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Evaluation of changes in the vertical facial dimension with different anchorage systems in extraction and non-extraction subjects treated by Begg fixed appliances: a retrospective study

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SUMMARY The aim of the study was to evaluate and compare the effects of mesial movement of the maxillary and mandibular molars on the facial vertical dimensions following orthodontic treatment. Patients with an Angle Class I malocclusion were treated by four first premolar extractions and Begg fixed appliances (moderate and maximum anchorage groups), while those with an Angle Class II malocclusion were treated by Begg intraoral distalization mechanics without extractions (distalization group). Following treatment, the patients were grouped according to the mesial movement of the mandibular first molars and compared with an Angle Class I control group. All groups comprised 15 patients, their mean pre-treatment ages were 14.95 years for the moderate (13 females, 2 males), 14.88 years for the maximum (13 females, 2 males), 14.41 years for the distalization (10 females, 5 males), and 14.38 years for the control (13 females, 2 males) groups. Lateral cephalometric measurements were performed at two time points (T1: pre-treatment/control, T2: post-treatment/control). A paired *t*-test was used for within-group comparisons and non-parametric Kruskal–Wallis and Dunn's multiple-comparison tests to determine any differences.

The increases in anterior and posterior face heights were similar between groups. The mandibular plane angle (SN/GoGn) was increased in all treatment groups, while it decreased in the control group. Although SN/GoGn increased more in the distalization and less in the moderate anchorage groups, these differences were not statistically significant. The change in SN/GoGn was significantly different only between the distalization and control groups. Facial vertical dimensions were not significantly affected by the amount of mesial movement of the molar teeth.

Introduction

Many studies have been published that examine the effects of extraction and non-extraction fixed appliance treatment on mandibular rotation (Sassouni and Nanda, 1964; Schudy, 1965) and facial structures (Barton, 1973; Venezia, 1973; Menezes, 1975; Meistrell *et al.*, 1986; Arat *et al.*, 1988; Cangialosi *et al.*, 1988; Carter, 1988; Uner and Dincer, 1989; Ball and Hunt, 1991; Cook *et al.*, 1994; Staggers, 1994; Sarac and Cura, 1995; Kocadereli, 1999; Sarisoy and Darendeliler, 1999; Kim *et al.*, 2005). When reviewing these articles, a controversy exists concerning the effects of premolar extractions on facial vertical dimensions. Many authors report that extraction causes a 'close down of the bite effect' and decreases the vertical dimension (Sassouni and Nanda, 1964; Schudy, 1965; Mair and Hunter, 1992). But, some suggest premolar extractions in subjects with a hyperdivergent face type (Pearson, 1978). However, others report that extraction has almost no effect on facial vertical dimensions (Dougherty, 1968; Edwards, 1983; Klapper *et al.*, 1992; Chua *et al.*, 1993; Cusimano *et al.*, 1993; Staggers, 1994; Sarac and Cura, 1995; Bishara *et al.*, 1997; Kocadereli, 1999; Hayasaki *et al.*, 2005; Kim *et al.*, 2005). It has been stated that extraction, in isolation, could not be effective in decreasing the facial vertical dimension (Yamaguchi and Nanda, 1991; Chua *et al.*, 1993; Staggers, 1994; Sarac and Cura, 1995; Kim *et al.*, 2005).

Instead of discussing the effect of extraction on facial vertical dimensions, investigating the mesial or distal displacement of molar teeth would be more beneficial. The starting point would be to distinguish how the extraction site was closed during orthodontic treatment. Was it closed by mesial movement of the molars and/or by retraction of the incisors?

In the present study, the aim was to evaluate the effects of orthodontic treatment on facial vertical dimensions in groups created due to the amount of anchorage loss of the first molar teeth, instead of taking extraction/non-extraction into consideration. Therefore, the purpose of this study was to compare the effects of moderate and maximum anchorage use or distalization on the facial vertical dimensions.

