Effects of distal jet appliance for the first molar distalization on the second molar eruption

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Purpose: The purpose of this study was to assess the effects of distal jet for the first molar distalization on the eruption of maxillary second molar.
Materials and Methods: The dental casts and cephalograms of 33 patients with class II malocclusion were analyzed. The group of distal jet appliance consisted of 18 patients with the second molars absent or partly erupted. And 15 patients with conventional orthodontics treatment (non-extraction) were adopted as the control. Nine linear and proportional, angular measurements were made. Statistical evaluation was conducted by Student's t-test for paired data.
Results: There were significant changes in nine linear and proportional angular measurements of two groups ($p<0.01$). The mean mesiobuccal rotations of the second molars were 4.2°. The changes of m2-SN (before treatment 54.3°, after treatment 48.0°) and m2-Ptv (before treatment 12.8 mm, after treatment 9.7 mm) in the second molar region proved that both expansion and tipping occurred in the second molars.
Conclusion: The study proved that both mesiobuccal rotation and vestibular drift happened in the second molars when distal jet was used for first molar distalization. **(Int Chin J Dent 2006; 6: 111-114.)**
Key Words: distal jet, eruption, second molar.

Introduction

In nonextraction class II malocclusion patients, maxillary molar distalization may be used to correct the molar relationship and to alleviate crowding in the maxillary arch. A variety of techniques for molar distalization have been suggested. The conventional approach for distalization of medially drifting molars was to apply either an intraorally anchored plate-type appliance according to Schwarz,[1] or an extraorally anchored headgear device. For recent years, the distal jet appliance has been introduced as an intraoral system to push molars distally and the clinical application of various distal jet appliances has got great success.[2-4] The aim of this study was to assess the efficiency of distal jet appliance for molar distalization related to second molar eruption stage.

Materials and Methods

A modified distal jet appliance for bilateral molar distalization was fixed in the maxillae of 33 patients (22 females and 11 males; mean age at 12.5 years old). The patients were divided into two groups according to the stage of second molar eruption, as we called them patient group 1 (P1) and patient group 2 (P2). The second molars of P1 (18 patients) had not yet erupted or incompletely erupted. Those of P2 (15 patients) had already developed to the occlusal plane with the third molars at the budding stage.

The distal jet appliance (Fig. 1) used in this study was a modified one of the pendulum appliance according to Hilgers[5] and Carano.[6] The appliance included a distal screw dividing the Nance button into two sections. After the distal jet has been tried in and cemented, squeeze the lingual sheath around the doubled-back wire. This tightens the connection of the molar to the bayonet wire for more precise control during distalization. Insert the activation wrench into the recess in the .050" hex-screw head. With the wrench as a guide, the slide was locked back to compress the spring completely, and tighten the screw.

Molar movement in the horizontal plane was monitored by taking alginate impressions and making dental casts both at the beginning of therapy (T1) and after removal of the pendulum appliance (T2).[7] The measurements were to identify any increase or decrease in transverse arch width in the region of the first and second molars in each patient group, as well as the magnitude and direction of molar rotation achieved by the therapy. On both sides of each dental cast, the distance between the cusps of mesiobuccal and distobuccal cusps of the first and second molars were measured, as well as the angles between the straight line transversing the mesiobuccal and distobuccal cusp tips and the raphe-median line (Fig. 2). Changes in the sagittal plane were determined by measuring relevant parameters in the cephalograms of both T1 and T2.

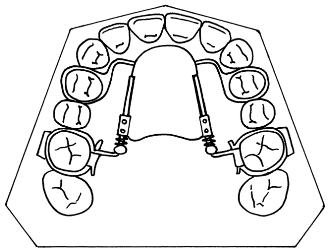

Fig. 1. Distal jet appliance.

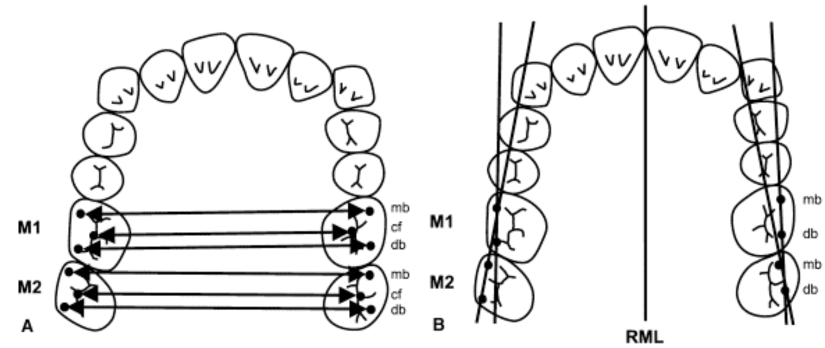

Fig. 2. Dental cast measurements.

