Distraction Osteogenesis in an Anterior Mandibular Bone Defect Utilizing Lingual Periosteal Release: A Case Report

Nils-Claudius Gellrich, DDS, MD, PhD[1]/Maria Mercedes Suarez-Cunqueiro, DDS, PhD[2]/Ralf Schön, DDS, MD[3]/
Mark Hoffmann, DDS[3]/Alexander Schramm, DDS, MD, PhD[3]

This clinical report presents a modified distraction technique to achieve height in the vector of distraction. The success of distraction osteogenesis depends on both biologic and biomechanical factors. The focus in this case is on correcting the direction of distraction; incorrect distraction direction is a frequent complication associated with distraction osteogenesis in the mandible. A 21-year-old man presented with a 10-mm vertical bone defect in the anterior mandible caused by facial trauma. The treatment chosen was distraction osteogenesis. After osteotomizing a bone segment and slitting the lingual periosteum, the bone segment was advanced anteriorly 4 mm and an extra-alveolar distraction device was applied. This approach allows the distraction device to be placed vertically, thus preventing lingual shift. The newly created alveolar ridge fully met prosthodontic requirements for a predictable outcome.
INT J ORAL MAXILLOFAC IMPLANTS 2004;19:753–757

Key words: *dental implants, distraction osteogenesis, endosseous implants, mandibular defects, vector distraction*

There has been a significant increase in recreation-related trauma in the last 10 years. Facial trauma often involves loss of teeth and bone, which complicates dental implant rehabilitation. Successful dental implant rehabilitation requires the availability of sufficient bone in all 3 dimensions. To obtain additional bone, it is often necessary to perform bone grafts or other techniques prior to the placement of dental implants.[1,2] In the mandible, vertical bone formation continues to be a complex challenge. The use of grafts in this area is not always completely successful because of problems involving the soft tissue envelope, such as a severely impaired relationship between highly mobile structures (eg, the lip, the floor of the mouth) and reduced attached gingiva, as well as partial resorption of the graft.[3] One alternative in cases of vertical bone loss is distraction osteogenesis prior to implant placement.[4–6] However, the intended vector of distraction in the mandible often becomes distorted and does not allow for a strictly vertical distraction.[7,8] This results in a lingually dislocated osteotomized bone segment, which has to be molded secondarily following the principles of Hoffmeister's floating bone concept.[9]

This case report involves a patient with extended posttraumatic vertical bone loss in the anterior mandible who underwent distraction

[1]Associate Professor, Department of Oral and Craniomaxillofacial Surgery, University Hospital Freiburg, Albert-Ludwigs-University, Freiburg, Germany.
[2]Research Fellow, Department of Oral and Craniomaxillofacial Surgery, University Hospital Freiburg, Albert-Ludwigs-University, Freiburg, Germany; Assistant Professor, Department of Stomatology, University Santiago de Compostela, Santiago de Compostela, Spain.
[3]Assistant Professor, Department of Oral and Craniomaxillofacial Surgery, University Hospital Freiburg, Albert-Ludwigs-University, Freiburg, Germany.

Correspondence to: Prof Dr Dr N.-C. Gellrich, Department of Oral and Maxillofacial Surgery, University Hospital Freiburg, Hugstetterstr. 55, D-79106 Freiburg, Germany. Fax: +49 761 270 4800. E-mail: nils-claudius.gellrich@uniklinik-freiburg.de

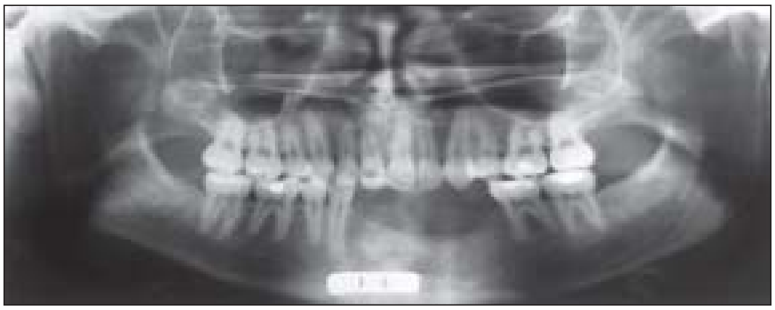

Fig 1 Preoperative panoramic radiograph showing the vertical bone loss in the anterior edentulous area.

osteogenesis prior to implant placement using a new modular distraction device and a modified vertical distraction technique to accurately obtain a vertical augmentation.

