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A COMPARATIVE STUDY OF PROFILE CHANGES WITH 3 DIFFERENT DISTALIZATION MECHANICS

Aim: *To compare the effects of 3 molar distalization appliances, the intraoral bodily molar distalizer, the Keles slider, and the acrylic cervical occipital appliance, from the viewpoint of skeletal and soft tissue changes.* ***Material and Methods:*** *Lateral cephalometric films taken before and immediately after distalization of 51 patients comprised the study material of this investigation. The lateral cephalograms were digitized and measured with Dolphin Imaging 9.0.* ***Results:*** *The intraoral bodily molar distalizer showed the most forward movement of the lips, with respect to E-plane. The maxillary incisal proclination presented by the U1-SN angle revealed that the most prominent proclination was caused by the intraoral bodily molar distalizer, followed by the acrylic cervical occipital appliance. The appliance that showed the most vertical opening was the intraoral bodily molar distalizer, followed by the acrylic cervical occipital appliance. ANB is the only sagittal skeletal parameter with a change: an increase with the intraoral bodily molar distalizer.* ***Conclusion:*** *The most prominent soft tissue profile changes were observed with the intraoral bodily molar distalizer. The acrylic cervical occipital appliance and the Keles slider generated milder changes on the profile. When selecting the appropriate method for maxillary molar distalization, the initial soft tissue profile should be considered.* World J Orthod 2007;8:37–44.

The nonextraction treatment option for dental Class II correction traditionally involves the distal movement of the maxillary molars. Conventional extraoral traction has been successful in correcting Class II malocclusions, either by restraining forward growth of the maxilla or by distalizing maxillary molars[1,2]; however, these appliances rely partially or totally on patient cooperation, which makes treatment success depend on patient motivation and attitude. In patients with inadequate cooperation, reaching a Class I occlusion by using headgear is difficult.[3,4] This is the reason why clinicians often prefer intraoral distalizing appliances that minimize the need for patient compliance. Removable plates used in conjunction with headgear or distalizers consisting of an acrylic Nance button as an anchorage unit with repelling magnets, coil springs on archwires, super-elastic nickel-titanium archwires, and springs in beta-titanium alloy as a force-generating unit have been used for intraoral distalization.[5] On the other hand, there are drawbacks with these intraoral techniques, such as considerable anchorage loss, proclination of the mandibular incisors, tipping of the maxillary molars, and difficulty in keeping the molars in position following distal movement, which has been reported to result in relapse of the distal movement.[6]

In a previous study, the comparison of the tooth movement changes produced by cervical headgear and the Pend-x appliance was analyzed only for the dental changes in the maxilla.[7]

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Table 1 Age (in years) and gender information for the study groups

	ACCO			Keles slider			IBMD		
	n	Mean	SD	n	Mean	SD	n	Mean	SD
Girls	8	12.9	1.4	12	13.18	1.31	10	14.05	2
Boys	7	13.5	1.4	9	13.34	1.27	5	12.98	1.77
Total	15	13.2	1.4	21	13.25	1.31	15	13.7	1.94

ACCO, acrylic cervical occipital appliance; IBMD, intraoral bodily molar distalizer; n, number in sample; SD, standard deviation.

Since the comparison of skeletal and soft tissue correction of intra-arch–only appliances with distalization appliances supported by headgear has not been investigated until now, the aim of this investigation was to compare the skeletal and soft tissue changes effected by 3 molar distalization appliances: *(1)* an intraoral distalization appliance activated by TMA springs, the intraoral bodily molar distalizer (IBMD); *(2)* an intraoral molar distalization appliance activated by closed coil springs, the Keles slider; and *(3)* a removable plate–headgear combination appliance, the acrylic cervical occipital (ACCO).

MATERIAL AND METHODS

Lateral cephalometric films taken before and immediately after distalization of 51 patients who had orthodontic therapy comprised the study material of this retrospective investigation. Age and gender information is documented in Table 1.

The patient selection criteria for all distalization patients were as follows: Class II molar relationship on both sides; all patients in permanent dentition; well-aligned mandibular dental arch; and sagittally directed or normal growth pattern.

Appliance design and activation

In the IBMD group, the appliance design was made as described by Keles and Sayinsu[7] (Fig 1). It consisted of an acrylic Nance button and a bite plane covering the palatal surfaces of the maxillary incisors, attached to the first premolars, and containing 2 extending 0.032 × 0.032-inch TMA springs. The springs had a tipping and an uprighting preactivation. A force of 230 g was measured when the springs were activated into the palatal hinge caps of the molar bands. At every monthly visit, the springs were checked and activated when needed.

