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Maxillary molar mesialization with the use of palatal mini-implants for direct anchorage in an adolescent patient

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A unique clinical challenge presents when dealing with a compromised first permanent molar. A compelling treatment option for consideration is the removal of a nonrestorable first permanent molar, with the subsequent “replacement” through controlled mesial tooth movement of viable second and third molars. To reinforce the anchorage support associated with such a planned movement, indirect or direct implant-supported mechanics may be used. With the use of direct anchorage, orthodontic brackets are not required and space closure can be commenced immediately. In this article, we report the clinical procedure and design of direct-anchorage mechanics used for the successful closure of a maxillary first permanent molar space with the use of an implant-supported appliance (Mesialslider). Treatment was completed in just under 12 months, with successful mesial movement of the maxillary second and third molars without the need for the bonding of orthodontic brackets on the anterior dentition. The result was determined to be stable over a 3-year period. (*Am J Orthod Dentofacial Orthop* 2019;155:725-32)

The first permanent molar is the tooth most frequently lost to dental caries or periodontal disease.¹ Although there are a number of prosthetic options readily available for tooth replacement, orthodontic space closure by controlled mesial movement of the second and third permanent molars may be preferable and mitigates the need for ongoing restorative maintenance.²⁻⁵ A complex biomechanical challenge exists when protraction of the molars is required without retraction of the anterior teeth and premolars. Anchorage control is crucial in the treatment of such patients because lingual tipping of the incisors must be prevented while protracting the second and third molars.

Titanium mini-implants are commonly used as a source of absolute anchorage during various types of tooth movement, because they are simpler, more cost-

effective, and more convenient to use than endosseous implants.⁶⁻¹⁰ The most frequently reported site for insertion and placement of these mini-implants is the buccal dentoalveolar region which can potentially be in the path of moving teeth. Therefore, particularly in the maxilla, the anterior palatal area seems advantageous, because all of the teeth can be moved without any interference from the mini-implants.¹¹ Other considerations that make the anterior palate a preferred site for implant placement includes good bone quality, a thin attached mucosa, minimal risk of tooth injury, and a high associated success rate.^{12,13}

To reinforce anchorage with the use of mini-implants, direct or indirect mechanics can be applied. In indirect anchorage treatment strategies, one tooth or many teeth are stabilized with the use of a rigid orthodontic wire, with an adjunctive full multibracket appliance needed. In contrast, the use of mini-implants with direct anchorage concepts involve forces being directly applied to the teeth that are to be moved. Considerations that may favor direct over indirect anchorage approaches include a possible esthetic advantage if concomitant orthodontic bracket placement is not required. A further corollary of such an approach is the reduced friction within the system, leading to treatment objectives being achieved over a shorter period of time. Furthermore, direct anchorage bypasses the initial

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Fig 1. Pretreatment facial and intraoral photographs and panoramic radiograph. (Patient was treated in cooperation with Dr Bahareh Wymar, Cologne, Germany.)

alignment and leveling period associated with most conventional straight-wire systems, with the immediate commencement of space closure. In the present paper, the clinical procedure and design of direct anchorage mechanics for maxillary space closure with the use of 2 palatal mini-implants (Mesialslider) are described.

CLINICAL EXAMPLE

A 17-year-old adolescent female patient presented with the absence of the maxillary first permanent molars. She was seeking orthodontic treatment to facilitate mesial movement of the maxillary second and third molars (Fig 1). Both maxillary first molars were lost because of periodontitis and nonrestorable decay. The patient reported that she had previously undergone a comprehensive course of orthodontic treatment, and she presented with an Angle Class I occlusion sound buccal

intercuspidation. Her malocclusion was characterized by minor incisor irregularity, and mild mandibular arch-length insufficiency was noted. The panoramic radiograph confirmed the presence of the unerupted maxillary third molars, the periapical periodontitis of the upper right first molar, and a mucous retention cyst noted in the maxillary left sinus. The functional assessment of the occlusion did not show a discrepancy between centric occlusion and centric relation. There were no signs or symptoms of temporomandibular dysfunction.

