in the posterior mandibular area does not have sufficient height to allow the placement of dental implants with long-term success.

lengthening the mandible.[16] The potential applications of this technique include the horizontal and vertical regeneration of bone in the alveolar ridges, where height and width inadequacies may restrict or contraindicate implant treatment.[8] DO could be used as an alternative to bone grafting or guided bone regeneration (GBR) techniques.[6,17] Using DO to move the superior surface of the alveolar ridge, Block and coworkers[8] found that sufficient bone was regenerated to allow the placement of dental implants. Bone regeneration is accompanied by soft tissue neogenesis; it appears that soft tissues are able to adapt if clinical lengthening is less than 10% of the initial bone length.[6]

The loading time of intraosseous implants placed in vertically distracted areas is not well established in human subjects.[17] In recent years, several clinical and histologic reports in humans and experimental animals have shown that implants can be immediately loaded with success. The reported overall survival rate ranges from 95% to 99.4%.[18–22] It has been reported that patients with immediately loaded implants resumed masticatory function quickly and that function was uniformly judged to be superior to pretreatment.

The present article is a case report of an application of DO in implant dentistry, which, to the authors' knowledge, has not been previously reported in the literature.

CASE REPORT

A 40-year-old female patient was evaluated for rehabilitation of an edentulous mandible. The radiographic examination (Figs 1a to 1c) showed evidence of moderate atrophy in the intraforaminal area (division B according to Misch[23] or Lekholm and Zarb[24]) and an even more pronounced level of bone resorption in the posterior mandible (division C according to Misch or Lekholm and Zarb). The patient desired a fixed rehabilitation with re-establishment of the distal occlusal plane. Analysis of the diagnostic casts, the radiographic evaluation (which included a cephalometric analysis), and the kinesiography led to formulation of the following treatment plan: *(1)* advancement of the mandibular alveolar ridge by 5 mm by means of the Le Fort I distraction procedure to correct the skeletal third class and *(2)* increase of the interarch space. At the

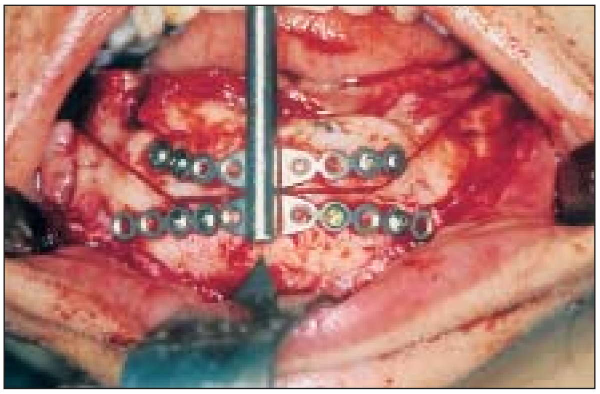

Fig 2 The distractor in place. The osteotomy cuts can be viewed.

outset of the treatment, a diagnostic denture tooth setup was used to demonstrate the desired final result. It was necessary for esthetic reasons that the crowns in the restoration be the same height as the original elements; at the same time, the authors needed to avoid an unfavorable biomechanical situation (ie, crown-to-implant ratio). For this reason, vertical distraction of the mandible was performed using a Martin distractor (Gebruder Martin, Tutlingen, Germany) according to the Hoffmeister technique[25] to obtain bone augmentation in both the intraforaminal and posterior areas.

The procedure was performed under general anesthesia. Through a full-thickness incision in the buccal vestibule, the underlying bone was exposed. Care was taken to preserve as much as possible the lingual mucoperiosteal attachment. The intraoral distractor was pre-plated before the osteotomy began. With an oscillating saw, the bone segment to be vertically distracted was completely separated from the basal bone. The distraction device was then applied, fixed, and temporarily activated to ensure the correct direction of distraction and freedom of movement (Fig 2). The surgical incision was closed using resorbable sutures (Vicryl; Johnson & Johnson/Ethicon, Somerville, NJ); a portion of the distractor was exposed through the incision. Postoperatively, the patient was provided with antibiotics and nonsteroidal analgesics. A soft diet as well as appropriate oral hygiene with 0.2% chlorhexidine mouthwash were prescribed for 2 weeks postoperatively.

After a 7-day latency period for healing of the surgical wound, the distraction protocol was started at a rate of 1 mm/d by turning the device twice each day. Thirteen millimeters of vertical gain were obtained in 15 days, permitting the planned correction of the deficient interarch distance (Figs 3a to 3d). An overcorrection of the deficient tissues was planned to compensate for the relapse expected during the later period of healing. Subsequently, 70 days were permitted for bone consolidation to occur. The consolidation period proceeded without complications. The patient reported no pain or discomfort and tolerated the procedure well.