Patients in the ACCO group wore a combination of a part-time extraoral appliance with a full-time intraoral appliance. The intraoral removable appliance was prepared similar to Cetlin's design (Fig 2).[8] The appliance consisted of 0.032-inch-diameter stainless steel distalization finger springs, an acrylic plaque, Adams clasps for first premolars, and a 0.021 × 0.025-inch stainless steel labial arch adapted to the vestibular surfaces of the incisors and covered with a ribbon of acrylic. The patients in this group also had night-time cervical headgear with the outer bows of the facemask bent 25 degrees upward for molar uprighting. The facebow was applied to the molar bands. The intraoral springs produced approximately 160 g and the headgear approximately 400 g of force bilaterally. Patients were seen every month and activation of intra- and extraoral appliances was carried out.

In the Keles slider group (Fig 3), maxillary first molars and first premolars were banded. On the palatal side of the first molar bands, a 1.3-mm-diameter tube was soldered (607-301-00; Dentaurum, Germany). First premolar bands were attached with stainless steel retaining wires, 1.1 mm in diameter, to the Nance button. Stainless steel wire (1.2 mm) was embedded into the acrylic to pass about 5 mm apical to the gingival margin of the first molars, oriented parallel to the occlusal plane, and through the tube attached to the first molar bands. For molar distalization, a heavy NiTi coil

Fig 1 Occlusal view of the IBMD appliance.

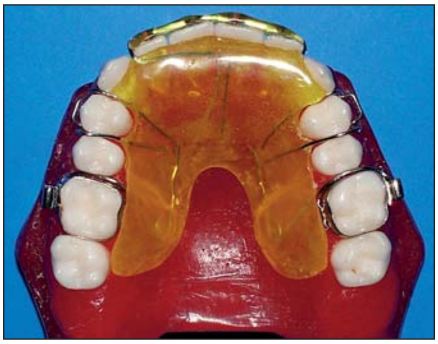

Fig 2 Occlusal view of the ACCO appliance.

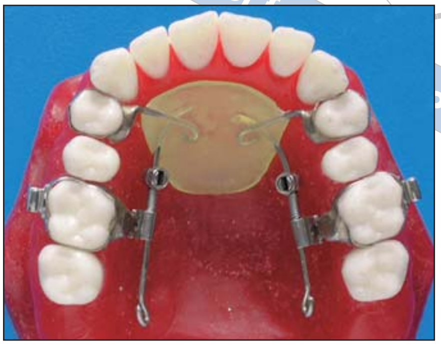

Fig 3 Occlusal view of the Keles slider.

spring (C1214-55; Leone, Firenze, Italy), 11 mm in length, 1.3 mm in diameter, was placed between the screw on the wire and the tube while in full compression. The amount of force generated with the full compression of the 11-mm open coil was about 150 g. This force system would apply consistent distal force at the level of center of resistance of the first molars. Patients were seen once every month and the screws were reactivated as needed with a special screwdriver.

After the distalization in all 51 patients, the appliances were removed and molars were stabilized by the Nance appliance for 2 months before second-phase orthodontic treatment began.

Cephalometric analysis

The cephalometric radiographs before and immediately after distalization were scanned into the digital format at 300 dpi (1680 Pro; Epson, Nagano, Japan). All the scanned images were then digitized and processed by 1 investigator using Dolphin Imaging 9.0 (Dolphin, Chatsworth, CA, USA).

Statistical method

Statistical calculations were performed with the GraphPad Prisma Version 3.0 software (GraphPad Software, San Diego, CA, USA) for Windows. In addition to standard descriptive statistical calculations (mean and standard deviation), one-way analysis of variance (ANOVA) was used for intergroup differences at the start of treatment; subgroup comparisons were carried out with Tukey's multiple comparison test. For the comparison of repeated measurements, paired *t* test was utilized. Because the data were not normally distributed, nonparametric Kruskal Wallis and Dunn's post tests were used to evaluate the results within a 95% confidence interval. Only the parameters that pointed to a difference between the groups with the Kruskal Wallis test were put through the Dunn's test. The statistical significance level was established at $P < .05$.

Method error

For the detection of method error, 15 randomly selected radiographs were digitized and measured with the Dolphin software a second time. The difference between the first and second measurements was evaluated by the intra-class correlation coefficient for intra-rater agreement. The results demonstrated that the parameters that showed the largest method error were the nasolabial angle (1.15 degrees) and the lower lip length (1.02 mm), with 0.93 as the correlation coefficient.

