European Journal of Orthodontics 22 (2000) 293–298

Effects of a three-dimensional bimetric maxillary distalizing arch

T. T. Üçem, S. Yüksel, C. Okay and A. Gülşen
Department of Orthodontics, Gazi University, Ankara, Turkey

SUMMARY This study aimed to investigate the dental effects of a three-dimensional (3D) bimetric maxillary distalizing arch. The Wilson rapid molar distalization appliance for Class II molar correction was used in 14 patients (10 girls and four boys with a mean age of 12.18 years). The open coil springs were activated with bent Omega stops and Class II intermaxillary elastics. The mandibular anchorage was gained by a 0.016×0.016 utility arch with a 3D lingual arch or a lip bumper with a standard lingual arch. The lateral cephalograms taken before and after treatment formed the material of the research. A Wilcoxon test was used to statistically evaluate the treatment effects.

The results showed that the distal tipping of the maxillary first and second molars, and first and second premolars and canines were statistically significant. Significant distal movement occurred in all posterior and canine teeth. The maxillary first molar distalization was found to be 3.5 mm. The maxillary incisor showed significant proclination and protrusion. The decrease in overbite was found to be statistically significant. The mandibular plane angle significantly increased by a mean of 0.5 mm. In addition, significant soft tissue changes were observed.

Introduction

Class II malocclusions may be corrected by combinations of restriction or redirection of maxillary growth, distal movement of the maxillary dentition, mesial movement of the mandibular dentition, and enhancement or redirection of mandibular growth. To establish a Class I molar relationship and create space in the lateral segments for the canines or premolars, in non-extraction treatment modalities, distalization of the maxillary first molars is the aim. Commonly used mechanics include extraoral forces such as headgear.

Orthodontists have long sought methods of correcting Class II malocclusions without the need for strict patient compliance. In the 1990s, non-compliance therapies in various forms became more widely used. These systems include repelling magnets (Gianelly *et al*., 1988, 1989), nickel titanium coil springs (Gianelly *et al*., 1991), the K-loop (Kalra, 1995), super-elastic wires (Locatelli *et al*., 1992), and the Pendulum (Hilgers, 1992), distal-jet (Carano and Testa, 1996), and Jones jig appliances (Jones and White, 1992).

Wilson (1978) introduced the concept of 'modular orthodontics' and the method of rapid molar distalization which is one aspect of modular orthodontics. This treatment approach to distalizing maxillary molars has been designed using a 3D bimetric distalizing arch and a 3D mandibular lingual arch with Class II elastics (Wilson, 1978a,b; Wilson and Wilson, 1980a,b).

Until now, limited research has been conducted to analyse the effects of this appliance. The aim of this study was to evaluate the effects of the 3D bimetric rapid molar distalization arch on maxillary dentoalveolar structures.

Subjects and methods

The subjects were 14 non-extraction patients (10 girls, four boys) with a full Class II molar relationship in the late mixed dentition. At the beginning of treatment, the average chronological age was 12.20 years.

The upper molars were banded and the upper incisors were bonded with 0.22-inch Roth brackets (Rocky Mountain Orthodontics, Denver Colorado, USA). To establish a Class I molar relationship all patients received appropriately sized 3D maxillary bimetric distalizing arches. The anterior arch (0.022-inch Truchrome; Rocky Mountain Orthodontics) was adjusted to insert passively into incisor brackets. The posterior 0.040-inch end section with inter-maxillary hooks had Omega adjustable stops attached. Elgiloy open coil springs (0.010×0.045 inches; Rocky Mountain Orthodontics) 5 mm in length, were inserted between the Omega adjustable stops and buccal tube. The coil springs were compressed to 3 mm to produce a 2-mm activation and movement. This was supported by an inter-maxillary elastic system (Wilson and Wilson, 1980a,b,c; Figures 1 and 2a,b). Those authors recommended using three 2-oz elastics during the first 5 days, two during the second 5 days and one during the final 11 days of treatment. In this study, the elastic load reduction principle was modified from its original version. The elastic force was adjusted until the arch inserted into the brackets slots and weekly arrangements were made to maintain this force. Fresh elastics were applied daily.

Mandibular anchorage was gained by a 0.016×0.016-inch utility arch, with a 3D lingual arch in six patients. Eight patients had a lip bumper (which was in contact with the labial surface of the lower incisors) with a standard lingual arch for anchorage.