After extensive discussion with the patient and her parents, informed consent was obtained to proceed with a program of orthodontic care to protract the maxillary second molars and close the residual extraction spaces in the first permanent molar site. Alternative treatment approaches that were also considered were the use of removable or fixed prosthesis options,

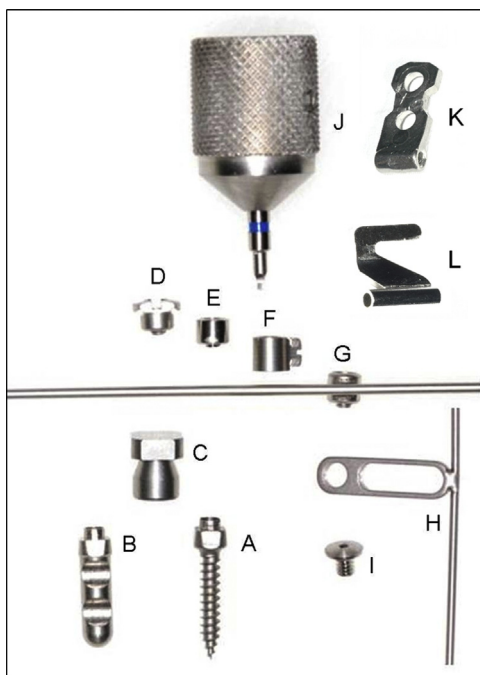


Fig 2. Parts for the Mesialslider.

osseointegrated implants, and autotransplantation of the third molars. Although such alternative treatment approaches may be readily delivered with relatively shorter treatment times, they involve invasive surgical procedures (dental implants, autotransplantation) or are potentially biologically costly, often involving significant tooth preparation (fixed prosthesis). Variable long-term survival rates and complications of the alternate prosthetic and surgical options have been reported.^{14,15} The patient made an informed decision to proceed with a treatment program involving closure of the residual maxillary arch spacing through the advancement of the maxillary second molars. Further consideration was given for the potential favorable eruption of the maxillary third molars into the original second molar position.

INSTALLATION OF THE MESIALIZATION APPLIANCE AND TREATMENT PROGRESS

The treatment objectives consisted of type C anchorage requirements, in which more than 75% of the residual space needed to be closed by the forward movement of the posterior segments through the mesialization of the maxillary second molars. A Mesialslider (1.1 mm stainless steel wire) connected to 2 median palatal mini-implants (anterior 2 × 11 mm, posterior 2 × 9 mm; Benefit System, PSM North America), as reported previously by Wilmes et al,^{16–20} was planned

for the maxillary arch as a source of direct anchorage (Fig 2). Other mini-implant systems with abutments may be used as well (eg, OrthoEasy Pal, Forestadent).²¹ Treatment commenced with the insertion of the 2 palatal mini-implants, under local anesthesia, distal to the third palatal rugae (T-zone).²² Stainless steel circumferential bands were cemented to the maxillary second molars, and an impression was recorded at the same appointment for laboratory fabrication of the Mesialslider. For this purpose, impression caps and laboratory analogs were used. Several days later, the Mesialslider appliance was fitted and engaged to the maxillary second molars (Fig 3). No brackets were bonded. Mesialization of maxillary molars commenced bilaterally with the application of a nickel-titanium closing coil spring (200 g). Over the next 6 months, approximately one-half of the first permanent molars space was closed, and elastic chains were then added to maintain the necessary mesialization force to facilitate continued space closure (Fig 4). Twelve months after the commencement of treatment, the bilateral spaces were closed and the planned mesial tooth movement of the maxillary left second molars was achieved (Fig 5), and the Mesialslider was removed (Figs 6 and 7). A vacuum-formed stent was prescribed for retention.

TREATMENT RESULTS

The planned treatment objective of maxillary space closure without concomitant anchorage loss was achieved. The maxillary third molars moved forward autonomously secondary to the pull of the interdental periosteal fibers. The chosen biomechanical approach enabled the line of force action to be applied closer to the center of resistance of the maxillary second molars, thereby achieving space closure predominantly through translation, or bodily tooth movement. The posttreatment panoramic radiograph (Fig 7) showed bodily mesialization of the maxillary second and third molars into the first molar spaces and sound alveolar bone levels. The superimposition of pre- and posttreatment 3D scans (superimposed on the palatal rugae²³) showed the mesialization of both second and third molars (Fig 8). The posttreatment retention review was completed 3 years after the treatment was finished, and records demonstrated good stability of the dental movements. The small space between the maxillary right second and third molar disappeared owing to a final mesial drift of the third molar (Figs 9 and 10).

