Original Article

A Miniature Tooth-borne Distractor for the Alignment of Ankylosed Teeth

Toros Alcan

Abstract: The ankylosis of a tooth is one of the most difficult clinical problems that an orthodontist faces. In the literature, the treatment protocols for ankylosed teeth are still insufficient and questionable when considering gingival esthetics and conservation of bone health. The purpose of this report is to evaluate and discuss the effects of a newly designed miniature tooth distractor (MTD), which can be used with infrapositioned ankylosed teeth. Two cases with vertically malpositioned incisors were treated using the MTD, and this device was evaluated and compared with the distraction appliances used before in the literature. In conclusion, it was found to be efficient with its small dimensions, ease of application and removal, ease of activation, buccolingual control, and patient tolerance. (*Angle Orthod* 2006;76:77–83.)

Key Words: Tooth ankylosis; Distraction osteogenesis; Repositioning

INTRODUCTION

Ankylosis is the fusion of the cementum or dentin to the alveolar bone. It is reported to be caused by endocrine or metabolic diseases, genetic tendency, or local conditions such as periapical infections, trauma, or previous surgical procedures.[1–7]

Ankylosis of a tooth in mixed or early permanent dentition results in severe esthetic problems, especially in the anterior region. It is frustrating to observe an ankylosed maxillary incisor appearing to intrude while the other teeth erupt past it in a rapidly growing adolescent. The treatment of such a tooth is not possible by conventional orthodontics.

The diagnosis of ankylosis should be based on clinical and radiographic evidence. Usually, affected teeth remain shorter (unerupted) or displaced relative to the neighboring teeth. Radiologically, the lack of periodontal membrane supports the clinical diagnosis.[1,8–16]

In the primary dentition, ankylosis is usually treated by simple procedures such as prosthetic buildups or extractions. However, the ankylosis of a permanent tooth requires a more complex treatment. One can either remove the ankylosed tooth by a surgical extraction and use a prosthetic replacement or bring it into proper occlusion by orthodontics after luxation, corticotomy, or osteotomy. According to the ''American Association of Orthodontics guideline for orthodontic and dentofacial orthopedic treatments,'' the treatment modalities for ankylosed teeth are;

- extraction,
- surgical luxation,
- surgical repositioning,
- fixed or removable appliances, and
- retention with or without coronal modifications.[8,15,17–19]

When the clinical signs of ankylosis are present, but the radiographic diagnosis is not clear, the first thing to do would be to luxate the tooth and apply an orthodontic force. However, if ankylosis is obvious by clinical and radiological evidence, a corticotomy or osteotomy of the alveolar bone of ankylosed tooth is needed to bring it into proper occlusion. In this manner, many researchers have moved an ankylosed tooth to its proper position right after the corticotomy of the alveolar bone of ankylosed teeth.[2,15,19–22]

Although the surgical repositioning seems to be one of the best treatment choices, there are two points that should be considered; (1) The immediate repositioning needs a total segment mobilizing, ie, the separation of the bone segment from the palatal mucosa. Because the blood supply of the separated bone is maintained through the lingual periosteum and mucosa, total repositioning of the separated bone needs special atten-

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The miniature tooth-borne distractor (MTD) was designed and manufactured by the author, Dr Alcan.

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tion to avoid embarrassing the blood supply to the segment. (2) Gingival recessions and gingival margin level problems may occur because the gingival tissues cannot proliferate as fast as the immediate repositioning of the tooth.

The necessity of supplying a better health and gingival esthetics should direct a contemporary orthodontist to an alternative treatment method such as the distraction of the alveolar bone.

Thus, the aim of this study is to examine the effects of a tooth/arch-borne (miniature tooth distractor [MTD]) appliance, designed for the alignment of ankylosed teeth.

MATERIALS AND METHODS

In this report, two upper permanent incisor teeth that failed to erupt because of early ankylosis are described. Panoramic, lateral cephalometric, P-A cephalometric and periapical radiographs, intraoral and extraoral pictures, and study models were obtained initially.

Bands with soldered incisor brackets (Unitek Dyna-Lock wide twin 018–401, 3M Unitek, Monrovia, CA), instead of direct-bond brackets, were applied to the malpositioned incisors to counteract the possibility of bracket failure during distraction procedure. The first step of the treatment was to align the upper dental arch, excluding the ankylosed incisor, and to create sufficient interradicular distance in the projected region of the osteotomy. After the alignment of the upper dentition, a rigid 0.017 $\times$ 0.025 inch stainless steel archwire was inserted. The archwire included a step down to increase the distraction distance in the infrapositioned incisor region. Before distraction, conventional osteotomy procedures were carried out.