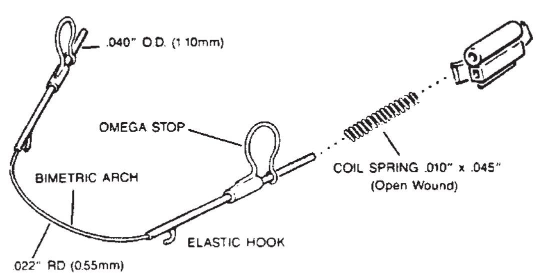

Figure 1 The components of the 3D bimetric distalizing arch (Wilson and Wilson, 1980b).

Figure 2 (a,b) Intra-oral view of 3D bimetric distalizing arch.

Lateral cephalometric radiographs were taken at the beginning of treatment and after a Class I molar relationship was obtained. All radiographs were taken at the same laboratory with the patient orientated in a cephalostat. The enlargement was 8.3 per cent. No corrections were made for the enlargement.

The approximate treatment time (from the start of active treatment to the second radiograph) was 1.5 months. Treatment time for each subject is shown in Table l.

To evaluate the effects of the appliance, the tracings of the lateral cephalograms obtained pre- and post-treatment were superimposed on the best fit of palatal structures. The ANS–PNS plane of the pre-treatment radiograph was used as the horizontal reference plane. A line perpendicular to the ANS–PNS plane at point T (the most superior point of the anterior wall

Table 1 Treatment times for each subject.

Case no.	Treatment time (days)
1	63
2	42
3	49
4	42
5	63
6	42
7	35
8	56
9	42
10	63
11	42
12	42
13	56
14	42

of the sella turcica at the junction with the tuberculum sella) on the pre-treatment radiograph was used as the vertical reference plane (RD1). Twenty-three parameters were measured as shown in Figure 3. When the right and left tooth images were not coincident on the lateral cephalometric radiographs, the mid-point of the cusp tip images were traced.

All of the lateral cephalometric radiographs were retraced and recalculated, including superimpositions, after 15 days. The method error coefficients ranged from 0.97 to 0.99 and were found to be within acceptable limits (Winner, 1971).

A Wilcoxon test was used to determine the differences in mean changes during treatment.