Subjects and methods

The design of the study was retrospective and comprised patients with a similar chronological age and malocclusions. The subjects, 15 in each group, were selected from patients referred to the Department of Orthodontics of Ankara University, who fulfilled the following inclusion criteria:

1. good-quality lateral cephalometric radiographs;
2. similar chronological age at the beginning of treatment/control periods;
3. no extraoral appliances;
4. dental Class I subjects to be treated by extraction, dental Class II subjects by non-extraction mechanics.

Patients with an Angle Class I malocclusion were treated by four first premolar extractions and Begg mechanotherapy (TP Orthodontics®, La Porte, Indiana, USA), while those with an Angle Class II malocclusion were treated by Begg intraoral distalization arches without extractions. Intermaxillary Class II elastics and anchorage bends were used in all extraction groups if required. The elastic force applied in those groups was approximately 60.

The treatment protocol for the Begg intraoral distalizing system was as follows: all teeth were bonded and banded, including the maxillary and mandibular first molars and mandibular second molars. Following alignment of the maxillary and mandibular dental arches, a maxillary 0.018-inch Australian wire distalizing arch with a bilateral double-twisted single vertical loop was prepared (Figure 1a). The distalizing arch, which was positioned one loop-width anterior to the maxillary incisors (Figure 1b), was activated by intermaxillary Class II elastics. The mandibular anchorage was reinforced by anchorage bends and uprighting springs (Figure 1c) applied on the mandibular archwire. The elastic force for each patient was determined by dividing the total amount of force needed to seat the wire inside the bracket slots into two sides. This total amount was approximately 160–170 g, and so intermaxillary Class II elastics were adjusted to apply a force of 80–85 g bilaterally. The most important factor was to eliminate the protrusive effect of the distalizing arch on the maxillary incisors and divert the force directly to the maxillary molar teeth.

Following treatment, the patients were grouped according to the mesial movement of the mandibular first molars. Mesial movement was measured between the perpendicular distances through the mesial cusp of the mandibular molar on the occlusal plane before (T1) and after (T2) treatment following mandibular structural superimposition (Figure 2; Björk and Skieller, 1983). The mesio-distal width of an extracted first premolar tooth was assumed as 7.5 mm. Thus, patients who had 0–1.8 mm of molar mesialization were included in the maximum and 1.8–3.6 mm in the moderate anchorage groups. Patients treated by Begg intraoral distalization system were included in the distalization group.

Table 1 shows the distribution of subjects and the mean, minimum, and maximum ages and the distalization/control periods in both treatment and control groups.

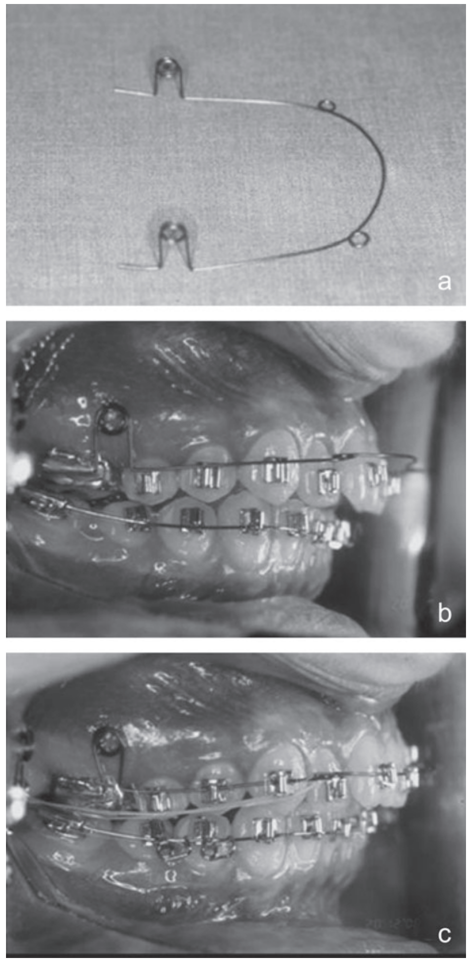

Figure 1 Begg maxillary intraoral distalization system. (a) Maxillary 0.018-inch Australian wire distalization arch with a bilateral double-twisted single vertical loop; (b) note the distalization arch positioned a loop-width anterior of the maxillary incisors; and (c) uprighting springs to reinforce the mandibular anchorage and activation of the arch with intermaxillary Class II elastics.