CASE REPORT

A 21-year-old man was referred to the Department of Oral and Maxillofacial Surgery, University Hospital Freiburg, Germany, for treatment with endosseous dental implants. His dental history indicated that 6 mandibular teeth (both lateral incisors, both central incisors, and the left canine and second premolar) were avulsed together with a fragment of bone and overlying gingiva as a result of a bicycle accident. All 4 first premolars had been removed years before as part of the patient's orthodontic treatment.

Clinical examination showed a severe reduction in the height of the anterior edentulous ridge. A panoramic radiograph showed that the reduction of the edentulous ridge was caused by a loss of the alveolar bone (Fig 1). A steel plate in the anterior mandible remained from former fracture treatment at another center and was removed during the surgery described here. Treatment of the bone defect by distraction osteogenesis was proposed to achieve correct implant placement and optimize the crown-to-implant ratio. The patient gave informed consent to the procedure.

Under general anesthesia the buccal cortical bone was exposed through a mucoperiosteal flap. The entire surgical anterior mandibular region, including both mental foramina, was revealed. However, the lingual and alveolar ridge soft tissue attachment was preserved to maintain blood flow. The vertical bone defect measured 10 mm with respect to the bone margin of the adjacent teeth.

Osteotomy was performed with an oscillating microsaw using continuous sterile saline irrigation and was completed with chisels to avoid uncontrolled lingual soft tissue damage, especially bleeding. The procedure involved a horizontal osteotomy followed by 2 slightly divergent vertical osteotomies. The osteotomized bone segment was completely detached from the mandibular basal bone. To provide a strict vertical distraction vector, the osteotomized bone segment was moved 4 mm anteriorly after slitting the lingual periosteum without detaching further lingual soft tissue.

The distractor used was a Modus MDO 1.5 (Medartis, Basel, Switzerland), which was fixed to the buccal cortex of both the mandibular basal bone and the osteotomized bone segment (Fig 2a). Lower fixation to the basal bone was performed with a 2-armed 8-hole adaptation plate that was anchored with 6 monocortical screws (screw diameter 1.5 mm, length 6 mm) to the buccal cortex. Upper fixation of the 10-mm distraction cylinder was performed with 2 separately articulating 6-hole T-left Modus MDO 1.5 adaptation plates reduced by 2 vs 1 holes. Every hole was mounted with a 1.5×6-mm screw. Because the originally supplied articulating arms were relatively stiff, the single superior arm was replaced with 2 separately articulating unilateral arms to provide optimal adaptation to the convex buccal cortex of the osteotomized bone segment. Subsequently, the osteotomized bone segment was separated from the basal bone by activating the distraction device to check the vector of distraction and freedom of movement. Once checked, the osteotomized bone segment was returned to its initial position. Care was taken to ensure the strictly vertical orientation of the distraction device shaft (Figs 2b, 2c, and 3).

After the mucoperiosteal flap was repositioned and sutured, an individually prefabricated mandibular occlusal splint with an inner bulge was placed to prevent the distraction cylinder from shifting because of externally applied forces. The patient was prescribed 1,000 mg amoxicillin (Amoxi; Abz Pharma, Blaubouren, Germany) 3 times a day for 7 days, 25 mg diclofenac (Voltaren; Novartis Pharma, Nürnberg, Germany) 3 times a day for 3 days; and topical chlorhexidine digluconate 0.2% for 7 days.

Fig 2a Intraoperative photograph showing the shape of the osteotomized bone segment and the application of the distractor device.

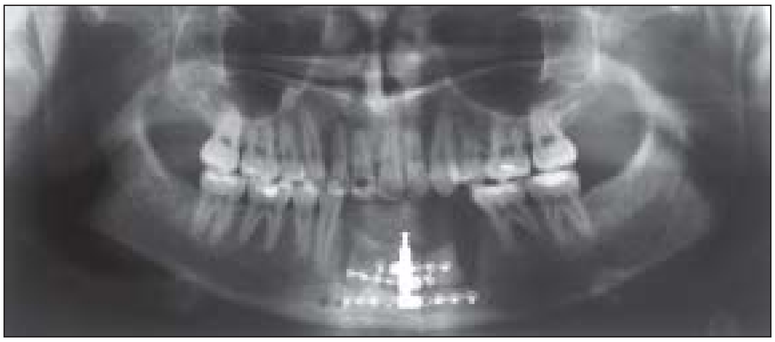

Fig 2b Panoramic radiograph showing the distractor at the beginning of the distraction period.