Surgical procedure

The operations were carried out in an outpatient clinic, and both patients were sedated before the operation. A mucoperiosteal flap was reflected, and the alveolar bone was exposed around the malpositioned tooth. A vertical cut was made from the mesial and distal interdental sides (interdental osteotomy). Reciprocal microsaws were used (Nouvag MSS 5000; Goldach, Switzerland) for parallel vertical osteotomies. Then, the two vertical cuts were combined by a third cut (subapical osteotomy), which was done horizontally two mm above the root apex using oscillating microsaws (Nouvog OMS 5000). During the cutting procedure, great care was taken not to harm the palatal mucosa. The alveolar segment was mobilized with the help of an osteotome. The mucoperiosteal flap was then closed and sutured without repositioning the mobilized segment.[15,16,20,23–27]

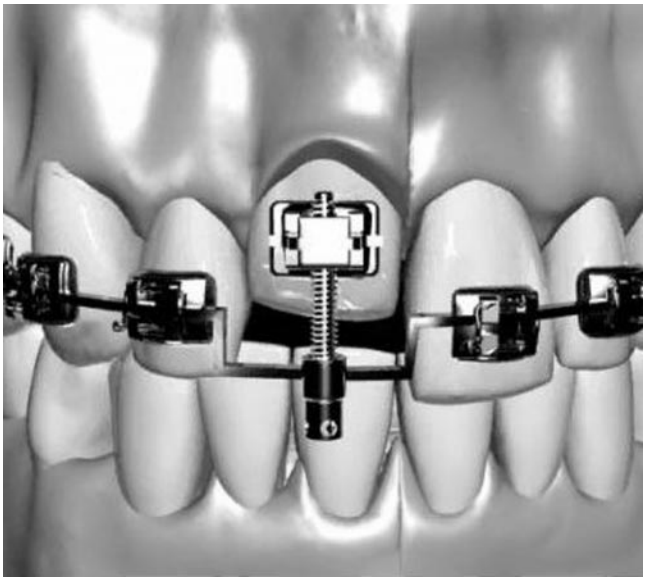

FIGURE 1. Miniature tooth-borne distractor attached to the archwire and the incisor bracket.

Distractor and the distraction procedure

The distraction device (MTD) was composed mainly of three parts;

- threaded transporting nut,
- main threaded rod with a screw head, and
- crimpable guide tube (Figure 1).

The main threaded rod was 15 mm in length and 1.5 mm in diameter, performing a 0.25 mm distraction/turn.

First, the threaded transporting nut, which was specially designed to fit into the central incisor bracket, was inserted and ligated to the bracket of the ankylosed tooth. Then, the crimpable guide tube was crimped to the 0.017 $\times$ 0.025 inch stainless steel archwire. The transporting nut and the guide tube were paralleled and aligned. Finally, the main threaded rod was inserted in the transporting nut passing through the crimpable guide tube. The pieces can also be attached extraorally and inserted as one piece. The MTD was applied to the mobile tooth-bone segment using the archwire as the anchorage unit.

The distraction procedure began after a seven-day latency period. If needed, tooth inclinations can also be corrected by applying torque and artistic bends in the archwire, which changes the inclination of the MTD. When the infrapositioned tooth reached the level of its neighbor, distraction was stopped and the MTD removed. The banded-type central incisor bracket was replaced by a bonded-type bracket. If any fine alignment was needed, additional torque and artistic bends can be performed because there is a ''floating bone.'' Then, ideal archwire was applied for stabilization.

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FIGURE 2. Initial records of Case 1. (a) Full face. (b) Profile. (c) Lateral cephalometric tracing. (d) Frontal intraoral view. (e) Occlusal intraoral view. (f) Panoramic detail of the ankylosed tooth.

Bone formation after distraction was evaluated by both panoramic (OPTG) and periapical radiographs.[28]

Case 1

The first case was a 16-year-old girl with an infrapositioned left central incisor. She was skeletally Class I with a narrow maxilla, and her left upper second premolar was congenitally missing. The infrapositioned tooth was also broken and treated endodontically and prosthetically restored when the patient was nine years old (Figure 2). The patient initially underwent a rapid maxillary expansion. After expansion, the right central incisor started moving toward the midline diastema with the help of transeptal fibers, but the left infrapositioned central did not move, which was another clinical confirmation of ankylosis. The right central incisor was held in place by brackets and a ligature wire to not shift the midline. Then, the upper arch was leveled and aligned until a 0.017 $\times$ 0.025 inch stainless steel archwire was applied and patient was ready for the distraction.