Table 2 Mean, standard deviation, and intragroup analysis for the ACCO

	Pretreatment Mean	Pretreatment SD	Posttreatment Mean	Posttreatment SD	*P*
Upper lip thickness at A point (mm)	16.5	2.70	17.77	1.86	>0.05
Upper lip thickness at vermillion border (mm)	14.06	2.02	13.12	2.15	<0.05
Upper lip to E-plane (mm)	−1.21	3.24	−1.38	3.26	>.05
Lower lip to E-plane (mm)	0.23	3.01	0.80	2.79	>.05
Nasolabial angle (degrees)	114.23	9.18	111.29	9.92	>.05
Soft tissue convexity (degrees)	124.19	3.93	124.33	4.11	>.05
Upper lip length (mm)	21.80	2.29	23.01	2.19	<.05
Lower lip length (mm)	50.25	5.30	53.57	5.53	<.0001
Overbite (mm)	4.57	1.44	1.71	1.44	<.0001
Overjet (mm)	5.49	1.84	7.18	2.24	<.01
U1-SN (degrees)	98.32	7.05	103.72	5.19	<.01
U1-NA (mm)	3.06	2.78	5.21	2.53	<.01
IMPA (L1-MP) (degrees)	94.21	5.85	95.41	6.97	<.05
L1-NB (mm)	5.46	2.76	6.09	2.74	<.05
Pog-NB (mm)	2.29	1.84	2.07	1.94	>.05
Interincisal angle (degrees)	131.21	10.75	122.75	9.73	<.0001
MP-SN (degrees)	36.26	4.46	37.47	5.02	<.01
ANS-Me/Na-Me (%)	56.56	2.54	57.35	1.92	>.05
Occlusal plane to SN (degrees)	17.53	3.84	15.93	4.25	<.05
SNA (degrees)	79.94	2.52	79.82	2.69	>.05
SNB (degrees)	74.71	1.68	74.50	1.63	>.05
ANB (degrees)	5.23	2.37	5.33	2.58	>.05
A-Na perpendicular (mm)	−2.44	4.70	−1.31	4.13	>.05
SN−palatal plane (degrees)	8.51	3.56	9.18	3.73	>.05

ACCO, acrylic cervical occipital appliance; SD, standard deviation.

RESULTS

The values for the groups at the start of treatment matched, with the exception of overbite, which showed a significant difference between the ACCO (4.5 ± 1.44 mm) and Keles slider (3.08 ± 1.81 mm) groups.

Upper lip thickness at the vermillion border parameter revealed that the ACCO and IBMD appliances caused a decrease in the upper lip thickness of 0.94 ± 1.51 mm and 1.44 ± 1.46 mm, respectively. However, when the position of the upper and lower lips is examined with respect to E-plane, the IBMD showed the most forward movement of the lips. All of the appliances showed the same effects on soft tissue convexity, nasolabial angle, and upper lip length, together with the parameters on maxillary and mandibular incisor angulations (Tables 2 to 5). The skeletal parameters SNA, SNB, and A-Na perpendicular have highlighted similar changes in all groups. The maxillary incisal proclination presented by the U1-SN angle revealed that the most prominent proclination was caused by the IBMD, followed by the ACCO (Tables 5 and 6). As for the vertical skeletal dimension, the most vertical opening was achieved by the IBMD, followed by ACCO. Another parameter that introduced a difference between the appliances was the rotation of the occlusal plane, with respect to SN. Among the 3 groups, only the ACCO group showed a negative value, which points to a counterclockwise rotation of the occlusal plane. SN−palatal plane angle values, on the other hand, point to a clockwise rotation with the ACCO and approximately the same magnitude of counterclockwise rotation with the Keles slider and the IBMD. ANB is the only sagittal skeletal parameter with a change: an increase with the IBMD.

Table 3 Mean, standard deviation, and intragroup analysis for the Keles slider

	Pretreatment		Posttreatment		
	Mean	SD	Mean	SD	*P*
Upper lip thickness at A point (mm)	16.97	2.96	17.45	3.94	>0.05
Upper lip thickness at vermillion border (mm)	14.23	2.77	14.52	2.74	>.05
Upper lip to E-plane (mm)	−2.64	2.78	−1.75	2.38	<.05
Lower lip to E-plane (mm)	−0.86	2.89	−0.54	3.16	>.05
Nasolabial angle (degrees)	112.03	10.10	110.78	11.47	>.05
Soft tissue convexity (degrees)	127.21	4.49	126.70	4.11	>.05
Upper lip length (mm)	21.45	2.16	22.01	2.13	<.05
Lower lip length (mm)	51.18	3.04	52.67	3.27	<.001
Overbite (mm)	3.08	1.81	1.94	1.95	<.0001
Overjet (mm)	4.06	1.79	5.43	1.92	<.0001
U1-SN (degrees)	97.69	8.26	101.28	7.09	<.0001
U1-NA (mm)	3.28	2.81	5.04	2.62	<.0001
IMPA (degrees)	91.61	5.78	92.45	5.50	<.05
L1-NB (mm)	4.88	2.30	5.51	2.22	<.01
Pog-NB (mm)	2.37	1.69	2.51	1.75	>.05
Interincisal angle (degrees)	132.96	9.54	127.31	8.31	<.0001
MP-SN (degrees)	37.76	3.08	37.99	3.19	>.05
ANS-Me/Na-Me (%)	56.23	2.38	56.80	2.58	<.01
Occlusal plane to SN (degrees)	18.92	4.93	19.04	4.47	>.05
SNA (degrees)	78.19	4.37	78.25	4.10	>.05
SNB (degrees)	74.47	4.07	74.41	3.61	>.05
ANB (degrees)	3.71	2.30	3.75	2.38	>.05
A-Na perpendicular (mm)	−3.31	3.39	−3.24	3.05	>.05
SNpalatal plane (degrees)	9.33	3.86	8.96	4.30	>.05

