Anteroinferior Distraction of the Atrophic Subtotal Maxillary Alveolus for Implant Placement: A Case Report

Katsuhiro Horiuchi, DDS, PhD[1]/Hiroya Uchida, DDS[2]/Kazuhiko Yamamoto, DDS, PhD[3]/Naoki Hatano, DDS[4]

Most reports on alveolar distraction have been related to vertical distraction in the mandible and the maxilla. There have been few reports on horizontal or oblique alveolar distraction. A case of an atrophic subtotal maxillary alveolus distracted 10 mm anteriorly and 5 mm vertically, followed by the placement of 9 implants, is presented. A healthy, 55-year-old woman presented with a chief complaint of mobility of all maxillary teeth. All remaining 11 teeth except the maxillary left second molar were diagnosed as being involved with advanced marginal periodontitis, and were considered hopeless and subsequently extracted. Three months after extraction, a horizontal osteotomy was performed with a bone saw between the bilateral second premolar regions, extending vertically distal to the second premolars, without involving the maxillary sinuses. After confirming mobility of the alveolar bone, a distraction device was seated with titanium miniscrews and adhesive resin cement over the hard palate. After a 7-day waiting period, the maxillary alveolus was distracted anteroinferiorly 0.25 mm twice a day for 25 consecutive days. The distraction process was completed uneventfully. Postdistraction computed tomography demonstrated that the maxillary alveolus was adequately distracted to place implants in an ideal position. Nine endosseous implants were placed 4 months after seating the distraction device. All implants had good primary stability and were submerged. All implants osseointegrated, although 2 anterior implants were replaced due to disintegration resulting from transmucosal overloading of the interim removable prosthesis. No significant marginal bone resorption was seen around the implants 16 months after implant placement. It was concluded that alveolar distraction can be very useful for augmenting the atrophic alveolus, not only vertically but also horizontally or obliquely. (INT J ORAL MAXILLOFAC IMPLANTS 2002;17:416–423)

Key words: *alveolar ridge augmentation, dental implants, distraction osteogenesis, maxillary advancement*

Tooth loss resulting from trauma, periodontal disease, or congenital absence leads to loss of height and width of alveolar bone and mucosa. Therefore, to achieve an esthetic and functional restoration using endosseous implants, the atrophic alveolus may need to be augmented. In recent years, bone grafting,[1,2] biomaterials,[3,4] and guided bone regeneration (GBR)[5,6] have been employed for alveolar ridge augmentation. GBR alone does not always induce true bone formation, especially for vertical ridge augmentation. Though many types of allogeneic bone and biomaterials have been developed, they are not always useful for extensive alveolar ridge augmentation. Autogenous bone is still generally considered the best material for all types of osseous reconstruction, including alveolar ridge augmentation. However, it has some disadvantages, such as the need for a second surgical intervention, donor site morbidity, unpredictable bone resorption, and difficulty in managing soft tissue coverage.

In the field of orthopedic surgery, distraction osteogenesis has been widely applied to the lengthening and reconstruction of extremities since Ilizarov established the concept in the early 1950s.[7,8]

[1]Private Practice, Nara, Japan; Former Associate Professor, Department of Oral and Maxillofacial Surgery, Nara Medical University, Nara, Japan.
[2]Senior Resident, Department of Oral and Maxillofacial Surgery, Nara Medical University, Nara, Japan.
[3]Lecturer, Department of Oral and Maxillofacial Surgery, Nara Medical University, Nara, Japan.
[4]Private Practice, Saitama, Japan; Director, Maxis Implant Institute, Saitama, Japan.

Reprint requests: Dr Katsuhiro Horiuchi, Nakatani Dental Clinic, 4-11-3 Nohara-nishi, Gojo, Nara 637-0036, Japan. Fax: +81-7472-2-4580. E-mail: k.hori@d5.dion.ne.jp

Fig 1a *(Left)* Initial panoramic radiograph.

Fig 1b Initial intraoral view.

