Long- and short-term effects of headgear traction with and without the maxillary second molars

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Introduction: A quantitative assessment of maxillary first molar distalization with and without the maxillary second molar (M2) was carried out. **Methods:** Fifty-six cervical headgear patients undergoing fixed appliance orthodontic treatment were divided into 2 groups: before (G − M2) and after (G + M2) eruption of the maxillary second molars (ages, 11.87 ± 1.20, and 13.05 ± 1.55 years, respectively). The tightness of the dental contact point (TDCP) and the space between the second premolar and the maxillary first molar were measured at 6 levels of headgear force (0-15 N) at 3 intervals 6 months apart (T0, T1, T2). **Results:** Relationships were found between space and TDCP, time, and presence or absence of the maxillary second molar at T1 and T2 ($P < 0.001$). The TDCP decreased and space increased with increase in initial headgear force. An increase in initial force beyond 6 to 9 N did not significantly increase the initial maxillary first molar distalization. The G − M2 TDCP and space measurements were similar to those of G + M2 at T2 with the eruption of the maxillary second molar. From T0 to T1, maxillary first molar distalization was greater in G − M2. In comparison with our previous headgear-alone study, initial distalization with a fully bonded appliance was reduced by 4-fold. **Conclusions:** Headgear therapy is more effective before the eruption of the maxillary second molar. Once it erupts, the distalization pace of the maxillary first molar is reduced, but it can nevertheless be pursued at a slower pace when the maxillary second molar is present. (Am J Orthod Dentofacial Orthop 2014;146:467-76)

It is an accepted treatment modality to direct extraoral forces through the maxillary permanent first molar to cause its distalization via headgear (HG). However, this effect can vary considerably under different HG loading conditions as well as in the presence or absence of teeth distal to the maxillary permanent first molar.[1] The presence of the second molar (M2) and third molar in different developmental and eruptive stages can also act as a physical impediment to the extent and direction of maxillary permanent first molar distalization.[2-5]

Kloehn[6] advocated early HG treatment to distalize the maxillary teeth into correct occlusion with the mandibular dentition. It has also been proposed that treatment of Class II malocclusions should be performed before the eruption of the maxillary permanent second molars and canines, since the latter might affect treatment efficiency.[7,8] Previous studies with noncompliance appliances have reported that before maxillary second molar eruption, the maxillary first molar can be distalized by 1 to 2 mm per month with little anchorage loss—ie, forward displacement of the anterior segment.[2,9] It has been shown when using the pendulum appliance that once the maxillary second molars have erupted, distal movement of the maxillary first molar is slowed, and anchorage loss is more common,[4] producing mesial movement of the anterior teeth.[10] Ten Hoeve[2] and Jeckel and Rakosi[3] concluded that distalization of the maxillary permanent first molar is restrained by the maxillary second molar; consequently,

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they recommended distalization before second molar eruption. Similar findings have been reported for several intraoral molar distalization appliances.[11,12]

On the other hand, Muse et al,[13] using a Wilson rapid molar distalization appliance, and Ghosh and Nanda,[14] using the pendulum appliance, found that the presence of the maxillary second molar did not significantly affect the rate of first molar movement. Additional studies with repelling magnets[15] and the pendulum appliance[10,16] support the latter claims of the minor effect of the maxillary second molar on first molar distalization. This diversity could be related to the interrupted force regimen produced by HG compared with the continuous force of noncompliance appliances.

In a previous study, we demonstrated that an incremental increase in cervical HG force, applied per se, caused differences in the gap created between the maxillary first molar and the second premolar, and that first molar distalization was influenced by the absence or presence of the maxillary second molar.[2] In this study, we investigated whether similar effects on molar distalization can be expected when HG traction is applied during full-arch fixed appliance therapy and over a longer period of time. Furthermore, we investigated whether HG therapy is affected by short-term (initial periodontal ligament [PDL] reaction to HG placement) and long-term (bone remodeling) changes, and we determined the range for the initial HG force.

With respect to the latter, few previous studies have examined this issue, mostly describing the orthopedic effects of diverse HG forces. For example, Zentner et al[17] studied orthopedic forces of 5.6 N (Newton = 101.97 gram-force = 3.597 oz) vs orthodontic forces of 3.5 N on a macerated human skull using holographic interferometry. They reported that lower HG forces produced significantly greater deformations than did higher forces; this indicates that there might be an upper limit to the optimal force level.

Dental changes caused by HG therapy have been reported in the literature. Andreasen and Johnson[18] applied diverse forces in each side and found that over a 12-week period the molar receiving 4 N of HG force distalized 2.5 times more than did the other molar, which received 2 N of force. After 8 weeks in the 2-N side, no further increase in molar distalization was found, whereas the 4-N side demonstrated continuation of molar distalization at the same pace to end of the study (12 weeks). This suggests that there might be a lower limit to the optimal force level.

The objectives of this study were to evaluate HG distalization efficacy concomitant with edgewise fixed appliance treatment in relation to 4 variables: the absence or presence of the maxillary second molar, the amount of distal movement of the maxillary first molar, the magnitude of the HG force, and maxillary second molar eruption.

The null hypotheses were that at all stages of treatment, the amount of distalization of the maxillary first molar is not affected by the presence or absence of the maxillary second molar, and the initial force magnitude has no effect on initial maxillary first molar distal displacement.

MATERIAL AND METHODS

The study sample comprised 56 patients presenting for treatment at the Department of Orthodontics, University of Tel Aviv in Israel, diagnosed as having an Angle Class II malocclusion and treated without extractions with cervical HG for at least 1 year for a minimum of 12 hours per day. Subjects were included in the study when part of their malocclusion was related to maxillary dentoskeletal protrusion (SNA, $>83°$; mean, $85.9° \pm 2.03°$). Syndromic patients (eg, cleft lip) were excluded, as were those with early mesial drift of the maxillary first molar (eg, congenitally missing second premolar) and adults (age, >16.5 year). The Class II severity ranged from a half-step to a full-step molar relationship. All treatments included the use of fully bonded edgewise appliances without intermaxillary or intramaxillary elastics. Data were gathered at 3 time points: T0, start of HG therapy; T1, 6 months after T0; and T2, 12 months after T0.

The sample was divided into 2 groups: (1) G − M2: both maxillary second molars were unerupted at T0 or showed both clinically and radiographically no contact point between the first and second molars (21 subjects: 9 boys, 12 girls; mean age, 11.87 ± 1.20 years), and (2) G + M2: at T0, both maxillary second molars were present in the oral cavity, with both clinically and radiographically an interproximal contact point between the first and second molars (35 subjects: 18 boys, 17 girls; mean age, 13.05 ± 1.55 years).

In addition to determining the presence or absence of the second molars, we examined the Nolla[19] stage of maxillary second molar development radiographically.

A 0.022×0.028-in preadjusted appliance was bonded to the maxillary dentition, into which was inserted an uncinched nickel-titanium archwire. The archwires were changed according to the progress in leveling, from 0.014 to 0.018 in. A Kloehn type of cervical HG was delivered to the bands on the permanent first molars. The HG consisted of a medium outer bow, with "U" loops (3M Unitek, Monrovia, Calif); the outer arm was positioned horizontally (with no adjusted upward tilt). The HG force was increased gradually from 0 to 15 N in 3-N increments (0, 3, 6, 9, 12, and 15 N). Zero reflected the measurement when the facebow was inserted in the mouth without attaching the (activation) neck