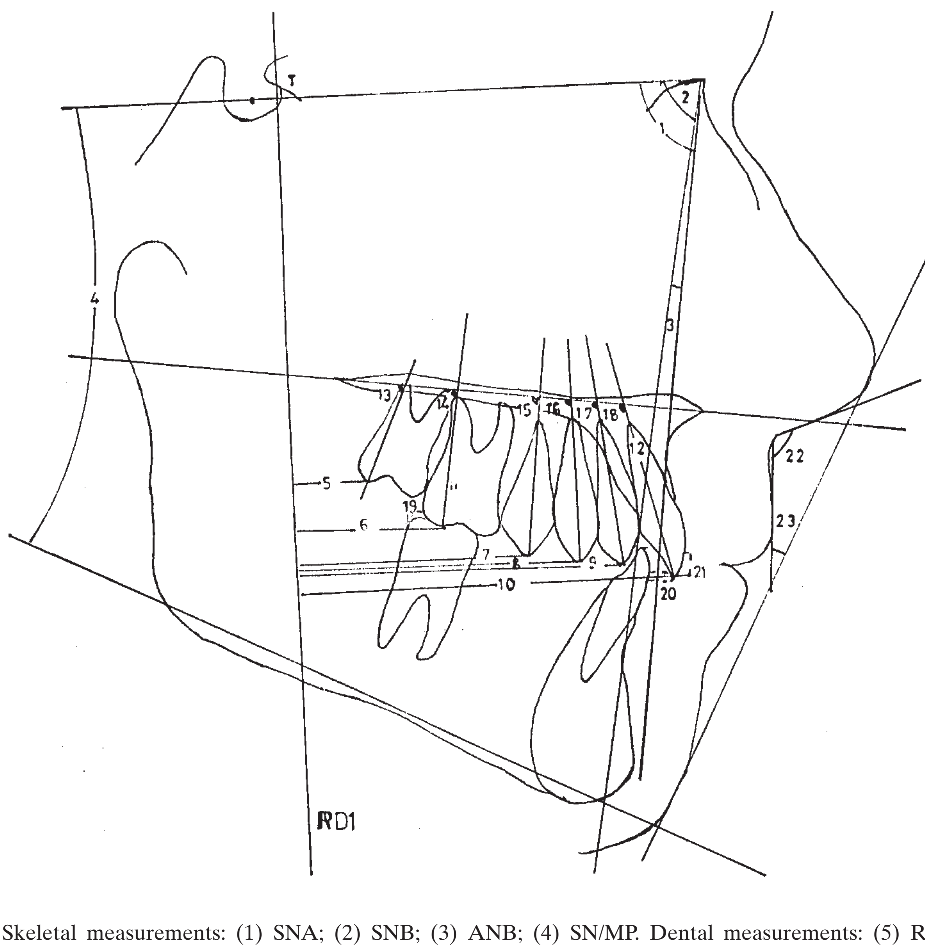

Figure 3 Skeletal measurements: (1) SNA; (2) SNB; (3) ANB; (4) SN/MP. Dental measurements: (5) RD1–U7; (6) RD1–U6; (7) RD1–U5; (8) RD1–U4; (9) RD1–U3; (10) RD1–U1; (11) ANS–PNS–U6; (12) ANS–PNS–U1; (13) U7/ANS–PNS; (14) U6/ANS–PNS; (15) U5/ANS–PNS; (16) U4/ANS–PNS; (17) U3/ANS–PNS; (18) U1/ANS–PNS. (19) Molar relationship (the distance between the distal curvature of upper and lower first molar). (20) Overjet. (21) Overbite soft tissue measurements. (22) Nasolabial angle. (23) Aesthetic plane-upper lip.

Table 2 Descriptive statistics, mean changes and *P* values for 3D maxillary bimetric distalizing arches.

	Pre-treatment		Post-treatment		Mean changes		
	x	SE	*x*	SE	D	S_E	*P*
1. SNA	77.0	1.00	77.0	1.01	0.0	0.23	1.000
2. SNB	73.3	1.01	73.1	0.99	–0.2	0.33	0.174
3. ANB	3.7	0.38	3.9	0.39	0.2	0.25	0.136
4. SN/MP	38.0	1.30	38.5	1.40	0.5	0.30	0.037*
5. RD1U7	15.8	1.40	13.6	1.53	–2.2	0.33	0.001**
6. RD1U6	22.7	1.63	19.2	1.74	–3.5	0.36	0.001**
7. RD1U5	38.5	1.81	36.4	1.85	–2.1	0.23	0.001**
8. RD1U4	46.3	2.00	44.6	2.05	–1.7	0.21	0.001**
9. RD1U3	56.0	1.87	54.4	1.98	–1.6	0.33	0.002**
10. RD1U1	62.3	1.88	63.3	1.95	1.0	0.24	0.006**
11. U6–ANS–PNS	20.7	0.66	20.7	0.68	0.0	0.25	0.600
12. U1–ANS–PNS	30.0	0.51	30.5	0.59	0.5	0.30	0.168
13. U7/ANS–PNS	63.7	2.02	62.4	2.05	–1.3	0.47	0.008**
14. U6/ANS–PNS	71.3	1.49	69.5	1.13	–1.8	0.63	0.044*
15. U5/ANS–PNS	82.9	0.98	81.5	1.03	–1.4	0.37	0.048*
16. U4/ANS–PNS	91.4	1.36	89.6	1.10	–1.8	0.62	0.006**
17. U3/ANS–PNS	106.0	1.81	101.4	1.55	–4.6	0.89	0.002**
18. U1/ANS–PNS	106.2	1.74	109.8	1.68	3.6	1.14	0.015**
19. Molar relationship	–0.7	0.47	2.9	0.44	3.6	0.49	0.001**
20. Overjet	2.6	0.35	2.5	0.24	–0.1	0.39	0.844
21. Overbite	3.3	0.38	2.6	0.29	–0.7	0.31	0.044*
22. Nasolabial angle	118.2	1.58	114.7	2.10	–3.5	0.36	0.032*
23. Aesthetic plane —upper lip	–3.3	0.52	–2.5	0.61	0.8	0.49	0.019*

$^*P < 0.05$; $^{**}P < 0.01$.
x = Pre- and post-treatment mean values. SE = standard error of the mean pre- and post-treatment values. D = the difference between pre-and post-treatment mean values. S_E = the standard error of the mean differences.

Results

The means, standard deviations and the significance of the treatment changes are shown in Table 2.

The increase in SN/MP angle was found to be statistically significant ($P < 0.05$).