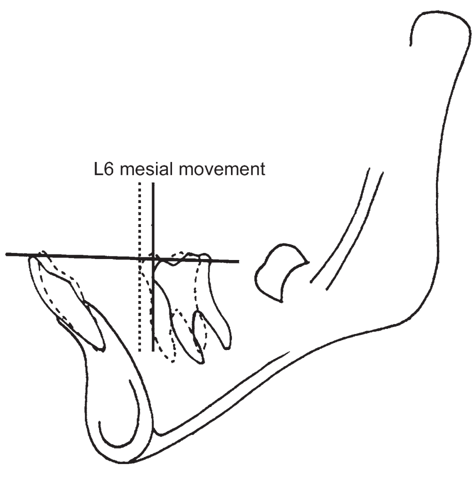

Figure 2 Measurement of the amount of mandibular molar movement.

Table 1 The mean (X), minimum (min), and maximum (max) treatment/control periods and the ages of the subjects in the treatment and control groups.

Groups	*n*	Gender	Pre-treatment/ pre-control chronological age (years)	Treatment/ control period (years)	Treatment/control period (years)			
			X	Min	Max	X	Min	Max
Moderate	15	F: 13 M: 2	14.95	11.25	20	2.41	1.25	3.58
Maximum	15	F: 13 M: 2	14.88	12.58	21.33	2.83	1.83	3.25
Distalization	15	F: 10 M: 5	14.41	12.00	19.58	1.01	0.75	1.67
Control	15	F: 13 M: 2	14.38	12.00	19.58	2.5	1.92	3.17

Cephalometric analysis

Lateral cephalometric radiographs were taken of all groups at T1 and T2. The cephalograms were obtained under standardized conditions (the film–focus distance was 155 cm and the distance from the midsagittal plane 12.5 cm) in order to eliminate the error of magnification in linear measurements.

To define the similarities and differences between the groups, one proportional, nine angular, and 11 linear parameters were measured. Total structural superimpositions were applied to evaluate the changes in the craniofacial structures and soft tissues (Björk and Skieller, 1983). SN was used as the horizontal reference plane and the perpendicular to SN through point S as the vertical reference plane. These reference planes were then transferred to the second radiographs with total superimpositions.

In order to evaluate dentoalveolar changes, maxillary and mandibular local superimpositions were performed. Maxillary local superimpositions were undertaken along the palatal plane (ANS–PNS) registered at ANS (Broadbent, 1937). The mandibular local superimpositions were carried out based on the structural methods of Björk and Skieller (1983). The reference planes of the first radiograph were transferred to the second radiograph using these superimpositions. The total (Figure 3), maxillary (Figure 4a), and mandibular (Figure 4b) measurements were undertaken on the total vertical and horizontal, and local vertical and horizontal reference planes.