At the end of the consolidation period, the distractor was removed under local anesthesia. Upon flap elevation, there was clinical evidence of complete bone fill of the distracted segment. A surgical template (Fig 4a) was fabricated using the previous diagnostic waxup and postdistraction computerized tomography (CT) scans. According to the template, 8 Frialit-2 Synchro implants (Friadent, Mannheim, Germany) were placed in the predetermined sites (Fig 4b). An acrylic resin temporary restoration duplicating the diagnostic waxup had been prepared in advance. Temporary abutments were connected to the implants and the provisional prosthesis was relined, trimmed, polished, and cemented the same day the surgery was performed. The postoperative radiologic examination showed that the coronal portions of the implants were immersed in the preexisting bone, while the apical portions of the implants were immersed in the distracted bone (Figs 5a and 5b). Ten months later the definitive restoration was delivered (Fig 6a). The implants had been functionally loaded for 1 year at the time of the radiograph seen in Fig 6b.

DISCUSSION

Implant sites must be restored with a view to both the biomechanical and esthetic outcomes.[26] An ideal implant site is one in which both hard and soft tissues are available in an ideal quantity that will allow a definitive prosthetic restoration to be fabricated with the original dimensions of the lost dentition. An atrophic bony ridge may still be rehabilitated by means of an implant-supported prosthesis, but the maxillomandibular relationship may lead to an unfavorable crown-implant relationship, which may in turn create esthetic, periodontal, or biomechanical problems that compromise the long-term survival of the implants.[27]

Current treatment modalities for alveolar ridge augmentation include autogenous bone grafting, GBR, and connective tissue grafting.[26] With DO it is possible to obtain a progressive increase in the hard and soft tissues, producing an appropriate crown-implant relationship and, consequently, improving the long-term prognosis of the implants without the use of bone grafts or pedicle flap procedures, both of which produce donor site defects.[3]

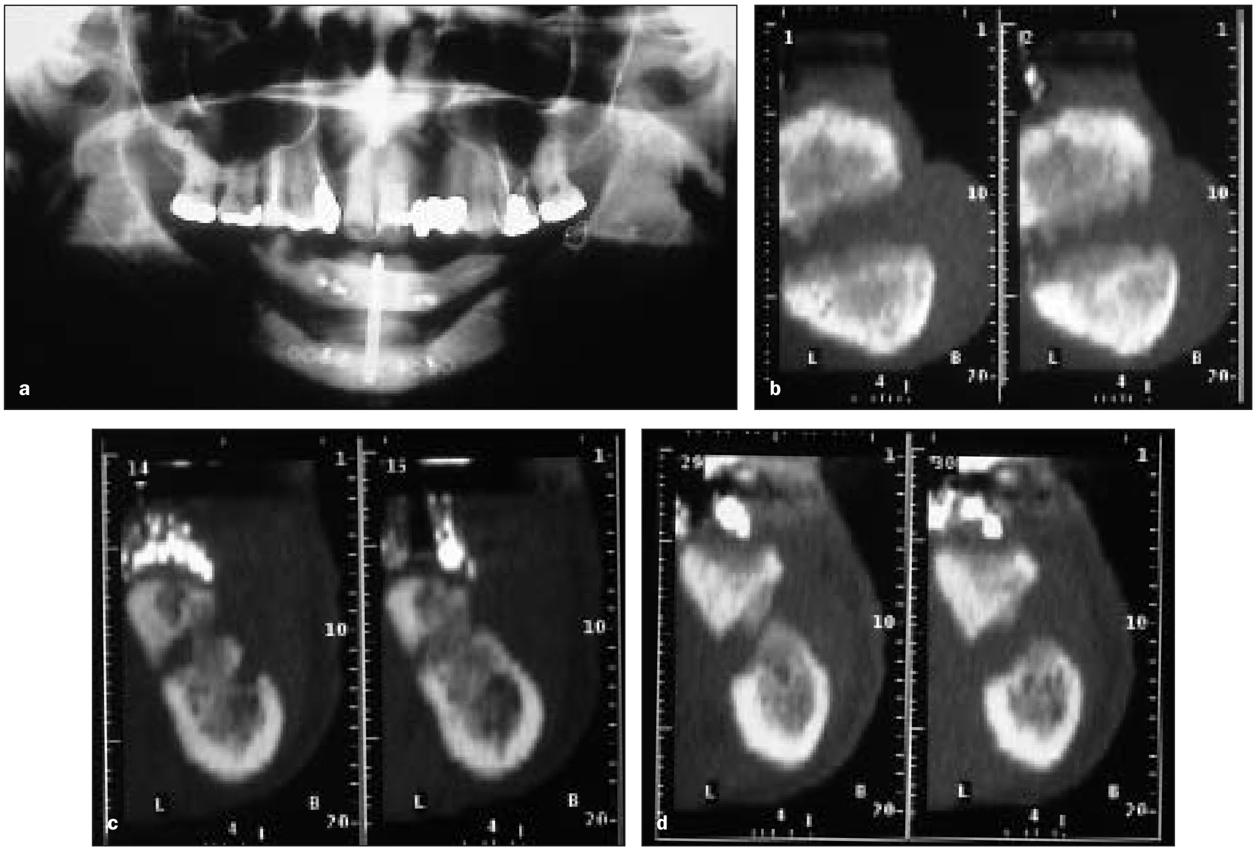

Fig 3a to 3d Panoramic radiograph *(a)* and details from the CT scan at the end of the distraction revealing bone regeneration achieved at both the interforaminal area *(b)* and at the retroforaminal area *(c, d).*

Fig 4a Surgical template for implant placement.