DISCUSSION

There has been a plethora of published cases and clinical studies recently describing the mesialization of

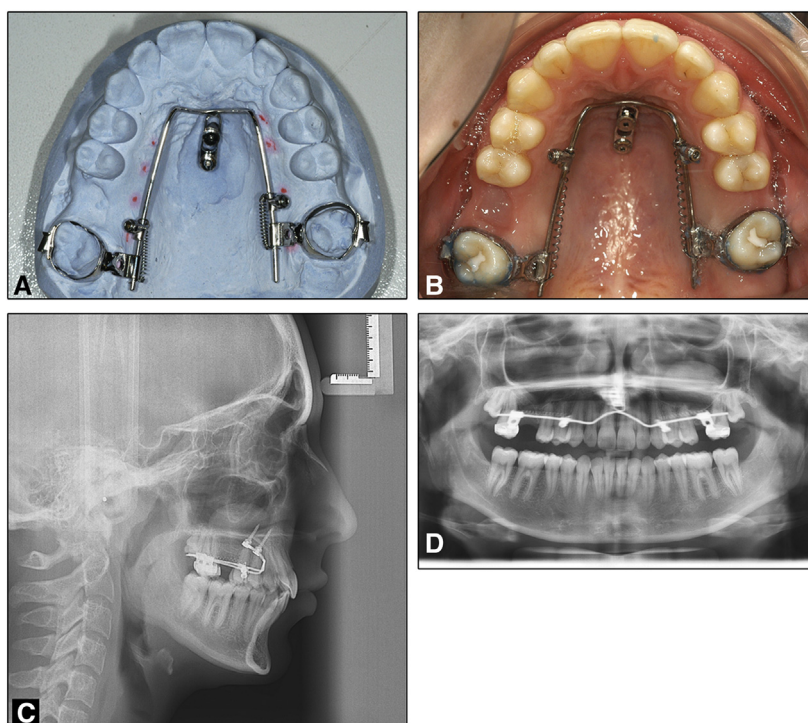


Fig 3. A, Mesialslider adapted on a plaster model. B, Intraoral photograph after placement of palatal mini-implants and the Mesialslider. C, D, radiographs after placement.



Fig 4. Progress occlusal photographs after 6 months; elastic chains were added.



Fig 5. Occlusal photograph after 12 months, at the end of treatment.

second and third molars into the space of missing first molars.^{2-4,19,24-26} However, our treatment mechanics was unique from previously reported cases, because there is no need for brackets if a direct anchorage-based mechanism is used.

In this case, the mini-implants used had dimensions of 2×11 mm anteriorly and 2×9 mm

posteriorly. Recently published cone-beam computed tomographic studies revealed that a length of 9 mm is sufficient to serve as anchorage in the anterior palate.^{27,28} The framework for the Mesialslider appliance (Fig 2, H) is readily available and allows for the Mesialslider to be adapted and manipulated at chairside. This potentially removes the need for laboratory



Fig 6. Posttreatment extraoral and intraoral photographs, after removal of the Mesialslider.

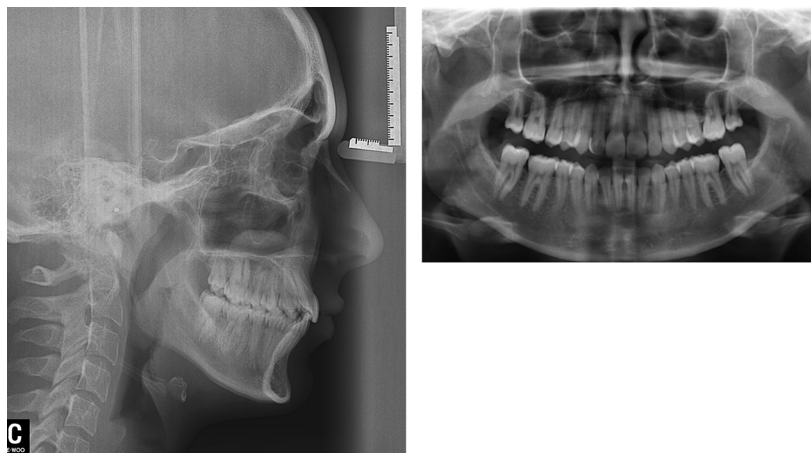


Fig 7. Posttreatment lateral cephalogram and panoramic radiograph after removal of the Mesialslider.