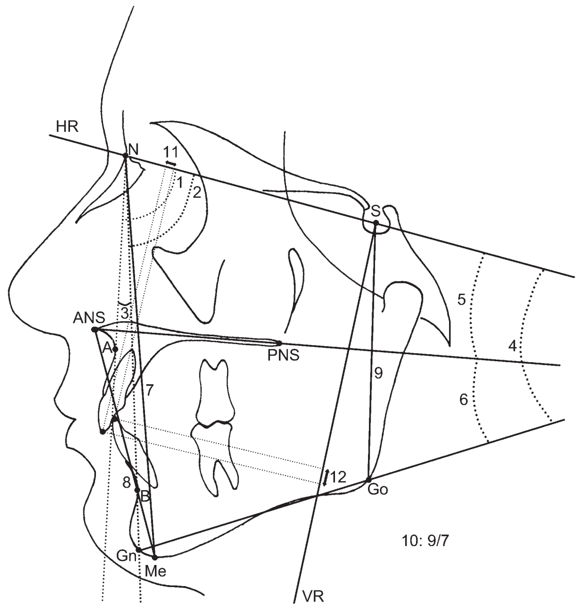

Figure 3 The angular measurements: 1: SNA, 2: SNB, 3: ANB, 4: SN/GoGn, 5: SN/ANSPNS, and 6: ANSPNS/GoGn; the linear measurements: 7: N–Me, 8: ANS–Me, 9: S–Go, 10: Jarabak (S–Go/N–Me), 11: overjet, and 12: overbite.

Statistical analysis

Statistical analysis included calculations of the mean and standard error of the mean for each variable. Analysis of variance and Tukey's test were performed to compare the differences in the pre-treatment/pre-control measurements between the groups (Table 2). A paired *t*-test was performed to determine any significant changes between T1 and T2 within each treatment and control group (Table 3). As the distribution of the differences was not homogeneous, a non-parametric Kruskal–Wallis test and Dunn's multiple comparison test were carried out for comparison of the differences between the groups (Table 3).

Error study

Forty randomly selected cephalograms were retraced 1 month later. The reliability of a single measurement was compared using the formula described by Winner (1971). No significant differences between the two series were

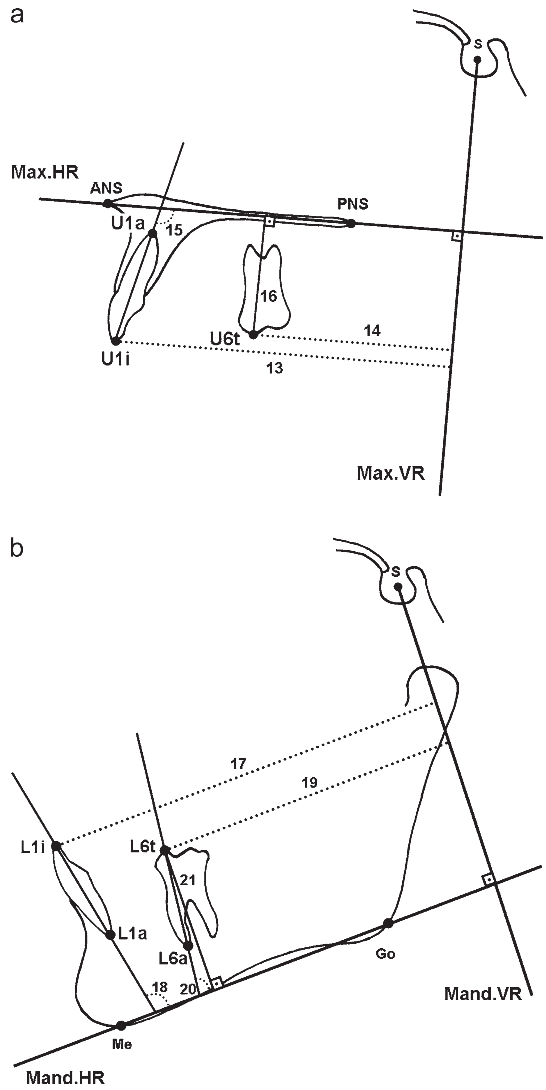

Figure 4 (a) The measurements on maxillary local tracings: 13: U1i-max.VR, 14: U6t-max.VR, 15: U1/max.HR, and 16: U6t-max.HR. (b) The measurements on mandibular local tracings: 17: L1i-mand.VR, 18: L1/mand.HR, 19: L6t-mand.VR, 20: L6/mand.HR, and the ages 21: L6t-mand.HR.

found and the reliability coefficients (*r*) ranged between 0.94 and 0.99.