Fig 2c Lateral radiograph showing the vertical position of the distractor after advancement of the osteotomized bone segment.

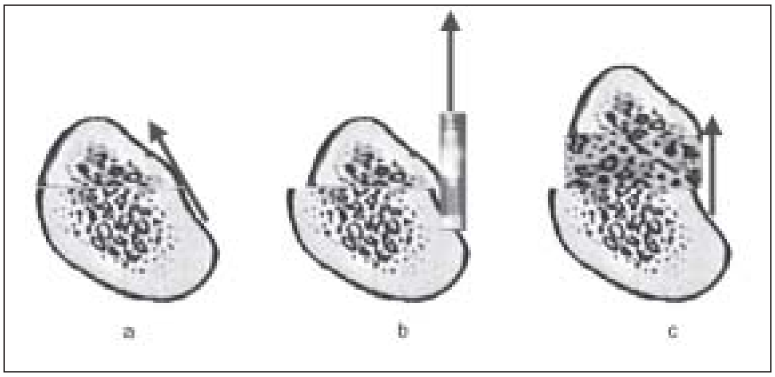

Fig 3 A diagram of the position of the Modus MDO 1.5 distraction device showing the vector of distraction *(a)* before advancement of the osteotomized bone segment, *(b)* after advancement of the osteotomized bone segment, and *(c)* after distraction starting from the position shown in *b*.

Distraction device activation was started 7 days after placement at a rate of 0.5 mm every 12 hours to elongate the bone a total of 10 mm in height. This was achieved after 10 days with no sign of infection or complication. The patient reported no pain or discomfort and tolerated the procedure well. After an 8-week consolidation period the distraction device was removed. During exposure of the distracted bone, the stability of the osteotomized bone segment and bone callus in the distraction site was evaluated. The 10-mm vertical bone augmentation was confirmed clinically. At the distracted mandibular site, 5 dental implants (Friadent, Mannheim, Germany) were placed at the sites of the mandibular left and right lateral incisors, right central incisor, left canine, and left first premolar. Each implant was 3.4 × 18 mm, except for the implant in the position of the left first premolar, which was 3.8 mm wide. Additional implant placement in the premolar position was avoided to prevent interference with the mental nerve.

The implants were anchored through areas of the osteotomized bone segment and new bone. They barely extended into the mandibular basal bone. Finally, the implants were covered subperiosteally. As expected, a panoramic radiograph obtained after implant placement (8 weeks after the end of distraction) showed a properly distracted gap with few signs of bone mineralization (Fig 4).

At the time the implant heads were exposed (10 weeks after implant placement), an epiperiosteal vestibuloplasty was performed to replace the missing attached gingiva and to restore the depth of the buccal vestibule using hard palate mucosa raised with a mucotome. Ten days postoperatively, the healing splint was removed. It had been tooth-supported in the lateral aspect. It was anchored with a single 1.5 × 12-mm screw in the anterior mandible to secure the mucosal grafts.

Ten weeks after implant placement an implant-supported fixed partial prosthesis was fabricated. A panoramic radiograph obtained 18 weeks after the completion of distraction showed increased bone density, indicating mineralization in the newly formed bone. The implants were clinically and radiologically osseointegrated (Fig 5).

The follow-up period after implant loading was 6 months. No complications were observed during this period.

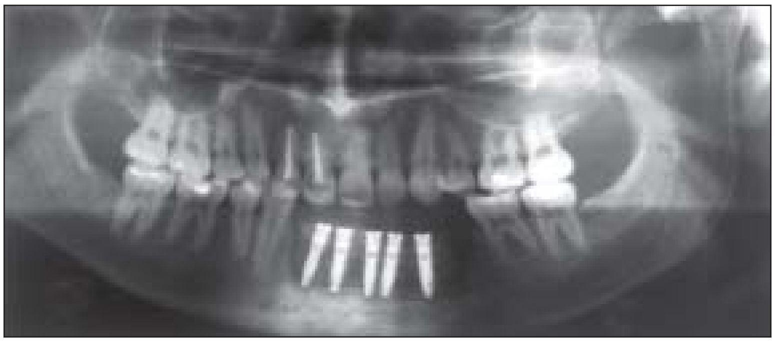

Fig 4 Panoramic radiograph showing the implants immediately after placement.

