Case Report

Miniscrew implant-supported Frog® appliance for maxillary molar distalization

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ABSTRACT

Various appliances have been used for the correction of Class II malocclusion. The majority of these appliances depend on patient compliance for a successful treatment outcome. An 11-year-old girl was referred to our clinic for orthodontic treatment. She had a mild skeletal Class II malocclusion with Class II molar and canine relationship on both sides. The treatment plan included bilateral distalization of the maxillary first molars using a miniscrew implant-supported frog appliance along with comprehensive orthodontics. Successful correction of Class II malocclusion was achieved with the use of a relatively new intraoral distalization appliance—the Frog® Appliance. Proclination of maxillary incisors was minimal due to the use of miniscrew implants. This article presents an effective, noninvasive, and compliance-free intraoral distalization appliance for achieving maxillary molar distalization.

1. Introduction

Various distalization appliances have been developed to overcome compliance issues: the pendulum appliance [1], the distal jet [2], the Jones jig [3], the first-class appliance [4], the Carriere distalizer [5], appliances with nickel-titanium springs [6], and the simplified molar distalizer, also known as the Frog® Appliance (Forestadent, Pforzheim, Germany) [7]. Although all of these appliances achieve distalization of the maxillary molars, the reciprocal forces produce undesirable side effects, such as proclination of maxillary incisors, maxillary molar distal-crown tipping, and bite opening. Recently, miniscrew implants (MSIs) have been used clinically to reinforce anchorage during distalization and to avoid these side effects.

Use of a skeletally anchored Frog Appliance was first reported in 2011 [8]. This appliance constitutes of an expansion screw and a removable distalizing spring that connects the expansion screw to the maxillary first molars (Fig. 1). The distalizing spring is fabricated from 0.032-in. TMA® (Ormco, Orange, CA) or stainless steel wire with adjustment loops. These adjustment loops are used to adjust the distalizing spring as needed. The ends of the distalizing spring have double back bends, which insert into the lingual sheaths of the maxillary first molar bands. The entire assembly is anchored to a pair of MSIs placed on either side of midline of the anterior palate. It is attached to the MSIs by using a modified acrylic Nance palatal button.

This case report describes an 11-year-old girl who presented with a Class II malocclusion and maxillary crowding, including partially blocked-out canines (Figs. 2 and 3). The maxillary second molars were still in the tooth-bud stage when orthodontic appliances were placed, and an MSI-supported Frog Appliance was fitted.

2. Etiology and diagnosis

The patient had a mesocephalic facial form with competent lips and no significant facial asymmetries (Fig. 2). Intraorally, she had Angle Class II molar relation on both sides (Figs. 2 and 3). She had mild mandibular crowding, a 3-mm overjet, 75% overbite, and coincident maxillary and mandibular midlines. Soft tissue analysis revealed that she had normal upper lip, retrusive lower lip, and retrusive chin (Table 1).

No abnormalities were noted on the panoramic radiograph (Fig. 4). Clinical examination did not reveal any temporomandibular joint problems. Periodontal health was found to be within normal limits.
The pretreatment lateral cephalometric radiograph (Fig. 5) and analysis (Table 1) demonstrated a skeletal Class II malocclusion (A point, nasion, B point [ANB] = 5°). The maxillary incisors had a 19° angle relative to the nasion point A line, and the mandibular incisors had a 100° angle relative to the mandibular plane. The Frankfort mandibular plane angle (FMA) of 18.5° and sella nasion (SN)-mandibular plane (GoGn) angle of 28° revealed the hypodivergent skeletal pattern. A 6-mm space requirement in the maxillary arch and a 3-mm space requirement in the mandibular arch were found on study model analysis.

2.1. Treatment objectives

Treatment objectives for this patient were to (1) relieve maxillary and mandibular crowding, (2) distalize the maxillary molars to establish a Class I molar and canine relationship, (3) achieve a well-intercuspated occlusion, (4) achieve ideal overbite and overjet, and (5) improve the skeletally hypodivergent profile and soft-tissue profile.