Results

The cephalometric measurements of the four groups at T1 and T2 are shown in Table 2.

Comparison of the treatment changes between the moderate, maximum, distalization, and control groups together with the statistical evaluation (paired *t*-test) of the treatment changes for each treatment group and growth changes for the control group are presented in Table 3.

Skeletal comparison

Treatment changes for SN/GoGn showed significant ($P < 0.05$) differences between the treatment and control groups. It increased 0.40 degrees in the moderate, 1.08 degrees in the maximum, and 2.20 degrees in the distalization group but decreased 0.58 degrees in the control group. The most significant difference was observed between the distalization/control groups.

For SNA, the treatment changes showed significant ($P < 0.01$) differences between the treatment and control groups. It increased 0.62 degrees in the moderate, 0.46 degrees in the distalization, and 1.42 degrees in the control group but decreased 0.70 degrees in the maximum anchorage group. These significant differences were observed between the moderate/distalization, moderate/control, and maximum/control groups.

The treatment change for SNB also showed significant ($P < 0.001$) differences between the treatment and control groups. It increased 0.45 degrees in the moderate, 0.81 degrees in the distalization, and 1.39 degrees in the control group but decreased 1.02 degrees in the maximum anchorage group. These significant differences were observed between maximum/control, maximum/distalization, and distalization/control groups.

The amount of change in anterior and posterior face heights was similar between all treatment/control groups.

Dentoalveolar comparison

Maxillary incisors. The maxillary incisors (U1i-max.VR and U1/max.HR) were retracted in all treatment groups, while protracted in the control group. The differences were significant ($P < 0.01$) between the moderate/distalization and moderate/control groups.

Maxillary first molars. The maxillary first molars (U6t-max.VR) mesialized significantly in the moderate, maximum, and control groups, but distalized in the distalization group ($P < 0.001$). Similarly, they were extruded and/or dentoalveolar growth was observed in all groups other than the distalization group (U6t-max.HR; $P < 0.01$). For displacement in the sagittal dimension, significant differences were observed between the moderate/distalization, moderate/control, maximum/distalization, and distalization/control groups. For displacement in the vertical dimension, the significant differences observed were between the moderate/distalization and distalization/control groups.

Mandibular incisors. The mandibular incisors (L1i-mand.VR and L1/mand.HR) were retracted in the moderate, maximum, and control groups. The differences were significant ($P < 0.001$) between the moderate/distalization, maximum/distalization, distalization/control, and maximum/control (for L1/mand.HR only) groups.

Mandibular first molars. The mandibular first molars (L6t-mand.VR) were mesialized in all groups, and the difference between them was significant ($P < 0.01$). For L6t-mand.VR the most significant differences were between the moderate/control, maximum/distalization, and distalization/control. There was extrusion and/or dentoalveolar growth of

Table 2 Comparison of the means (X) and standard error of the means (Sx) at the beginning of treatment/control between the moderate, maximum, distalization, and control groups, by analysis of variance and Tukey's tests.

