Alveolar Cleft Closure by Distraction Osteogenesis with Skeletal Anchorage During Consolidation

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Intraoral distraction osteogenesis (DO) has been widely used for the reconstruction of various dentoalveolar defects. However, its use in the management of alveolar clefts is relatively new. This method allows the closure of the cleft via the regeneration of new alveolar bone and attached gingiva through the distraction of a dento-osseous segment. It eliminates the need for a donor site for autogenous bone grafting and possible graft failure. However, the relatively long consolidation period required for the use of intraoral DO devices may result in soft tissue irritation that would compromise patient cooperation, especially in children. In the case presented, the intraoral DO technique was used for the treatment of a unilateral residual alveolar cleft and an implant was subsequently placed in the regenerated bone. A miniplate was also placed to serve as a skeletal anchor to enable the early removal of the distractor device. The distractor was removed before the beginning of the consolidation phase. INT J ORAL MAXILLOFAC IMPLANTS 2008;23:147–152

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The surgical repair of an alveolar cleft and oronasal fistula is a challenging issue for both orthodontists and maxillofacial surgeons. Management of alveolar clefts and associated oronasal fistulae is required for bone support for teeth adjacent to the cleft site, maintenance of the bony matrix for the eruption of the teeth aligned with the cleft site, and bony continuity in the maxillary arch and creation of satisfactory alveolar bone contour. Arch width must be maintained and collapse of the maxillary arch prevented. Oronasal fistualae must be eliminated, and oral hygiene should be attended to by separating the nasal and oral cavities. Treatment may also be necessary to improve facial symmetry, alar base support, and nasolabial contour.[1–4] Secondary bone grafting at the stage of mixed dentition in conjunction with orthodontic treatment has become a well-established treatment modality. However, this method is associated with several shortcomings, including the requirement of a donor site for autogenous cancellous bone grafting and the possibility of graft failure depending on the size of the alveolar cleft. Furthermore, autogenous bone grafting may not be desirable for every patient. Distraction osteogenesis (DO), which was originally used for correction of craniofacial deformities in the early 1990s and subsequently for congenital anomalies and maxillofacial reconstructive procedures, may be considered a treatment alternative with several pronounced advantages.[5–7]

A number of authors have reported successful clinical outcomes with the DO technique in alveolar cleft repair since Liou et al initially used interdental DO and rapid orthodontic tooth movement for this purpose.[8] Liou et al performed interdental DO in 11 patients for the reconstruction of 6 unilateral and 4 bilateral alveolar clefts and 1 partially avulsed maxilla.[8] Mitsugi et al reported satisfactory results for the closure of alveolar clefts with transport DO in 22 patients.[9] Tae et al treated a 20-year-old female patient with a unilateral alveolar cleft and oronasal communication,[10] and Yen et al closed a large bilateral alveolar cleft by transport osteogenesis.[11] Dolanmaz et al reported 8 successful alveolar cleft repairs

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with DO in 5 patients.[12] Intraoral DO eliminates not only donor site morbidity but also the visible scars associated with external distraction. Moreover, the distribution of distraction forces is better, as the distractors are placed directly on the bone.

Early applications of intraoral DO included a consolidation period of 2 months. However, because relapses have occurred in some cases, it has been recommended that the consolidation period be increased to up to 3 months.[13–15] This relatively long consolidation period, during which the intraoral distraction device must remain in place, is sometimes intolerable for the patients. This is particularly true for children, and the success of the treatment requires excellent patient cooperation. In spite of the aforementioned advantages of these devices, they may cause soft tissue irritation and esthetic problems during the consolidation period. There is some risk of losing the tooth in the transported segment or even the transport segment itself in case of inaccurate planning.

The concept of skeletal anchorage was introduced by Creekmore and Eklund in 1983 to overcome the clinical limitations associated with tooth-borne appliances and extraoral anchorage systems.[16] Since then, many skeletal anchorage units, including retromolar implants, onplants, zygomatic wires, palatal implants, mini-plates, mini-screws, and mini-implants, have been used in contemporary orthodontics for various clinical purposes.[17–21] Among different skeletal anchorage systems, mini-screws and mini-plates have been found to have a number of advantages, including ease of manipulation, ability to withstand immediate force loading, and minimal irritation of the oral tissues.[21] To date, there is no report presenting the use of skeletal anchorage in conjunction with the DO technique for the elimination of the long consolidation period in alveolar cleft repair.

In the presented case report, a mini-plate was inserted for skeletal anchorage simultaneously with the placement of an intraoral distractor. The mini-plate was placed to facilitate control of the distraction vector and enable the early removal of the distractor (ie, prior to the consolidation period). A dental implant was placed in the regenerated alveolar bone.