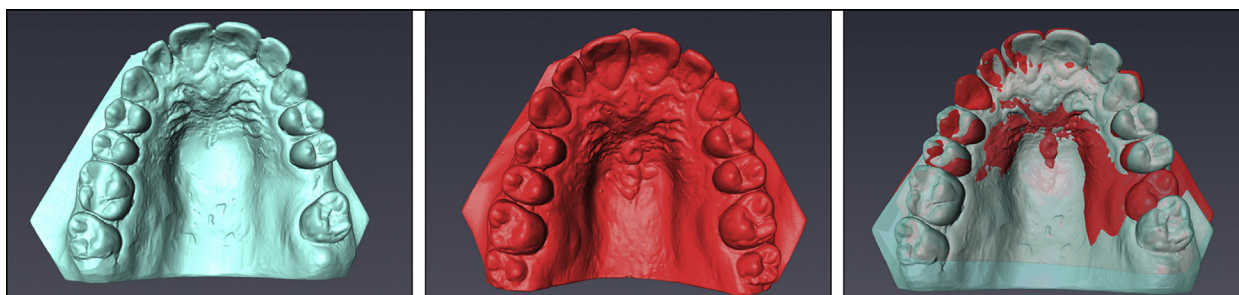


Fig 8. 3D scans of the maxilla: **A**, before treatment, **B**, after treatment, and **C**, superimposition of before and after scans.



Fig 9. Superimposition of the pretreatment and posttreatment lateral cephalograms.

support and its associated costs. However, depending on the experience of the operator, chairside adjustments may require additional clinical time. Alternatively, an impression or scan and adaptation of the Mesialslider on a plaster model might prove to be more practical. Figure 2 illustrates the mesialization system and its constituent parts for individualization in differing anchorage requirements. Although in our case we soldered part *K* directly to the maxillary molar bands, as shown in Figure 3, *A*, part *L* can be inserted directly into a standard molar band sheath chairside and does not require a laboratory soldering procedure. Our clinical experience has revealed that associated molar tipping can be prevented absolutely if the connection is as rigid as possible through the use of a soldered connector (Fig 2, *K*).

In our case, the maxillary second and third molars were moved anteriorly into alveolar ridges with

previous bone loss. Both nonhuman²⁹ and human³⁰ experiments have shown that when a tooth is mesialized into a reduced bony ridge, the periodontal apparatus of the newly moved tooth undergoes minimal periodontal alterations. In addition, there can be a positive change in the width of the alveolar ridge,³⁰ as was observed in the present case. Moving teeth through the maxillary sinus is considered to be one of the most challenging treatment tasks in orthodontics, because it requires compensatory new bone apposition in the direction of tooth movement. Some papers reported root resorption, loss of pulp vitality, and perforation of the sinus membrane as possible complications after moving molars through a lowered maxillary sinus.^{31,32} However, it is well known that orthodontic tooth movement may also cause bone apposition at border structures, such as the sinus floor, as was demonstrated by Oh et al.³³ In a nonhuman animal experiment it was shown that the sinus wall may maintain a consistent thickness.³⁴

The total treatment time was 12 months, which is relatively short compared with the reported average of 24–48 months for cases requiring molar mesialization.³⁵ Active mesialization of the second molar was commenced shortly after the reported loss of the maxillary first permanent molar. Most conventional straight-wire approaches involve a preliminary phase of alignment and leveling, which serve to delay the commencement of active space closure.

The patient was particularly pleased about the lack of visibility of the appliance, maximizing the smile esthetics during treatment and reducing the risks of enamel decalcification and root resorption. There were no significant complications noted or reported during and after orthodontic treatment. The patient was highly motivated and maintained good oral hygiene.



Fig 10. Intraoral photographs after 3 years in retention.

CONCLUSIONS

Bilateral maxillary orthodontic traction of the second and third upper molars into the missing maxillary first molar space was achieved without retracting or even using the anterior teeth, by means of an implant-supported mechanical procedure. The total treatment time of 12 months was well below reported averages in the literature for molar mesialization. The desired objectives of smile and facial esthetics, functional occlusion, and stability were achieved without complications.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at <https://doi.org/10.1016/j.ajodo.2019.01.011>.

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