Distraction osteogenesis has some advantages over autogenous bone grafting: No additional surgery involving a harvesting procedure is needed; there is no limit to lengthening; and simultaneous lengthening of the surrounding soft tissues, such as skin, muscle, blood vessels, and nerves, occurs. However, the disadvantages include a long treatment period, need for a suitable distractor, and danger of infection.[9]

In the field of oral and maxillofacial surgery, McCarthy and coworkers[10] first reported lengthening the human mandible by gradual distraction in hemifacial microsomia patients in 1992. Since then, distraction osteogenesis has been used to lengthen or repair continuity defects in the mandible,[11] maxilla,[12–14] and cranial complex.[15] In 1996, Block and colleagues demonstrated clinical, radiographic, and histologic vertical bone augmentation using alveolar distraction in dogs.[16] Chin and Toth[11] described alveolar distraction and implant placement in a human in the reconstruction of an alveolar ridge defect following traumatic loss of teeth in 1996. Most reports on alveolar distraction have been related to vertical distraction in both jaws. There have been few reports on horizontal or oblique alveolar distraction. In the case of relatively small defects, veneer bone grafting or GBR has been used for alveolar ridge augmentation. With large defects, however, alveolar ridge augmentation has been achieved only with the iliac bone graft, not with the chin bone graft or GBR. In addition to complications and morbidity associated with the iliac bone graft, there have been difficulties concerning soft tissue coverage and vestibuloplasty.

The purpose of this article is to report a case of anteroinferior (oblique) alveolar distraction and implant placement in a patient with an atrophic subtotal maxilla using a palatal distraction device.

CASE REPORT

A healthy 55-year-old woman presented with a chief complaint of mobility of all maxillary teeth. All remaining 11 teeth except the left maxillary second molar were diagnosed as involved with advanced marginal periodontitis and were considered hopeless (Fig 1a). The anterior teeth, splinted with a palatal casting, were exposed up to the root apex (Fig 1b). All remaining teeth were extracted, except the maxillary left second molar and the right first molar, which were needed to retain an interim removable prosthesis. Computed tomography (DentaScan, General Electric, Fairfield, CT) revealed that the anterior alveolar ridge was positioned 10 mm palatally and that there was 5 mm of vertical bone loss between the bilateral second premolar regions (Fig 2). Therefore, anteroinferior distraction of the subtotal maxillary alveolus was chosen to maximize esthetics and function using endosseous implants.

Three months after the extractions, the patient was anesthetized with local anesthetic and intravenous sedation. An incision was made bilaterally along the mucogingival sulcus between the first molar regions, extending vertically mesial to the first molars. The mucoperiosteum was reflected,

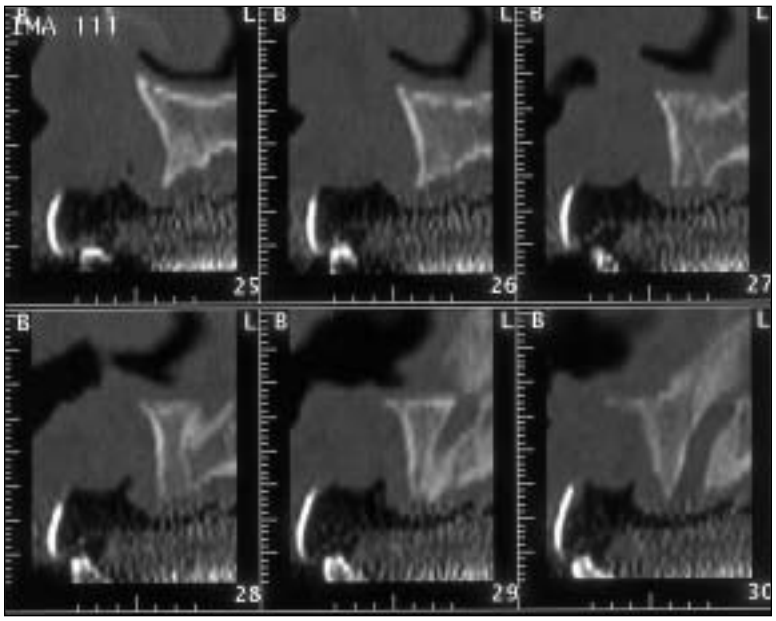

Fig 2 Predistraction DentaScans.