The surgical procedure was carried out as described above. In addition, some additional bone was removed from the mesial side of the root to move the tooth mesially after distraction by using the floating bone concept. After a seven-day latency period, the distractor was inserted and the distraction procedure started. The patient opened the distractor screw twice a day (0.5 mm per day) and the distraction lasted for nine days (Figure 3). The distraction device and the banded incisor bracket were removed, and a bonded-type incisor bracket was applied. The ankylosed tooth and the bone segment were moved to the mesial using sliding mechanics. The case was continued and finished using the conventional orthodontic mechanics (Figure 4).

Case 2

The second case was a 17-year-old boy with skeletal Class II and a dental Class I relationship with an infrapositioned left central incisor nearly at the end of growth. There was no history of trauma, bad habits, or an infection, but the radiographic examination and the sharp and solid sound on percussion were diagnostically supportive of ankylosis. However, we started the treatment by conventional orthodontics to check whether the tooth would move. When the tooth failed to move, the diagnosis of ankylosis was confirmed and we started the distraction procedure. First, the upper arch was leveled, aligned, and a 0.017 $\times$ 0.025 inch stainless steel archwire was inserted. Then, the surgical procedure was carried out as described above. After a seven-day latency period, the distractor was inserted and the distraction procedure started. The pa-

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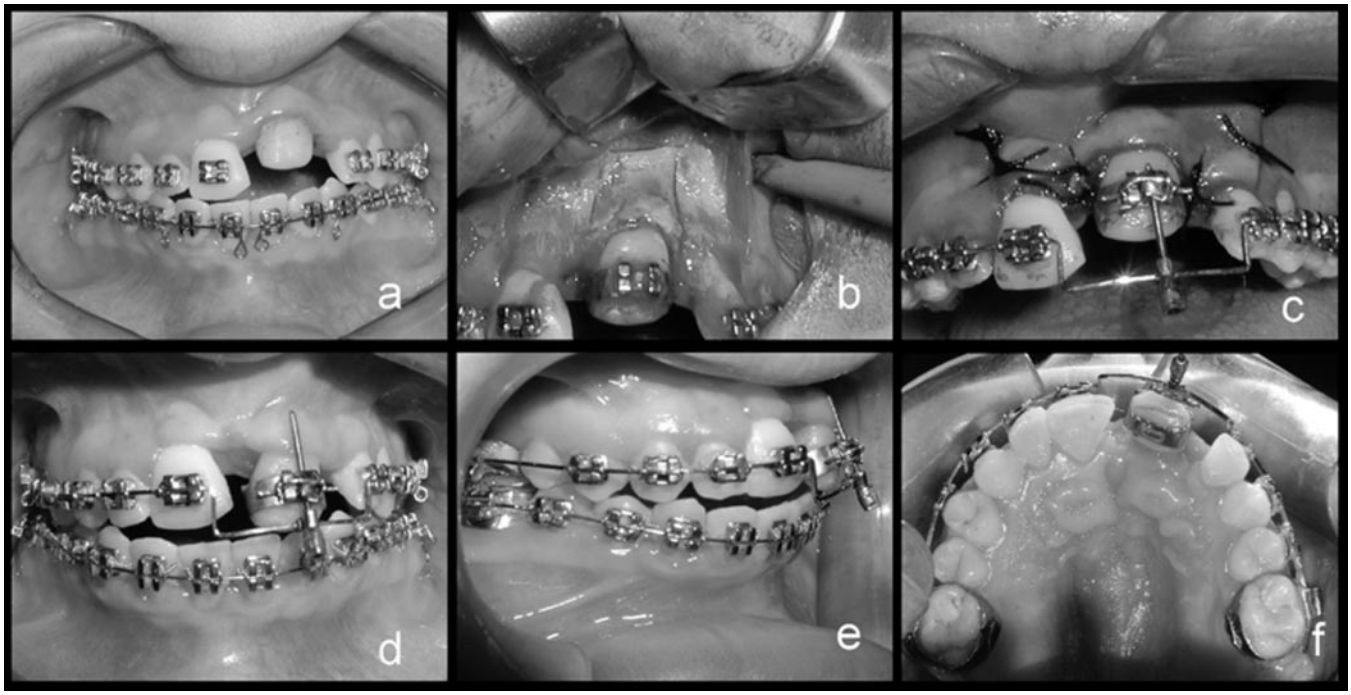

FIGURE 3. Case 1. (a) Intraoral view before distraction. (b) Vertical and horizontal osteotomies. (c) Miniature tooth-borne distractor, inserted in the arch and the ankylosed tooth. (d) The end of distraction (frontal view). (e) The end of distraction (lateral view). (f) The end of distraction (occlusal view).