Fig 4b Implants in the distracted ridge.

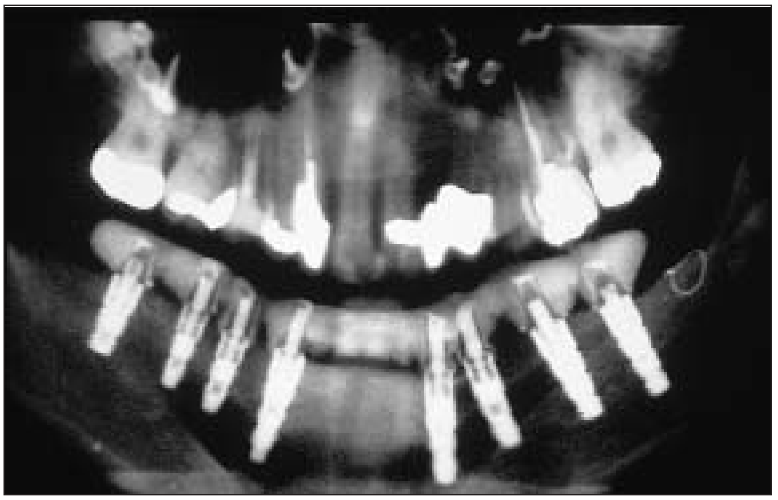

Fig 5a and 5b Postoperative panoramic radiograph and cephalometric radiograph showing how the coronal portions of the implants were immersed in the pre-existing bone, whereas the apical portions of the implants were immersed in the distracted bone.

Fig 6a The definitive restoration.

Fig 6b Panoramic radiograph obtained after 12 months of function.

The rate and rhythm of distraction are important: Rates below 0.5 mm/d may lead to premature union, while less than 1.5 mm/d may lead to nonunion.[6] In some cases, bones have been lengthened by up to 100% of their original length.[6] Two factors have been reported as limiting the possibilities for DO: *(1)* soft tissue damage or restriction of muscular function and *(2)* suboptimal bone formation with fibrous tissue, induced by too-rapid elongation.[2]

The hypothesis is that by distracting the superior surface of the alveolar ridge, sufficient bone and soft tissue can be generated to allow for dental implant placement and functional rehabilitation of the atrophic ridge.[8] As a result of this distraction process, a segment of mature bone is transported vertically into the alveolar ridge defect and becomes the reconstructed alveolar crest.[26] New bone is regenerated within the distracted osteotomy site at a distance from the prior deficiency.[26]

An important treatment decision relates to when to re-enter the distracted sites for implant placement. In one study, regenerated bone near the edges showed an advanced mineralization with the presence of networks of immature bone at 4 weeks; at 6 weeks the distraction gap was filled with a network of newly formed bone.[7] Block and associates[8] found that bone filled the gap in 6 to 8 weeks. The principal characteristic of this newly formed bone is the presence of mature lamellar bone with osteoblasts arranged on its surface.[7] The presence of the osteoblasts indicates that the process of bone deposition is active.[8] Histologically the lengthened bone is composed of mature lamellar and cancellous bone.[28] Newly formed osteons can be observed in a large part of the regenerated bone.[28] Usually, the distracted sites are entered for implant placement 10 to 16 weeks after completion of the activation phase. The implants should be submerged for 5 months, after which second-stage abutment connection may be performed.[26]

The challenge now is to use the modern DO procedure to shorten the treatment time necessary for implant rehabilitation. Urbani and colleagues[17] performed implant therapy about 75 days after the initial distraction surgery, and they concluded that, compared to GBR techniques for vertical augmentation, the time for implant loading can be drastically shortened. Oda and coworkers[28] demonstrated that DO can also be successfully performed with the simultaneous placement of implants. In fact, one of the most important properties of DO is that the superior distracted bone segment does not appear to undergo regeneration and is ready to allow implant placement.

The present case highlights the possibility of combining the advantages of alveolar DO with the immediate loading technique. After the consolidation period, implants were placed throughout the mandible and immediately loaded to provide the patient with a fixed provisional prosthesis. In this way, it was possible to avoid exposing the patient to the discomfort of a mobile provisional prosthesis during the healing period or even worse, of having to remain edentulous for a prolonged period of time.[29–31] The absence of any pathologic symptoms and negative radiologic findings 12 months following the surgery suggested that this treatment resulted in a favorable outcome. This method should not only lead to a shorter overall treatment time but also reduce strain and discomfort on the patient. When a large number of cases and longer follow-up periods have been reported, it will be possible to suggest that the combination of these 2 techniques can provide a positive and predictable result for the patient.

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