These parameters were: m1-PTV, distance from the first maxillary molar to pterygoid vertical; m2-PTV, distance from second maxillary molar to pterygoid vertical; m1/SN, angle between first maxillary molar and anterior cranium floor; and m2/SN, angle between second maxillary molar and anterior cranium floor (Fig. 3).

The dental casts and cephalograms were taken and measured twice at 3-month interval and then evaluated. The arithmetic mean and the standard deviation were calculated for each dental cast measurement and cephalometric analysis variable. Differences were evaluated as statistically significant if the p-value was smaller than 0.05.

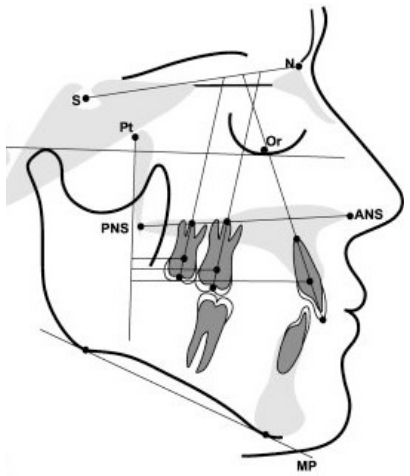

Fig. 3. Analysis of cephalogram.

Results

Measurement of the maxillary dental casts showed that, in relation to the dental arch shape before distal jet appliance fixation, the transverse arch width in the second molar area was greater than that in the first molar area (Table 1). The gains in transverse arch widths in the first molar area between the bilateral mesiobuccal cusp tips and distobuccal cusp tips after the treatment (mean (SD) values of 3.15 (1.44) mm, and 2.68 (1.34) mm, respectively) proved that both expansion and mesiobuccal rotation occurred in the first molar area. Expansion was also confirmed by the corresponding measurement data from the nonbanded second molars area, which displayed the increase in transverse arch width after the treatment between bilateral mesiobuccal cusp tips and bilateral distobuccal cusp tips were 2.62 (1.29) mm and 2.56 (1.25) mm respectively. Mesiobuccal rotations of the unbanded distalized second molars were 4.21 (0.64)° before the treatment and 1.45 (0.57)° after the treatment.

Mean values, standard deviations in parentheses, and minimum and maximum values of skeletal and dental changes as shown by cephalometric analysis are also given in Table 1. Mean distal tipping of the bilateral second molars was 8.4 (3.6)°. Mean distalization of the bilateral second molars was 2.8 (1.5) mm. Distal tipping of the first molars in the patients of PG 1 (0.1 (1.3)°) was less marked than that of PG 2 (4.9 (2.0)°).

Table 1. Comparison of the dental cast and cephalogram measurements before and after treatment.

Measurement	Group P (n=33)		Group T (n=33)	
	P1	P2	T1	T2
Dental casts				
Mb1 (mm)	50.80 (1.50)	53.49 (1.36)	50.51 (1.39)	50.34 (1.58)*
Db1 (mm)	53.24 (1.26)	55.19 (1.40)	53.24 (1.63)	52.51 (1.60)*
Mb2 (mm)		57.78 (1.29)		55.16 (1.11)*
Db2 (mm)		57.38 (1.25)		54.82 (1.07)*
R (°)		4.21 (0.64)		1.45 (0.57)*
Cephalograms				
m1-SN (°)	67.6 (2.1)	63.1 (2.0)	68.1 (1.4)	68.0 (1.3)*
m2-SN (°)	54.3 (3.7)	48.0 (3.5)	56.5 (2.7)	56.4 (3.0)*
m1-Ptv (mm)	21.9 (2.2)	18.5 (2.3)	22.0 (2.6)	21.3 (2.9)*
m2-Ptv (mm)	12.8 (1.6)	9.7 (1.4)	12.5 (1.4)	11.2 (1.3)*

*$p<0.05$ vs before treatment. P1, P2 Before treatment. T1, T2 After treatment. Mean (SD).

Discussion

There are controversial opinions about the effect of erupted maxillary second molars on distalization of the first molars. All investigators agree that the presence or absence of the second molars does not significantly influence the amount of first molar distalization with either the distal jet[8,9] or the pendulum appliance. Bussick and McNamara,[10] who studied the largest sample of subjects treated with the pendulum appliance to date, suggest to start moving the first molars distally before the eruption of the second molars to avoid significant increases in mandibular plane angle and lower anterior facial height. As for the distal jet appliance, Bolla et al.[9] found significantly less tipping of the maxillary first molars and significantly less anchorage loss and extrusion at the first premolars in subjects with erupted second molars when compared with subjects with unerupted second molars.