CASE REPORT

A healthy 13-year-old boy was referred to the Department of Orthodontics with complaints of dental crowding and esthetic concerns. Patient history was noncontributory except for a cleft lip repair at another medical center at the age of 6 months. Clinical and radiographic examination revealed a unilateral residual alveolar cleft between the maxillary right central incisor and canine; the right maxillary lateral incisor was congenitally missing, and the maxillary right central incisor adjacent to the cleft was hypoplastic, with a severe alveolar bony defect distally (Figs 1 to 3). Cephalometric evaluation revealed skeletal Class I and Class II malocclusion. The principles of both autogenous bone grafting with cancellous particulate graft harvested from the ilium and transport DO for the management of the alveolar cleft were explained to the patient and his parents. Since they were reluctant to permit autogenous grafting, it was decided to carry out an intraoral transport distraction with a dento-osseous transport segment involving the maxillary right canine. A mini-plate was to be placed simultaneously on the contralateral side to serve a skeletal anchorage unit to facilitate the orientation of the distraction vector and early removal of the distractor device.

After the completion of orthodontic tooth alignment, the surgical procedure was performed under nasoendotracheal anesthesia. A horizontal intraoral incision was made along the buccal side of the right maxilla, and a mucoperiosteal flap was raised to expose the site of the horizontal osteotomy. A vertical mucoperiosteal tunnel was created to expose the interdental osteotomy site between the maxillary right first premolar and canine. Following completion of the horizontal osteotomy, performed 4 to 5 mm away from the root apices with a saw, a vertical interdental osteotomy cut was made. The osteotomy was then completed using fine osteotomes. The hypoplastic maxillary right central incisor adjacent to the cleft was extracted at this time (Fig 4). The osteotomized segment was mobilized manually to avoid damage to dental structures. A unidirectional alveolar intraoral distractor (MODUS, MDO 1.5; Medartis, Basel, Switzerland) was placed horizontally on the dento-osseous transport segment and maxilla with 1.5-mm screws across the interdental osteotomy (Fig 5). Simultaneously, a titanium mini-plate was placed on the contralateral side below the left piriform aperture with its free end extending intraorally to the maxillary vestibule (Fig 6). After a latency period of 4 days, distraction was initiated. The device was activated twice a day to achieve 0.5 mm of advancement per day. Distraction was continued until close bone contact was obtained at the docking site as far as possible. During the activation process, the mini-plate and extraoral orthodontic force applied via a face mask were utilized to orientate the transport segment to the desired position (Fig 7). As soon as the ideal location was achieved, the intraoral distractor was removed, and the dento-osseous transport segment was fixed orthodontically to the

Fig 1 Intraoral frontal view of the alveolar cleft.

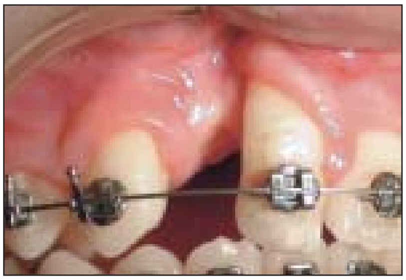

Fig 2 Intraoral lateral view of the dentition. Initial orthodontic alignment before DO.

Fig 3 Radiographic view of the cleft before DO.

Fig 4 Intraoperative view. Horizontal and vertical interdental osteotomies were completed, and the maxillary right central incisor was extracted.

Fig 5 Unidirectional alveolar intraoral distractor in place.

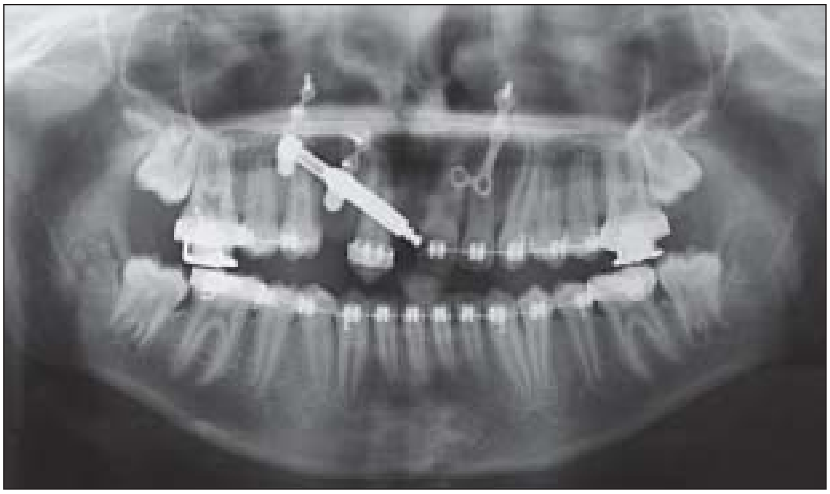

Fig 6 Radiographic view of the distractor and the contralaterally placed mini-plate.

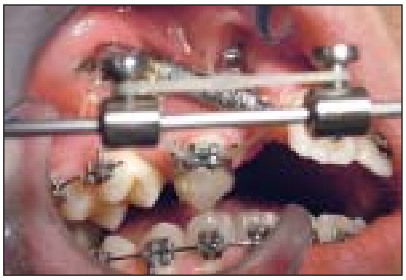

Fig 7 Orientation of the transport segment with the pre-located mini-plate and extraoral orthodontic force via a face mask.

Fig 8 Intraoral frontal view after DO and orthodontic tooth alignment. The distractor was removed, and the transport segment was fixed to the mini-plate during the consolidation period.