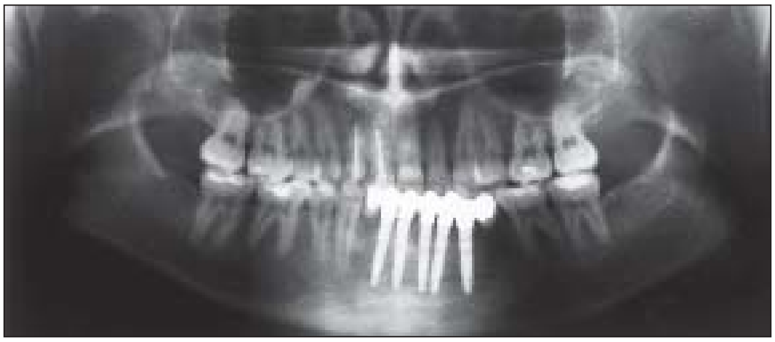

Fig 5 Panoramic radiograph showing the implant-supported prosthesis. Note the increased density of the new bone.

DISCUSSION

Distraction osteogenesis to correct vertical bone defects in the mandible is a viable treatment prior to implant placement. Distraction osteogenesis, which is an alternative to more commonly used techniques such as autogenous onlay bone grafting, alloplastic graft augmentation, and guided bone regeneration (GBR), provides a number of advantages. For example, with autogenous onlay bone grafting there can be considerable bone resorption. This does not occur with distraction osteogenesis; thus, the resulting height of the bony ridge is much more predictable and can be adapted dynamically during the process of distraction according to the local and prosthodontic requirements.[4] In comparison to GBR, distraction osteogenesis has the advantage of allowing greater vertical growth of the bony ridge. The significant risk of infection and membrane exposure incurred during GBR can be avoided with distraction osteogenesis.[10,11] Distraction osteogenesis also requires substantially less time than the alternative techniques. The principal advantage of distraction osteogenesis, however, is the simultaneous occurrence of histogenesis and osteogenesis.[4,5,12]

The success of distraction osteogenesis depends on both biologic and biomechanical factors.[13–15] The biologic factors include an adequate blood supply, the maintenance of latency and consolidation periods, and precision in the rate and rhythm of distraction. The biomechanical factors include tissue-related factors, fixator-related factors and, especially, the vector orientation of the device. The last of these has been the main focus of this case report. By applying a modified distraction technique to increase alveolar ridge height in the mandible, the crucial verticality of the vector of distraction was achieved without interference by lingual muscle pull, which is considered to be one of the most important parameters in bone distraction.[15]

Three factors contributed to this outcome: *(1)* primary advancement of the osteotomized bone segment by 4 mm after slitting the lingual periosteum, *(2)* ideal vertical adaptation of the distractor using a modular distraction device that allowed for the highest possible adaptability of the distraction cylinder, and *(3)* the use of a splint that protected the distraction cylinder from any soft tissue interferences in terms of distortion of the distraction vector.

One of the fundamental purposes of preimplantation bone distraction is to provide adequate bone quantity for rehabilitation using an implant-supported prosthesis. Correct implant placement in the alveolar bone ridge allows for an axially transferred load, thus maintaining implant osseointegration for predictable long-term results.[16] In distraction osteogenesis, it is essential that the vector of distraction remain constant over time to avoid displacement of the bony ridge.

Incorrect vector of distraction is a frequent complication associated with distraction osteogenesis in the mandible.[7,8] This may be the result of traction from muscles in the floor of the mouth, the shape of the mandible, and the lingual periosteum attached to the osteotomized bone segment working as a hinge. To solve this problem, some authors have suggested the application of orthodontic appliances that adjust the position of the osteotomized bone segment.[7,17] However, the modified technique proposed here, which is similar to one commonly used in chin advancement surgery, orthognathic surgery, and other craniomaxillofacial reconstructive surgeries, is simpler, enables the placement of the distraction device vertically, and minimizes the risk of lingual shift in the osteotomized bone segment. The newly created alveolar ridge fully addresses the prosthodontic requirements. Zaffe and associates[6] used a similar strategy but adjusted for the lingual effect by using an angular overcorrection of the device in the buccal direction. An advance was used here because it was hypothesized that this was the only reliable way to predict the proper vector of distraction.