FIGURE 4. Final records of Case 1. (a) Full face. (b) Profile. (c) Lateral cephalometric tracing. (d) Frontal intraoral view. (e) Occlusal intraoral view. (f) Panoramic detail of the ankylosed tooth.

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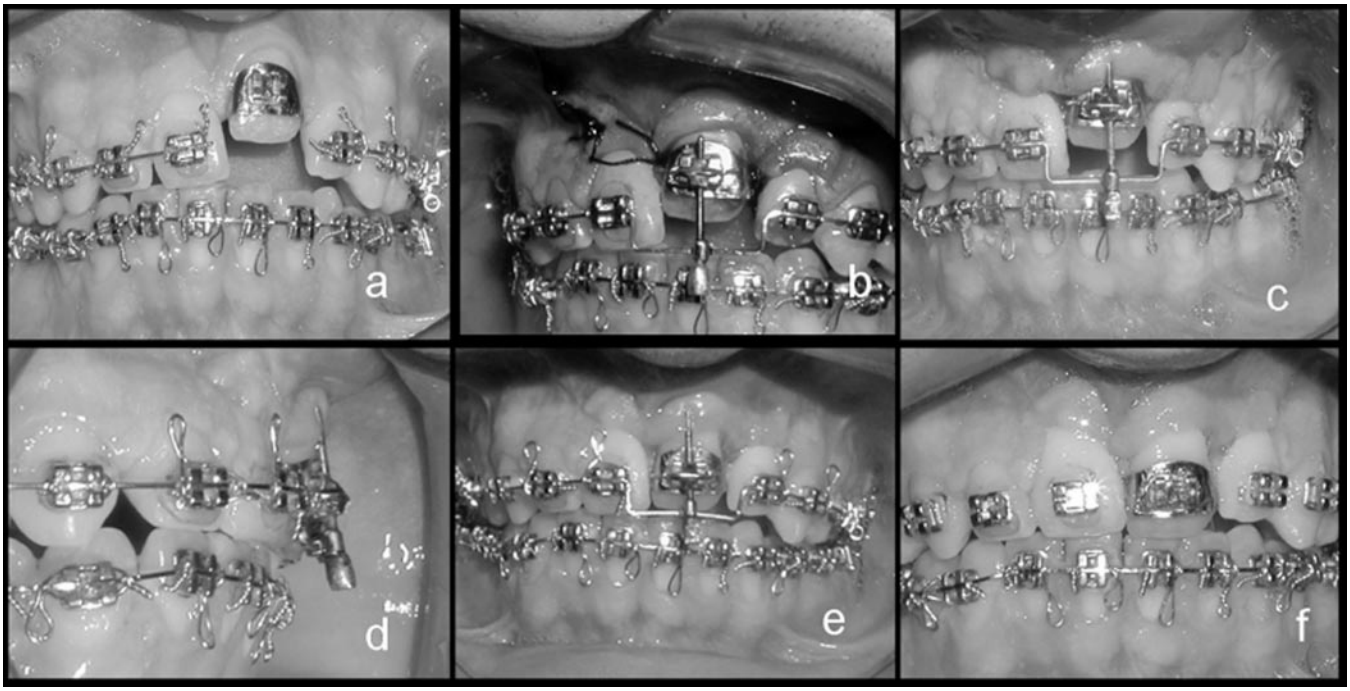

FIGURE 5. Case 2. (a) Intraoral view before distraction. (b) Miniature tooth-borne distractor (MTD), after the latency period. (c) MTD, inserted right after the osteotomy. (d) The end of distraction (lateral view). (e) The end of distraction (frontal view). (f) Intraoral view after MTD was removed.

tient opened the distractor screw twice a day (0.5 mm per day) and the distraction lasted for 10 days. One mm of overcorrection was performed because the patient was growing. The case was continued by proper orthodontic mechanics (Figure 5).

DISCUSSION

Treatment of infrapositioned ankylosed teeth is not possible by conventional orthodontics because of the fusion between cementum and the alveolar bone. The treatment methods in the literature include extraction, surgical luxation, surgical repositioning, and retention with or without coronal modifications.[19] Several new studies suggest the distraction of the surrounding alveolar bone for the positioning of ankylosed teeth allows a better blood supply, gingival reshaping, and better esthetics. Isaacson et al[29] moved an ankylosed central incisor using orthodontics, surgery, and distraction osteogenesis to bring both the incisal edge and the gingival margin of the clinical crown to the proper height in the arch relative to their antimeres. In another study done by Nocini et al,[30] the distraction osteogenesis procedure was performed in two malposed implants and an ankylosed tooth. Kinzinger et al[28] positioned ankylosed teeth by using a bone-borne distraction system.