Parameters	Moderate		Maximum		Distalization		Control		*f*-test	Moderate–maximum	Moderate–distalization	Moderate–control	Maximum–control	Maximum–distalization	Distalization–control
	X	±Sx	X	±Sx	X	±Sx	X	±Sx							
Sagittal angular measurements															
SNA (°)	78.01	0.75	77.46	0.80	77.56	1.04	80.28	0.72							
SNB (°)	75.44	0.75	74.98	1.00	72.80	0.85	78.11	0.78	***						***
ANB (°)	2.58	0.37	2.63	0.33	5.09	0.46	2.20	0.35	***		***			***	***
Vertical angular measurements															
SN/GoGn (°)	36.41	1.59	41.43	1.23	35.64	1.89	33.92	1.33	**				**	*	
SN/ANSPNS (°)	11.24	1.37	10.59	0.72	10.89	0.77	11.21	1.11							
ANSPNS/GoGn (°)	25.17	1.95	30.84	1.02	25.53	1.07	22.72	1.56	**	*			**		
Facial height variables															
N–Me (mm)	123.16	1.94	125.58	1.20	122.12	1.04	111.55	1.76							
ANS–Me (mm)	68.49	1.99	71.59	1.10	68.64	1.05	66.68	1.41							
S–Go (mm)	75.16	1.82	75.96	1.23	78.26	0.83	76.02	1.95							
Jarabak (%)	0.64	0.01	0.60	0.01	0.62	0.01	0.64	0.01							
Maxillo–mandibular dental relationship															
Overjet (mm)	3.27	0.20	3.49	0.52	4.93	0.57	2.60	0.19	**		*				***
Overbite (mm)	2.81	0.45	2.12	0.42	6.31	0.74	2.37	0.42	***		***			**	***
Maxillary dentoalveolar measurements															
U1i-max.VR (mm)	73.44	1.73	69.58	1.35	71.43	1.26	73.62	1.39							
U6t-max.VR (mm)	40.20	1.95	39.14	1.14	40.79	1.28	41.56	1.34							
U1/max.HR (°)	115.42	1.73	112.01	1.74	107.94	1.65	115.43	1.13	**		**				**
U6t-max.HR (mm)	80.32	1.97	80.65	1.28	83.88	1.13	83.51	1.30							
Mandibular dentoalveolar measurements															
L1i-mand.VR (mm)	93.17	1.56	94.06	0.89	89.98	1.07	92.66	1.40							
L1/mand.HR (°)	93.30	1.09	88.02	1.99	94.17	1.90	91.97	1.64	**					**	
L6t-mand.VR (mm)	69.15	1.28	72.15	0.78	66.73	1.07	67.66	1.30	**				*	**	
L6/mand.HR (°)	81.55	0.84	78.36	0.77	83.24	1.34	81.69	1.00	*					*	
L6t-mand.HR (mm)	30.90	0.83	31.29	0.67	29.25	0.53	30.24	0.69							

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

Table 3 The evaluation of the changes during treatment/control periods for moderate, maximum, distalization, and control groups, by paired *t*-test. The comparison of the means of differences (D) and standard error of the differences (Sd) between moderate, maximum, maxillary maximum–maximum, and control groups, by Kruskal–Wallis and Dunn's multiple-comparison tests.