In contrast to what is believed by most authors,[18,19] in this case it was seen that bone formation is possible even when the lingual periosteum is sectioned. Other factors, such as the rigidity of the fixation, degree of damage to the bone marrow, blood supply, rate of distraction, and observance of a proper consolidation period[13,14] may turn out to be more influential in the quantity and quality of the bone obtainable by distraction osteogenesis. Further research in this area is still necessary.

CONCLUSION

The use of a bone distraction technique involving anterior advancement of the osteotomized bone segment can achieve a vertical vector of distraction. The subsequent bony ridge formation occurred in the correct location, enabling adequate implant-supported prosthesis rehabilitation for predictable outcomes.

REFERENCES

1. Cordaro L, Amade DS, Cordaro M. Clinical results of alveolar ridge augmentation with mandibular block bone grafts in partially edentulous patients prior to implant placement. Clin Oral Implants Res 2002;13:103–111.
2. Bernhart T, Weber R, Mailath G, Ulm C, Dortbudak O, Watzek G. Use of crestal bone for augmentation of extremely knife-edged alveolar ridges prior to implant placement: Report of 3 cases. Int J Oral Maxillofac Implants 1999;14: 424–427.
3. Donos N, Kostopoulos L, Karring T. Augmentation of the mandible with GTR and onlay cortical bone grafting. An experimental study in the rat. Clin Oral Implants Res 2002; 13:175–184.
4. Chiapasco M, Romeo E, Vogel G. Vertical distraction osteogenesis of edentulous ridges for improvement of oral implant positioning: A clinical report of preliminary results. Int J Oral Maxillofac Implants 2001;16:43–51.
5. Rachmiel A, Srouji S, Peled M. Alveolar ridge augmentation by distraction osteogenesis. Int J Oral Maxillofac Surg 2001; 30:510–517.
6. Zaffe D, Bertoldi C, Palumbo C, Consolo U. Morphofunctional and clinical study on mandibular alveolar distraction osteogenesis. Clin Oral Implants Res 2002;13:550–557.
7. Urbani G. Alveolar distraction before implantation: A report of five cases and a review of the literature. Int J Periodontics Restorative Dent 2001;21:569–579.
8. Garcia AG, Martin MS, Vila PG, Maceiras JL. Minor complications arising in alveolar distraction osteogenesis. J Oral Maxillofac Surg 2002;60:496–501.
9. Hoffmeister B, Marcks C, Wolff KP. The floating bone concept in intraoral mandibular reconstruction. J Craniomaxillofac Surg 1998;26(suppl 1):76.
10. Jovanovic SA, Schenk RK, Orsini M, Kenney EB. Supracrestal bone formation around dental implants: An experimental dog study. Int J Oral Maxillofac Implants 1995;10:23–31.
11. Tinti C, Parma-Benfenati S, Polizzi G. Vertical ridge augmentation: What is the limit? Int J Periodontics Restorative Dent 1996:16:220–229.
12. Jensen OT, Cockrell R, Kuhike L, Reed C. Anterior maxillary alveolar distraction osteogenesis: A prospective 5-year clinical study. Int J Oral Maxillofac Implants 2002;17:52–68.
13. Ilizarov GA. The tension-stress effect on the genesis and growth of tissues: Part I. The influence of stability of fixation and soft-tissue preservation. Clin Orthop 1989;238: 249–281.
14. Ilizarov GA. The tension-stress effect on the genesis and growth of tissues: Part II. The influence of the rate and frequency of distraction. Clin Orthop 1989;239:263–285.
15. Cope JB, Samchukov ML, Cherkashin AM, Wolford LM, Franco P. Biomechanics of mandibular distractor orientation: An animal model analysis. J Oral Maxillofac Surg 1999;57:952–962.
16. Hansson S. The implant neck: Smooth or provided with retention elements. A biomechanical approach. Clin Oral Implants Res 1999;10:394–405.
17. Chin M. Distraction osteogenesis for dental implants. Atlas Oral Maxillofac Surg Clin North Am 1999;7:41–63.
18. Ozerdem OR, Kivanc O, Tuncer I, Acarturk S, Gocenler L, Gumurdulu D. Callotasis in nonvascularized periosteal bone grafts and the role of periosteum: A new contribution to the concept of distraction osteogenesis. Ann Plast Surg 1998; 41:148–155.
19. Choi IH, Ahn JH, Chung CY, Cho TJ. Vascular proliferation and blood supply during distraction osteogenesis: A scanning electron microscopic observation. J Orthop Res 2000;18:698–705.