Although osteodistraction is a good treatment modality for the subjects with ankylosed teeth, existing appliances are bulky and difficult to apply in dental regions. This newly designed MTD is quite efficient with its small dimensions, ease of application and removal, and patient tolerance. It uses both the tooth and the archwire as anchorage units, so it is superior to bone/bone-borne and bone/tooth-borne distractors. However, indications for the use of MTD are restricted because a multibanded appliance where the MTD can be fixed is obligatory. This type of anchorage depends on the patient's dentition and is critical, for instance, in jaws affected by periodontal involvement. Intrusive forces and moments on adjacent teeth develop automatically; whereas a conventional distractor is merely bone anchored and does not affect other teeth. Although the appliance is called a MTD, this procedure is not an actual tooth distraction. In fact, it is an alveolar bone distraction, which carries the ankylosed tooth.

Kinzinger et al[28] used a bone-borne distractor, which was bulky and difficult to apply. This distractor is attached to the bone by miniscrews, and this may create some surgical complications such as the perforation of the roots of adjacent teeth. The necessity of a second operation for the removal of these distractors appears to be another disadvantage. On the other hand, the MTD is not attached to the bone but to the tooth itself and the archwire, which makes it so easy to apply and remove.

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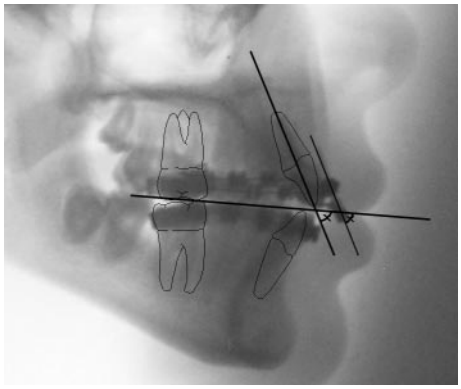

FIGURE 6. The parallel distraction vector of miniature tooth-borne distractor to the neighboring central incisor.

Because the body of the distractor seats between the right and left wings of the bracket, using a wide upper incisor bracket is compulsory. Using bands with soldered incisor brackets instead of direct-bond brackets is more beneficial against potential bracket failure; however, this creates an esthetic problem.

In the Isaacson et al[29] study, a one mm vertical extrusion bend was placed in the arch to produce distraction osteogenesis. Two weeks later, this step was repeated, and at the end of four weeks, extrusion was completed. For the healing of the bone segment, a passive archwire remained for six weeks. Considering the contemporary distraction osteogenesis protocol, in which the distraction rhythm is twice a day and the distraction rate is one mm per day, this method seems to be slower, but the authors explain this by the need to maintain the vitality of the attached soft tissue. Although the vitality of the attached soft tissue is an important issue, the conventional distraction protocols still recommend a much faster rate. Kinzinger et al[28] reported a 0.6 mm distraction rate per day by a bone-borne distractor and concluded that they achieved a good functional and esthetic outcome. In this study, a distraction protocol was followed where the rate was 0.5 mm per day and clinical observations of good gingival health and esthetics was recorded.

The MTD is an individualized appliance. While the distraction procedure is going on, the direction of the mobilized bone segment can be adjusted in three dimensions by creating artistic and torque bends on the stainless steel archwire (Figure 6). The bone-borne distractors work in a single vector, which makes them incompetent for correcting tooth positioning. Kinzingeret al[28] concluded that the bone-borne distractors are difficult tasks for the surgeon because the intraoral distractors are unidirectional and lengthening occurs only in a linear direction with no possibility of three-dimensional alignment of the mobilized segment.

In previous studies, the osteotomies were usually performed by a fissure-type bur. Nocini et al[30] used microoscillating saws for the vertical and horizontal cuts. In this study, two different types of microsaws (reciprocating for the vertical cuts and oscillating for the horizontal cuts) were used to have thinner cuts and to prevent bone loss. These microsaws allow the surgeon to produce interdental cuts even if the adjacent roots are very close. After the osteotomies were performed, the flap was closed and sutured. Because the MTD is a tooth/arch-borne device, there is nothing left under the mucosa to retard the healing of the flap. Consequently, there is no risk of inflammation or perforation of the operation site. This emphasizes the two advantages of a good prognosis of the mobilized bone and the patients' comfort.[20,29–31]

CONCLUSIONS

- The newly designed MTD was successfully used in osteodistraction treatments of infrapositioned ankylosed teeth.
- This appliance is highly advantageous from the aspects of application, easy activation, buccolingual control, patient tolerance, and easy removal at the end of the procedure.

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