Parameters	Moderate		Maximum		Distalization		Control		*f*-test	Moderate–maximum	Moderate–distalization	Moderate–control	Maximum–control	Maximum–distalization	Distalization–control
	D	±Sd	D	±Sd	D	±Sd	D	±Sd							
Sagittal angular measurements															
SNA (°)	0.62	0.45	−0.70	0.46	0.46	0.41	1.42***	0.26	**		**	**	*		
SNB (°)	0.45	0.33	−1.02	0.50	0.81	0.23	1.39***	0.22	***				*	*	***
ANB (°)	0.14	0.35	0.24	0.25	−0.47*	0.22	0.12	0.12							
Vertical angular measurements															
SN/GoGn (°)	0.40	0.42	1.08	0.66	2.20	1.26	−0.58	0.33	*						*
SN/ANSPNS (°)	0.59	0.67	0.9	0.53	1.35	0.75	−0.4	0.34							
ANSPNS/GoGn (°)	−0.2	0.47	0.18	0.56	0.07	0.59	−0.2	0.50							
Facial height variables															
N–Me (mm)	3.32***	0.77	3.00**	0.90	3.83***	0.93	2.42***	0.46							
ANS–Me (mm)	2.95***	0.70	1.41	0.68	3.40***	0.69	2.04***	0.36							
S–Go (mm)	2.26*	0.65	1.39*	0.59	3.16***	0.87	1.81*	0.66							
Jarabak (%)	0.00	0.00	0.00	0.001	0.00	0.01	0.00	0.00							
Maxillo–mandibular dental relationship															
Overjet (mm)	−0.52	0.27	−0.37	0.57	−3.01***	0.68	0.02	0.11	**		**			**	***
Overbite (mm)	−0.34	0.50	0.31	0.41	−3.65***	0.65	0.02	0.21	***		***			***	***
Maxillary dentoalveolar measurements															
U1i-max.VR (mm)	−2.75***	0.58	−2.2**	0.68	−0.49	0.70	0.18	0.29	**		*	**			
U6t-max.VR (mm)	3.58**	0.43	1.46***	0.28	−3.03***	0.40	0.92**	0.29	***		***	**		***	**
U1/max.HR (°)	−6.63***	1.26	−4.27*	1.85	1.27	1.86	0.25	0.76	**		**	**			
U6t-max.HR (mm)	2.81**	0.90	0.8	0.80	−1.53	1.38	2.62*	0.97	**		*				**
Mandibular dentoalveolar measurements															
17.L1i-mand.VR (mm)	−1.99	0.63	−2.34***	0.44	4.87***	0.65	−0.56	0.23	***		***			***	**
L1/mand.HR (°)	−1.38	1.71	−4.67***	1.15	14.16***	1.70	−0.93	1.11	***		***		*	***	***
L6t-mand.VR (mm)	1.94***	0.32	0.62	0.43	1.76	1.40	0.16	0.33	**			**		**	**
L6/mand.HR (°)	−2.40	1.18	−4.28***	0.98	−1.88	1.34	−1.43	0.89							
L6t-mand.HR (mm)	3.13***	0.38	1.57***	0.33	1.87	1.10	1.41***	0.23	**	*	**	*			

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

the mandibular first molars (L6t-mand.HR) in all groups ($P < 0.01$), but differences were observed between the moderate/maximum, moderate/distalization, and moderate/control groups.

Overjet. The overjet decreased in all groups other than in the control group, with differences between the moderate/distalization, maximum/distalization, and distalization/control being significant ($P < 0.01$).

Overbite. The overbite decreased in the moderate and distalization groups, but increased in the maximum and control groups and, the differences between the groups were significant ($P < 0.001$). These differences were again observed between the moderate/distalization, maximum/distalization, and distalization/control groups.

Discussion

Subjects and methods

The Begg (1954) technique is based on extraction and the use of light forces to promote freedom of tooth movement without any extraoral forces (Reddy *et al.*, 2000). As the use of extraoral forces (e.g. headgear) would affect anchorage management, the subjects included in the present study were selected from a limited number of patients who were treated by Begg fixed appliances and intermaxillary Class II elastics, which also enabled the creation of homogeneous groups. Therefore, while the sample was relatively small, their treatment modalities were precisely standardized.

The grouping of the subjects in the three anchorage groups was based on mandibular molar movement. The decision to use mandibular molar teeth only was made due to the difficulty in accurately defining and superimposing maxillary molars compared with mandibular molars (Nielsen, 1989). Nevertheless, as the intermaxillary Class II elastics were applied through the mandibular molars in all groups, would be more appropriate to assess mesial movement of these teeth.

The treatment/control time for the moderate, maximum, and control groups were 2.4, 2.8, and 2.5 years, respectively. However, the treatment time for distalization group was 1.0 years, which could be explained by non-extraction treatment protocol.

Mandibular plane angle changes

SN/GoGn angle, which is one of the most important indicators of the vertical dimension, was increased in the treatment groups, but decreased in the control group. The changes were too small to be statistically significant. When all groups were compared, a significant difference ($P < 0.05$) was observed, but this difference was between the distalization and control groups only.