Fig 9 Occlusal view after the distraction process. Adequate alveolar bone was attained for the placement of a dental implant placement.

Fig 10 *(Left)* Radiographic view of the regenerated alveolar bone and the definitive implant restoration immediately after insertion of the restoration.

Fig 11 *(Above)* Intraoral frontal view. To achieve satisfactory esthetic results, the tooth in the maxillary right incisor region was restored with a porcelain laminate veneer, and the implant in the maxillary right lateral incisor region was restored with a ceramic crown.

maxillary left central incisor and the mini-plate (Fig 8). After a consolidation period of 10 weeks following distraction, gingivoperiosteoplasty, and allogeneic bone grafting (demineralized bone matrix; Grafton putty; Osteotech, Eatontown, NJ) were performed under local anesthesia to repair the small residual bone defect at the docking site. The mini-plate was also removed at this time. The transported permanent maxillary right canine was reshaped to substitute for the maxillary right central incisor. A dental implant (SwissPlus; Zimmer Dental, Carlsbad; CA) with a diameter of 3.7 mm and a length of 10 mm was placed in the newly formed space and restored with a ceramic crown 7 months postdistraction (Figs 9 and 10). The transported maxillary right canine was restored with a porcelain laminate veneer (Fig 11).

DISCUSSION

Secondary autogenous alveolar bone grafting in conjunction with orthodontic treatment has long been a widely accepted treatment modality for the surgical repair of alveolar clefts and fistulae.[1–4,22] The technique requires a second surgical site for autogenous grafting and adequate soft tissue for the complete closure. It also requires orthodontic tooth alignment and maxillary expansion to correct the collapsed dental arches and dentition before bone grafting.[22,23] Consequently, an undesirable widening of the alveolar cleft and oronasal fistula becomes inevitable, making alveolar bone grafting and complete closure of the fistula by local soft tissue grafting more difficult. Furthermore, autogenous bone harvesting may not be acceptable to all patients, as in the presented case. DO, which was originally used for the reconstruction of the extremities and the management of congenital and posttraumatic deficiencies,[24–26] has been used frequently for various corrective surgical procedures in the craniofacial skeleton since the early 1990s.[5,27–29] The use of interdental DO in alveolar cleft repair was first established by Liou et al, who reported successful clinical outcomes in 11 patients with various dentoalveolar clefts and defects.[8] Their method is based on the generation of new alveolar bone and attached gingiva through the distraction of a dento-osseous segment created posterior to the cleft site; this provides dental space for orthodontic tooth alignment and also facilitates dental implant placement. Bony transport of a premaxillary segment with sufficient maintenance of space for the placement of incisal dental implants was demonstrated by Guerrero et al.[30] The segmental movement pattern of interdental DO did not result in alteration of the anteroposterior position of the soft palate; thus, velopharyngeal function was not negatively affected.[8] Intraoral DO has recently been introduced as an alternative treatment for repair of the alveolar cleft. However, this method requires relatively complicated procedures, such as accurate planning of transport segment to be distracted and precise adjustment of distractor device following meticulous fine osteotomies. Potential complications include harm to adjacent dental structures, particularly the tooth in the transported dentoalveolar segment. Moreover, the presented technique involved the reshaping of the transported permanent maxillary right canine to substitute for the maxillary right central incisor, which required an accurate restorative conception in order not to compromise the final esthetics. In addition, strict patient compliance was also mandatory throughout the treatment period for a successful outcome. Although an ideal bone contact at the docking site at the end of the distraction process was the authors' goal, a spontaneous union is generally difficult to achieve. Allogeneic bone grafting at the docking site was necessary, in accordance with most previous reports.[8–12] Also, the vector of distraction is of great importance for the docking of the segments and the placement of the distractor. Vector alignment is affected by the pattern of the osteotomies and the adjacent anatomic structures. In the presented case, the initial inferior-posterior direction of the segment could be compensated for by the orthodontic forces, which enabled the repositioning of the transport segment.

A review of literature revealed a lack of consensus regarding the superiority of tooth- or bone-borne devices for intraoral DO. Some investigators have reported significantly greater dental movement of the supporting teeth than skeletal movement and unfavorable dental tipping with tooth-borne distractors,[10,31] while the others did not observe such remarkable dental movements in their clinical studies.[8,12] This difference may be due to differences between the surgical techniques used and the different characteristics and designs of distraction devices. Nevertheless, the authors preferred to use a bone-borne distractor to eliminate the possibility of dental movement, which could have compromised accurate force distribution on the transport segment.

The relatively long consolidation period usually required for alveolar cleft repair with intraoral DO may often be intolerable to those typically in need of the procedure (ie, children and adolescents). Intraoral distractors may irritate soft tissues, interfere with feeding and occlusion, impede the maintenance of oral hygiene in children with their relatively bulky structure, and cause esthetic problems. Since Creekmore and Eklund described the concept in 1983,[16] the scope of skeletal anchorage has been enlarged to encompass many clinical indications in contemporary dentofacial orthopedics. In the present report, a mini-plate was used for skeletal anchorage to stabilize the distracted segment. The intraoral distractor was removed immediately after the completion of distraction, enabling a consolidation period without the distractor device in place.

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