2.2. Alternative treatment plans

The patient's chief concern was crowding in maxillary and mandibular arches. Treatment alternatives for this case were (1) distalization of maxillary molars using an extraoral headgear, (2) distalization of maxillary molars using the Frog Appliance, (3) extraction of maxillary first premolars only, (4) extraction of maxillary first premolars and mandibular second premolars, and (5) fixed orthodontic treatment with growth modification by using a functional appliance.
Due to the patient’s parents’ opposition to the extraction of healthy teeth for orthodontic purposes and the patient’s reluctance to wear headgear, intermaxillary elastics, or a functional appliance, the distalization of maxillary molars was evaluated as a treatment plan option. This treatment plan was selected by the patient and her parents.

2.3. Treatment progress

Preadjusted fixed appliances (0.022 × 0.028-inch, MBT system® 3M Unitek, Monrovia, CA) were placed in both arches for initial leveling and alignment. After 4 months of initial leveling and alignment, two MSIs were placed in the anterior palate. One MSI was placed on either side of the midline approximately 1 to 2 mm from the midpalatal suture and 5 to 6 mm behind the incisal papillae. A maxillary impression was taken for fabrication of the Frog Appliance. The Frog Appliance was cemented in the oral cavity 1 week later (Fig. 1). This appliance was activated by performing three rotations each at 4-week intervals. Then 5° to 10° of “toe-in” bends were placed in the double back bends of the springs as needed to prevent the undesirable rotation of maxillary molars during distalization.

Appliance stability and distalization progress were evaluated at each appointment. The maxillary first molars were distalized until a Class I molar relationship was achieved on both sides (Fig. 6). This was completed within 5 months of appliance cementation. The appliance was left in place for an additional period of 4 months to prevent any mesial movement of molars. Pull from the transseptal fibers helped in the distal drifting of maxillary canines and premolars during this period. Complete distalization of maxillary canines and premolars was achieved by using continuous archwires and power chains. The Frog Appliance was removed after 13 months of overall treatment. MSIs were removed 1 week after the removal of the Frog Appliance.

After a Class I canine relationship was achieved on both sides, 0.019 × 0.025-in. TMA® (Ormco, Orange, CA) archwire with “tear-drop” loops was used in the maxillary arch to retract the anterior teeth. Detailing bends were placed in 0.016-in. stainless steel wires to improve alignment of the teeth. Coordinated archwires and settling elastics were used to gain maximum intercuspation of the teeth. The orthodontic appliances were removed after 21 months of treatment. Hawley retainers were fabricated for retention in both arches.

3. Results

The patient’s chief concern of crowding was resolved while ideal overbite and overjet were achieved. Posterior occlusion was improved to a bilateral Class I molar relationship. Class I canine relationship was also achieved on both sides (Figs. 7 and 8). Satisfactory root parallelism was achieved as noted on the posttreatment panoramic radiograph (Fig. 9). No temporomandibular joint problems were noted. Improvement in soft-tissue profile was noted. Lower lip position improved by 1 mm, and the upper lip position was maintained with respect to the E line (Figs. 10 and 11 and Table 1).

Maxillary growth was noted to be in a forward direction predominantly (Fig. 11). Significant mandibular growth was observed in an anteroinferior direction. Bodily distal movement and simultaneous uprighting of maxillary first molars was also noted. Mandibular first molars demonstrated significant compensatory mesial and occlusal movement as a response to skeletal mandibular growth [9]. The maxillary incisors proclined minimally in a bodily fashion compared with their pretreatment