The most significant increase in SN/GoGn was in the distalization group, in which the subjects were treated by non-extraction Begg maxillary intraoral distalization mechanics. This increase could be explained by the distal displacement of the maxillary first molars, which was not evident in the other treatment groups. A tendency for an increase in SN/GoGn in subjects treated by non-extraction Begg mechanics has been reported (Gianelly *et al.*, 1984; Arat *et al.*, 1988; Ball and Hunt, 1991), while other authors found that the increase observed following the first stage of treatment (edge-to-edge incisor relationship) normalizes at the end of the treatment and the SN/GoGn remains stable (Williams, 1970; Menezes, 1975; Meistrell *et al.*, 1986).

Many researchers have reported a considerable amount of mandibular molar extrusion under the influence of intermaxillary Class II elastics (Swain and Ackerman, 1969; Venezia, 1973; Gianelly *et al.*, 1984; Meistrell *et al.*, 1986; Cangialosi *et al.*, 1988; Ball and Hunt, 1991; Xu *et al.*, 1992; Reddy *et al.*, 2000). Despite the fact that the intermaxillary Class II elastics caused significant extrusion of the mandibular molars in the treatment groups, this did not result in a significant increase in mandibular rotation. This contradiction can be explained by the compensatory increase in posterior face height (S–Go).

Anterior and posterior face height changes. N–Me and ANS–Me increased significantly during the observation period; however, these increases were not significant between the groups. The increases in these variables were greater in the moderate and distalization groups compared with the maximum and control groups. This finding is contrary to previous reports (Yamaguchi and Nanda, 1991; Chua *et al.*, 1993; Cusimano *et al.*, 1993; Staggers, 1994), which could be explained by the different treatment mechanics and anchorage units used.

Vertical displacement of the maxillary and mandibular molar teeth. Vertical displacement and dentoalveolar growth of the maxillary and mandibular posterior regions has significant effects on the vertical facial dimensions (Björk, 1969; Yamaguchi and Nanda, 1991; Staggers, 1994; Kocadereli, 1999; Kim *et al.*, 2005). There were significant increases in U6t-max.HR, which indicates extrusion, in the treatment and control groups but not in the distalization group. This intrusion of maxillary molars in the distalization group is in agreement with previous intraoral distalization studies (Kucukkeles and Doganay, 1994; Doganay, 1996; Rana and Becher, 2000; Ucem *et al.*, 2000; Alacam, 2003; Altug-Atac and Erdem, 2007). This can be explained by the dentoalveolar compensation mechanism against the extrusion of the mandibular first molars (Altug-Atac and Erdem, 2007). It can also be explained by the restriction of the natural forward and downward displacement of the maxillary first molars due to the distalizing mechanics, so-called ‘passive intrusion’ (Doganay, 1996).

The most significant increase in L6t-mand.HR, which indicates extrusion of the mandibular molar, was observed in the moderate anchorage group. This finding is consistent with previous studies (Meistrell *et al.*, 1986; Reddy *et al.*, 2000; Kim *et al.*, 2005). This can be explained by the conversion of the horizontal vector of the intermaxillary Class II elastics into a vertical vector gradually as the mandibular molars mesialize. The vertical vector would yield to a greater extrusion in the moderate anchorage group. Kim *et al.* (2005) reported that more mesial movement of the mandibular molars to close the extraction gap would result in more extrusion of the mandibular molars.

Conclusion

1. The changes in anterior and posterior face heights and Jarabak ratio were similar in all groups.
2. The mandibular plane angle changes were similar in all treatment groups. The increase of the mandibular plane angle in the distalization group was significantly different than the decrease in the control group.
3. Maxillary posterior dentoalveolar height was increased in all groups other than the distalization group, where a significant intrusion of the maxillary first molars was observed due to the molar distalization mechanics.
4. The mandibular posterior dentoalveolar height was increased in all groups, but the increase was greater in the moderate anchorage group.

Contrary to the results anticipated, the findings demonstrate that the vertical facial dimensions were not significantly affected by the amount of sagittal movement of the molar teeth.

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