exposing the lateral surface of the maxilla. A horizontal osteotomy was performed with a bone saw bilaterally between the second premolar regions, extending vertically distal to the second premolars, taking care not to perforate the maxillary sinuses (Fig 3a). After confirming mobility of the alveolar bone (Fig 3b), the distraction device was seated with 8 titanium miniscrews and adhesive resin cement over the hard palate, 4 screws in the transport bone, and the remaining 4 in the hard palate for anchorage (Fig 3c). The wound was closed with 5-0 Vicryl sutures (Johnson & Johnson, Somerville, NJ).

The distraction device was not activated for 7 days to allow for periosteal healing and early revascularization. After the 7-day waiting period, the maxillary alveolus was distracted anteroinferiorly 0.25 mm twice a day for 25 consecutive days. The distraction process was completed uneventfully (Fig 3d). Following fixation of the transport bone segment with 4 miniscrews, the distraction device was removed 10 days after completion of the distraction. A comparison of predistraction and postdistraction lateral cephalograms and casts revealed 10 mm of anterior movement and 5 mm of inferior movement of the subtotal maxillary alveolus (Figs 4 and 5). Postdistraction DentaScans showed that the maxillary alveolus was adequately distracted to place implants in an ideal position (Fig 6).

Endosseous implants were placed 4 months after seating the distraction device. A mucosal incision was made 2 to 3 mm palatal to the alveolar ridge crest. The periosteum was reflected upward to expose the entire regenerated alveolus. There was no bony step from the basal bone and the alveolar crest (Fig 7a). Moreover, the regenerated bone could not be distinguished from the basal and transport bones. Three 15-mm-long and two 18-mm-long Mark IV implants (Nobel Biocare, Göteborg, Sweden), all 4 mm in diameter, were placed in the anterior maxilla. In the posterior maxillae, 4 Osseotite implants (Implant Innovations, Palm Beach Gardens, FL) with a 4-mm diameter were placed: one 11.5-mm-long, one 15-mm-long, and two 13-mm-long implants (Figs 7b and 7c). Suction-trapped bone and autogenous bone harvested from the anterior maxilla were grafted in dehiscence defects. All implants could not be placed with a placement torque of more than 40 Ncm and were submerged, though the implants whose placement torque was more than 40 Ncm were intended to be

Fig 3a Clinical view of osteotomy of the maxillary alveolus. The black line shows the osteotomy line.

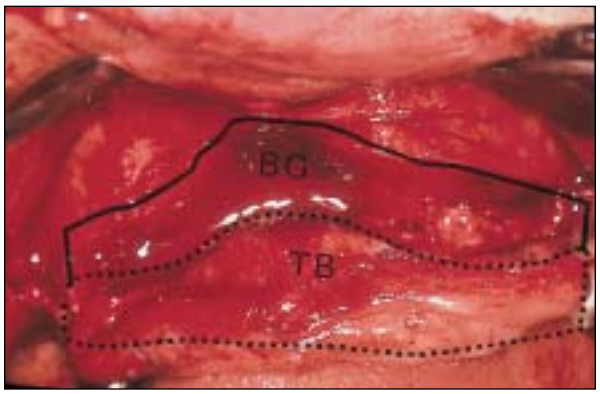

Fig 3b Clinical view after confirming mobility of the alveolar bone. The black line shows the osteotomy line. BG = bone gap between the basal and transport bones; TB = transport bone.

Fig 3c Occlusal view after seating a custom-fabricated palatal distractor.

Fig 3d Occlusal view after completion of a 25-day distraction period.

Fig 4a Predistraction lateral cephalogram.

Fig 4b Postdistraction lateral cephalogram.