<table>
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<tr>
<th>Measurement</th>
<th>Pretreatment</th>
<th>Posttreatment</th>
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<tbody>
<tr>
<td>SNA angle (°)</td>
<td>80</td>
<td>81</td>
</tr>
<tr>
<td>SNB angle (°)</td>
<td>75</td>
<td>77</td>
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<td>ANB angle (°)</td>
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<td>Wits appraisal (mm)</td>
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<td>SN-Go-Gn (°)</td>
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<td>2</td>
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<tr>
<td>Upper incisor to NA (°)</td>
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<tr>
<td>Lower incisor NB (mm)</td>
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<td>Lower incisor to NB (°)</td>
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<tr>
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<td>Upper lip to E line (mm)</td>
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<td>–1</td>
</tr>
<tr>
<td>Lower lip to E line (mm)</td>
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ANB, A point, nasion, B point; FMA, Frankfort mandibular plane angle; Gn, gnathion; Go, gonial; IMPA, incisor to mandibular plane angle; NA, nasion point A; NB, nasion point B; SN, sella nasion; SNA, sella nasion point A; SNB, sella nasion point B.
position. The mandibular incisors also showed slight labial movement (Fig. 11).

3.1. Case retention

The patient received Hawley retainers for maxillary and mandibular arches. The occlusion and treatment changes were stable at 1 year of posttreatment follow-up (Fig. 12).

4. Discussion

Distalization is one of the treatment modalities used by clinicians and practitioners for correction of Class II malocclusions without any major skeletal discrepancies. Use of various noncompliance intraoral molar distalization appliances [1–8] has been described in literature. Several studies have reported that obtaining a bodily distal movement of the maxillary first molars with minimal rotation and minimal distal-crown tipping remains a significant challenge of maxillary molar distalization [10–12]. In our patient, the Frog Appliance was oriented parallel to the occlusal plane and positioned approximately 10 to 12 mm apical to the occlusal surface of the maxillary first molar. This position is close to the trifurcation of roots of maxillary first molar and is considered its approximate center of resistance [13]. Positioning the appliance in this manner allows the effective distalizing force vector to pass through the center of resistance of the maxillary first molars, thereby producing bodily distal movement. In our case, the maxillary first molars moved distally in a bodily fashion and also exhibited distal-root movement.
tipping (Fig. 11). This distal-root tipping is very critical in achieving a well-intercuspated posterior occlusion [14].

Another significant challenge is prevention of bodily mesial movement, mesial tipping, and extrusion of maxillary first premolars during distalization [15,16]. A meta-analysis was performed to compare intraoral distalizer effects with conventional and skeletal anchorage [17]. The analysis showed an average molar distalization amount of 3.34 mm with conventional anchorage and 5.10 mm with skeletal anchorage. This analysis also showed mesialization of premolars by 2.3 mm in studies with conventional anchorage compared with −4.01 mm of premolar distalization in studies with skeletal anchorage [17]. This is a major drawback of tooth- and/or palate-borne distalization appliances. MSIs have been shown to act as efficient anchorage units and help overcome these limitations [18,19]. For our patient, mesial movement and/or mesial tipping of maxillary first premolars was avoided as the anchorage was obtained from MSIs instead of maxillary first premolars.

Finally, prevention of anchorage loss during distalization, which is expressed as either proclination of the maxillary incisors with increased overjet or maxillary anterior crowding, is equally important [15,16]. The anterior teeth cannot resist the opposing forces of distalization without moving in the anterior direction. Satisfactory distalization results without anchorage loss have been achieved in molar distalization studies using skeletal anchorage [18,19]. We were able to control the undesired proclination of maxillary incisors due to the direct anchorage from MSIs (Fig. 11 and Table 1).

5. Conclusion

The Frog Appliance is an effective, noninvasive, and compliance-free intraoral distalization appliance for achieving maxillary molar distalization. This case report should help other clinicians and practitioners to consider adding this appliance as another tool in their armamentarium for their Class II patients.

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References


Fig. 7. Posttreatment facial and intraoral photographs.
Fig. 8. Posttreatment dental casts.

Fig. 9. Posttreatment panoramic radiograph.
Fig. 10. Posttreatment lateral cephalogram and tracing.

Fig. 11. Superimpositions: pretreatment and posttreatment.
Fig. 12. Facial and intraoral photographs at 1-year follow-up.