The upper molars, premolars and canines distance to RD1 showed a significant decrease ($P < 0.01$). Upper incisor labial movement according to RD1 was found to be statistically significant ($P < 0.01$). The upper molars, premolars, and canines showed statistically significant distal tipping according to ANS–PNS plane ($P < 0.05$, $P < 0.01$) The upper incisor/ANS–PNS angle demonstrated a significant increase ($P < 0.05$) and the increase in molar relationship was found to be statistically significant ($P < 0.01$). Overbite showed a significant decrease ($P < 0.05$).

Soft tissue evaluation demonstrated that there was a significant decrease in the nasolabial angle ($P < 0.05$). The labial movement of the upper lip according to the aesthetic plane was statistically significant ($P < 0.05$).

Discussion

The early loss of the maxillary second deciduous molar is generally followed by mesial movements of the maxillary first molar (Northway *et al*., 1984). Several treatment methods are available to distalize the maxillary molars effectively. After Wilson (1978a,b) introduced the 3D bimetric distalizing arch as a part of 'modular orthodontics', a few studies were undertaken to evaluate the effects of the appliance. In this investigation, the effects of the appliance on the maxillary buccal teeth were evaluated in addition to the dentoalveolar effects.

The maxillary first molar moved distally 3.5 mm in relation to the vertical reference line (RD1). The molar relationship change was 3.6 mm resulting in a Class I molar relationship obtained by molar distalization. Muse *et al.* (1993) reported that 50.7 per cent of Class II correction was obtained by upper molar distalization (2.16 mm) and 39.8 per cent by lower molar mesialization (1.38 mm) using the 3D bimetric distalizing arch. Wilson (1995) and Yüksel *et al.* (1996) highlighted the preservation of anchorage of mandibular molars in their studies.

In this investigation, the upper first molar showed a significant 1.8 degree of distal tipping, while Muse *et al.* (1993) found 7.8 degrees of distal tipping. Wilson (1995) suggested that utilizing the elastic load reduction principle with adequate 3D anchorage would ensure no molar extrusion or tipping. Yüksel *et al.* (1996) reported maxillary molar distalization with mostly bodily movement in four subjects. Itoh *et al.* (1991) found a 7.4-degree distal tipping of the molars with repelling magnets and suggested this represented slight tipping. Byloff and Darendeliler (1997) suggested that the significant molar tipping should be taken into consideration when using the Pendulum appliance.

The forward movement of the upper incisors is in agreement with Muse *et al.* (1993). Itoh *et al.* (1991) reported 1.2-mm labial movement of the anterior teeth with a 2.1-mm molar distalization with repelling magnets.

The most significant findings of this study were the distalization of the upper premolars and canines. These results were as statistically significant as the upper first molar distalization. It should be pointed out that, clinically, no diastemas were observed between the first molar–second premolar and first premolar–second premolar. In the local evaluation the mean distalization for first and second premolar (RD1U4, RD1U5) was 1.7 and 2.1 mm, respectively. Distal movement of the canine was 1.6 mm. Gianelly *et al.* (1989) reported mesial movement in premolars with the use of magnets to move molars distally. Other types of intra-oral molar distalization appliance such as nickel titanium coil springs (Gianelly *et al.*, 1991) and the K-loop (Kalra, 1995) showed 1-mm anchorage loss in premolars during 4-mm molar distalization. With the use of a Pendulum appliance mesial movement occurred in the upper second premolars (Byloff and Darendeliler, 1997). This was an inevitable result of the design of those appliances.

The upper second molar showed a significant mean distalization of 2.2 mm. Bondemark *et al.* (1994) found that super-elastic nickel-titanium open coils were more effective than repelling magnets for the simultaneous distal movement of second molars.

The upper canine, first and second premolars, and second molar showed significant distal tipping similar to the upper first molar. The greatest degree of tipping 4.6 degrees was observed in the canine teeth. The reason for this could be as a result of the eruption path and time of eruption of the canine teeth, and the vestibulo position of the canine teeth due to the pre-treatment crowding.

Aras (1993) showed a posterior rotation of the mandible and suggested this was an effect of mandibular molar extrusion and maxillary molar distalization. This finding is in agreement with the increase in SN/MP angle found in this study.

The soft tissue changes were parallel to the upper incisor changes. The mean forward movement of the upper lip was 0.75 mm and the nasolabial angle showed significant decrease.

The 3D bimetric distalization system had no physical disturbance or hygienic disadvantage than any fixed appliance. However, in other intra-oral molar distalization systems patients reported difficulty in brushing and some discomfort of the buccal mucosa due to the size of the magnets and slight inflammation of the palatal mucosa. This resolved a week after appliance removal and was due to the Nance appliance (Byloff and Darendeliler, 1997).