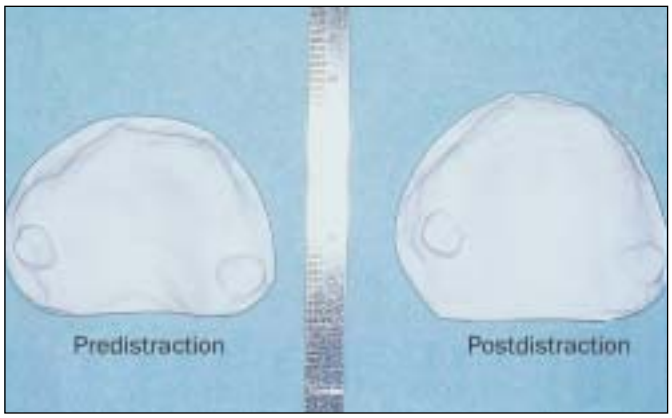

Fig 5 Pre- and postdistraction die casts.

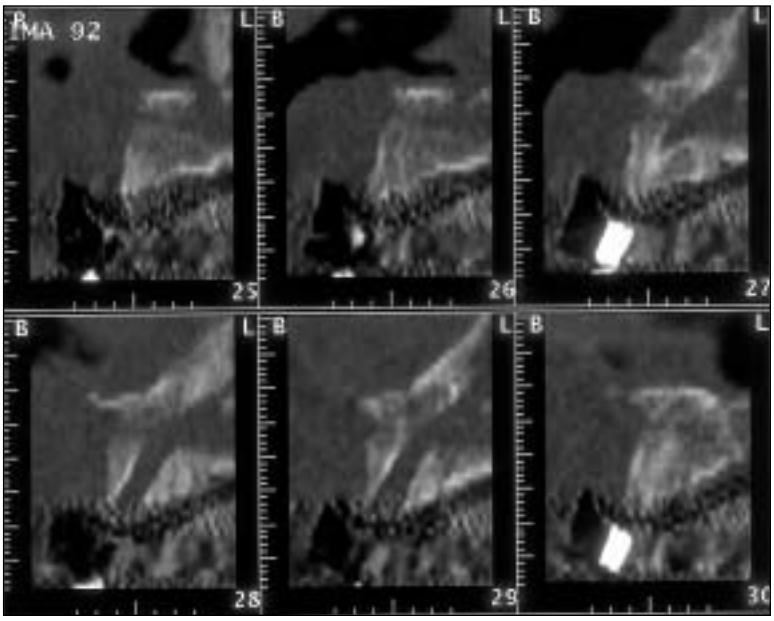

Fig 6 Postdistraction DentaScans.

immediately loaded. All implants had good primary stability.

Six months after placement, the implants were uncovered. Two right anterior implants were removed because they disintegrated from transmucosal overloading of the interim removable prosthesis. A screw-retained provisional prosthesis supported by the remaining 7 implants was fabricated and placed. Two months after the removal of the 2 right anterior implants, two 15-mm-long TiUnite implants (Nobel Biocare) were placed. They were uncovered 4 months later. The definitive prosthesis was then fabricated and placed (Fig 7d). No significant marginal bone resorption was seen around the implants 17 months after implant placement.

DISCUSSION

Advancement of the labial plate of the anterior maxilla allows restoration for nasolabial support with better esthetic results. Therefore, to create an esthetic restoration using endosseous implants, it is important for the atrophic alveolus to be augmented, not only vertically but also horizontally or obliquely. There have been few reports of horizontal

Fig 7a Clinical view of the maxillary alveolar bone at the time of implant placement 4 months after distraction.

Fig 7b Clinical view after implant placement.