Tooth movement of molar distalization by a distal jet requires evaluation from different spatial planes. In the horizontal plane, for the distalization effect of the pendulum spring on the first molars extended to the fully erupted second molars of PG 2, dental cast measurements showed that not only mesiobuccal rotation of both maxillary molars but also vestibular drift of the unbanded second molars occurred in the patients of PG 1. The possible factors behind the phenomenon of vestibular drift (clearly not depending on the third molars) might involve the morphology of the molars and the contact point areas, the relative position of the molars contacting to each other, and the anatomically fixed position of the spongiosa groove. A third molar bud seemed to give no restriction to the degree of vestibular drift.

In the sagittal plane, cephalometric analysis for identifying any changes showed that, in the same way, the distal tooth bud could act as a fulcrum for the medially adjacent tooth. It proved that tipping of the first molar was much more pronounced when the second molar was still at the budding stage. Again, when eruption of the second molar was complete, tipping of the tooth was greater when a third molar bud was located in the direction of movement. In contrast, distalization of the first molars was almost exclusively without inclination. If extraction of the wisdom teeth had previously been carried out, almost exclusively bodily distalization of both molars was possible, even when the second molar was not banded.

Cephalometric analysis of the 18 patients for whom the second molars had been simultaneously distalized by the distal jet appliance showed that loss of anchorage was slightly greater. Moreover, the duration of therapy and the number of distal screw activations also increased in this group. As demonstrated by the results of this study, the preconditions for distalization of the first molars varied with different development stage of the second and third molars. What follows outlines the phenomena occurring on application of the pendulum appliance in terms of biomechanics, whereby consideration is restricted to the molar area, while the reciprocal impact of forces and torques on the anterior anchoring block was ignored. The biomechanical properties of materials involved here, including tooth, band, and lingual sheath, are all assumed to be rigid, so the elastic deformation of them could be ignored and only the forces from orthodontic stimulus to the periodontal tissues of the teeth were concerned.

Unlike the first molars, the anatomical position of the second molars before eruption was not perpendicular to the occlusal plane. The roots of the second molars in the maxilla were markedly palatal to the roots of the first molars, and their occlusal surfaces directed buccodistally. On eruption, the cone-funnel mechanism brings the second maxillary molars into their definitive anatomical position guiding by the occlusion relationship with the opposite mandibular molars. Only when the molars reached occlusion contact plane did they begin to straighten and incline buccolingually.

When the lingual sheath of the molar band was acted on by a force FP (due to pendulum spring activation), a torque MP resulting from the product of the force FP and the vertical distance to the center of resistance of the molar, simultaneously arose. The resistance center of the tooth being moved was determined by anatomical and biological factors. According to Teuscher,[11] we can assume for a maxillary first molar with the center in the root trifurcation area, but, for a multiroot tooth, Smith and Burstone[12] placed the resistance center at the point 1 to 2 mm apical of the root trifurcation.

References

1. Schwarze CW. Zervikaler headgear. In: Schmuth, G editor. Kieferorthopädie II, Praxis der Zahnheilkunde 12. 2nd ed. München, Wien, Baltimore: Urban and Schwarzenberg; 1988. p.151-74.
2. Gianally AA, Bednar J, Deitz VS. Japanese NiTi coils used to move molars distally. Am J Orthod Dentofacial Orthop 1991; 99: 564-6.
3. Chaques-Asensi J, Kalra V. Effects of the pendulum appliance on the dentofacial complex. J Clin Orthod 2001; 35: 254-7.
4. Joseph AA, Butchart CJ. An evaluation of the pendulum distalizing appliance. Semin Orthod 2000; 6: 129-35.
5. Hilgers JJ. The pendulum appliance for Class II non-compliance therapy. J Clin Orthod 1992; 26: 706-14.
6. Carano A, Testa M, Bowman SJ. The distal jet simplified and updated. J Clin Orthod 2002; 36: 586-90.
7. Burstone CJ, Koenig HA. Force systems from an ideal arch. Am J Orthod Dentofacial Orthop 1974; 65: 270-89.
8. Ngantung V, Nanda RS, Bowman SJ. Posttreatment evaluation of the distal jet appliance. Am J Orthod Dentofacial Orthop 2001; 120: 178-85.
9. Bolla E, Muratore F, Carano A, Bowman SJ. Evaluation of maxillary molar distalization with the distal jet: a comparison with other contemporary methods. Angle Orthod 2002; 72: 481-94.
10. Bussick TJ, McNamara JA Jr. Dentoalveolar and skeletal changes associated with the pendulum appliance. Am J Orthod Dentofacial Orthop 2000; 117: 333-43.
11. Teuscher V. Prinzipien extraoraler Kräfte. Inf Orthod Kieferorthop 1976; 1: 9-16.
12. Smith RJ, Burstone CJ. Mechanics of tooth movement. Am J Orthod Dentofacial Orthop 1994; 85: 294-307.

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