This investigation focused only on upper arch changes as research evaluating the effects of different anchorage systems using the 3D bimetric maxillary distalizing arch on lower arch changes performed on a large sample is currently being undertaken.

Conclusion

1. Class I molar relationship was effectively established in approximately 1.5 months by upper molar distalization.
2. A significant distalization of the upper premolars and canines was obtained with the 3D bimetric arch system compared with other intra-oral mechanics.
3. The upper incisor labial movement and decrease in overbite should be considered before treatment.

Address for correspondence

Tuba Tortop Üçem
Gazi Üniversitesi
Diş Hekimliği Fakültesi
Ortodonti Anabilim Dalı
06510 Emek-Ankara
Turkey

References

Aras K 1993 3D bimetrik maksiller distalizasyon arklarının dentofasiyal sisteme etkilerinin sefalometrik olarak incelenmesi. Doktora tezi, Hacettepe Üniversitesi, Ankara

Bondemark L, Kurol J, Bernhold M 1994 Repelling magnets versus superelastic nickel-titanium coils in simultaneous distal movement of maxillary first and second molars. Angle Orthodontist 64: 189–198

Byloff F K, Darendeliler M A 1997 Distal molar movement using the Pendulum appliance. Part 1: Clinical and radiological evaluation. Angle Orthodontist 67: 249–260

Carano A, Testa M 1996 The distal jet for upper molar distalization. Journal of Clinical Orthodontics 30: 374–380

Gianelly A A, Vaitas A S, Thomas W M, Berger D G 1988 Case report: distalization of molars with repelling magnets. Journal of Clinical Orthodontics 22: 40–44

Gianelly A A, Vaitas A S, Thomas W M 1989 The use of magnets to move molars distally. American Journal of Orthodontics and Dentofacial Orthopedics 96: 161–167

Gianelly A A, Bednar J, Dietz V S 1991 Japanese NiTi coils used to move molars distally. American Journal of Orthodontics and Dentofacial Orthopedics 99: 564–566

Hilgers J J 1992 The Pendulum appliance for Class II non-compliance therapy. Journal of Clinical Orthodontics 26: 706–714

Itoh T, Tokuda T, Kiyosue S, Hirose T, Matsumoto M, Chaconas S J 1991 Molar distalization with repelling magnets. Journal of Clinical Orthodontics 25: 611–617

Jones R D, White J M 1992 Rapid Class II molar correction with an open-coil jig. Journal of Clinical Orthodontics 26: 661–664

Kalra V 1995 The K-loop molar distalizing appliance. Journal of Clinical Orthodontics 24: 298–301

Locatelli R, Bednar J, Dietz V S, Gianelly A A 1992 Molar distalization with superelastic NiTi wire. Journal of Clinical Orthodontics 26: 277–279

Muse D S, Fillman M J, Emmerson W J, Mitchell R D 1993 Molar and incisor changes with Wilson rapid molar distalization. American Journal of Orthodontics and Dentofacial Orthopedics 104: 556–565

Northway W M, Wainright R L, Demirjian A 1984 Effects of premature loss of deciduous molars Part ll. Angle Orthodontist 54: 295–329

Wilson R C 1995 Comment on rapid molar distalization. American Journal of Orthodontics and Dentofacial Orthopedics 107: 20A–22A

Wilson R C, Wilson W L 1980a Enhanced orthodontics. Concept, treatment and case histories. Rocky Mountain Orthodontics, Denver

Wilson R C, Wilson W L 1980b Enhanced orthodontics. Force Systems Mechanotherapy Manual. Rocky Mountain Orthodontics, Denver

Wilson W L 1978a Modular orthodontic systems Part 1. Journal of Clinical Orthodontics 12: 259–278

Wilson W L 1978b Modular orthodontic systems Part 2. Journal of Clinical Orthodontics 12: 358–375

Wilson W L, Wilson R C 1980c New treatment dimensions with first phase sectional and progressive edgewise mechanics. Journal of Clinical Orthodontics 14: 607–627

Winner B J 1971 Statistical principles in experimental design, 2nd edn. McGraw-Hill Co., New York

Yüksel S, Gülşen A, Üçem TT 1996 Modifiye 3D Bimetrik maksillar distalizasyon arkı ile molar distalizasyonu. Türk Ortodonti Dergisi 9: 229–235