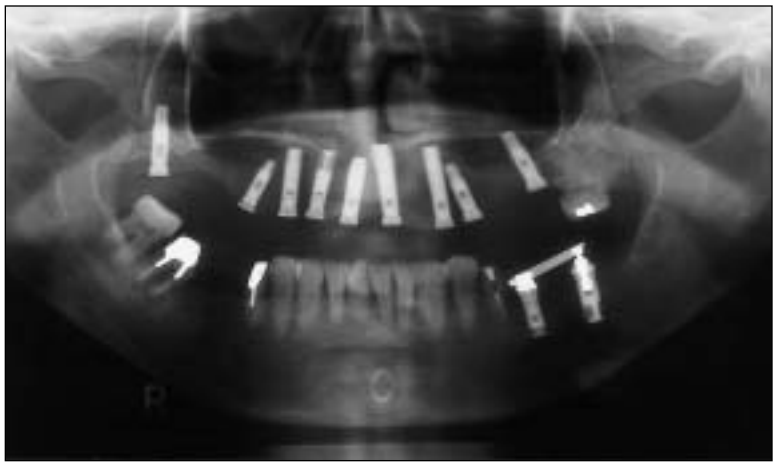

Fig 7c Panoramic radiograph after implant placement.

Fig 7d Panoramic radiograph after placement of the definitive prosthesis.

or oblique alveolar distraction, although advancement of the anterior or total maxilla by distraction osteogenesis has been reported experimentally[17,18] and clinically.[12–14] Therefore, autogenous veneer bone grafting is still considered a very reliable means of horizontal alveolar ridge augmentation. However, in cases with an extensive bone defect, as in the present patient, it is usually necessary to use an iliac bone graft, not chin bone or ramus grafts. Moreover, there have been difficult problems related to soft tissue coverage and vestibuloplasty. In such cases, a transverse and vertical lack of bone in the posterior maxillae can frequently coexist because of pneumatization of the maxillary sinuses. Chiapasco and coworkers[19] reported a method to simultaneously correct the 3-dimensional deficit of the edentulous maxilla with a combination of autologous bone grafting of the maxillary sinuses, buccal onlay grafts of the posterior maxilla, and sagittal osteotomy of the anterior maxilla with interpositional bone grafts. However, this method was quite invasive and would not be generally accepted, although it showed very promising results. The present method using distraction osteogenesis resulted in essentially the same results as achieved by Chiapasco and associates, but it was much less invasive. In addition, this alveolar distraction appears to be less invasive and more predictable than the interpositional iliac bone graft combined with Le Fort I osteotomy. Total maxillary distraction with an extraoral device, after a complete Le Fort I osteotomy, has been effective in treating patients with congenital cleft palate.[19] However, the alveolus cannot be augmented vertically by total maxillary distraction.

Ilizarov[7] emphasized the need for preservation of blood supply at the corticotomy site. However, Kojimoto and coworkers[20] reported that the preservation of periosteum was essential and more important than careful corticotomy for bone lengthening by callus distraction. In alveolar distraction, it is very important to avoid damage to the periosteum because performing osteotomy, not corticotomy, is necessary. Therefore, a vestibular incision rather than a crestal incision is recommended for minimal reflection and damage to the periosteum.

Ilizarov[8] defined an ideal latency period, rate and rhythm of distraction, and fixation period in lengthening limbs. In all kinds of distraction, this seems to be approximately 7 days to allow for soft tissue healing and early revascularization. As for a rate of distraction, the mandible or the maxilla, as well as limbs, can generally be distracted at a rate of 1.0 mm a day. The alveolus can be distracted mainly vertically at a rate of 0.5 to 1.0 mm a day.[9,11,16,21–24] Slower distraction rates result in premature ossification and fusion; faster rates induce fibrous tissue formation within the distraction gap. As the frequency of the distraction increments goes up, the tissue response is more normal in appearance. According to the present patient's result, horizontal alveolar distraction at a rate of 0.5 mm per day, with distraction increments 2 times per day, seems to be optimal.

Postdistraction bone resorption and relapse needs to be studied further, although there was little evidence to suggest that these occurred in the present patient.

CONCLUSIONS

1. The subtotal maxillary alveolus was distracted 10 mm anteriorly and 5 mm vertically, and 9 implants were placed in an ideal position 4 months after seating of a palatal distractor.
2. The present method does not require harvesting grafted bone, and no problems were encountered in soft tissue management.
3. Alveolar distraction can be useful for augmenting the atrophic alveolus, not only vertically but also horizontally or obliquely.

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