SD, standard deviation.

Table 4 Mean, standard deviation, and intragroup analysis for the IBMD

	Pretreatment		Posttreatment		
	Mean	SD	Mean	SD	*P*
Upper lip thickness at A point (mm)	15.70	1.38	17.34	2.16	<.05
Upper lip thickness at vermillion border (mm)	12.59	2.06	11.15	1.85	<.01
Upper lip to E-plane (mm)	−3.36	2.34	0.00	2.56	<.0001
Lower lip to E-plane (mm)	−1.88	2.55	1.03	2.40	<.0001
Nasolabial angle (degrees)	118.49	10.29	116.72	7.96	>.05
Soft tissue convexity (degrees)	126.69	4.76	125.72	4.26	>.05
Upper lip length (mm)	22.31	1.85	23.91	1.74	<.001
Lower lip length (mm)	48.46	3.46	51.94	3.54	<.0001
Overbite (mm)	3.91	1.92	−0.02	2.34	<.0001
Overjet (mm)	4.77	1.73	9.16	2.74	<.0001
U1-SN (degrees)	96.78	7.53	104.21	10.96	<.001
U1-NA (mm)	2.73	2.57	5.57	3.47	<.0001
IMPA (degrees)	95.55	7.98	97.01	8.09	>.05
L1-NB (mm)	4.65	1.71	5.66	1.83	<.01
Pog-NB (mm)	2.86	1.51	2.73	1.62	>.05
Interincisal angle (degrees)	133.07	10.04	122.09	12.79	<.0001
MP-SN (degrees)	34.57	4.03	36.67	4.60	<.01
ANS-Me/Na-Me (%)	55.34	2.05	56.96	1.37	<.0001
Occlusal plane to SN (degrees)	17.31	2.92	18.01	4.16	>.05
SNA (degrees)	79.78	3.60	81.37	3.74	>.05
SNB (degrees)	75.29	2.82	74.98	3.35	>.05
ANB (degrees)	4.50	2.03	6.33	2.58	<.001
A-Na perpendicular (mm)	−1.91	5.16	0.11	3.35	>.05
SN−palatal plane (degrees)	9.47	4.05	9.13	4.76	>.05

IBMD, intraoral bodily molar distalizer; SD, standard deviation.

Table 5 Intergroup comparison of 3 distalization appliances

	ACCO		Keles slider		IBMD		
	Mean	SD	Mean	SD	Mean	SD	*P*
Upper lip thickness at A point (mm)	1.02	2.10	0.48	2.91	1.64	2.67	>.05
Upper lip thickness at vermillion (mm)	−0.94	1.51	0.29	1.42	−1.44	1.46	<.01
Upper lip to E-plane (mm)	−0.17	1.64	0.90	1.75	3.36	2.74	<.0001
Lower lip to E-plane (mm)	0.57	1.92	0.32	1.70	2.91	2.49	<.01
Nasolabial angle (degrees)	−2.94	9.76	−1.25	5.91	−1.77	7.32	>.05
Soft tissue convexity (degrees)	0.15	2.80	−0.51	1.79	−0.97	2.97	>.05
Upper lip length (mm)	1.21	2.1	0.56	1.73	1.6	1.82	>.05
Lower lip length (mm)	3.32	2.23	1.50	1.82	3.48	1.81	<.01
Overbite (mm)	−2.86	1.59	−1.13	0.81	−3.93	2.26	<.0001
Overjet (mm)	1.69	1.79	1.37	0.95	4.39	2.46	<.0001
U1-SN (degrees)	5.4	6.05	3.59	2.43	7.43	7.24	<.05
U1-NA (mm)	2.15	2.34	1.76	1.73	2.84	2.21	>.05
IMPA (degrees)	1.20	1.96	0.84	1.48	1.46	3.24	>.05
L1-NB (mm)	0.63	0.83	0.64	0.86	1.01	1.04	>.05
Pog-NB (mm)	−0.21	1.07	0.14	0.50	−0.13	0.45	>.05
Interincisal angle (degrees)	−8.45	5.91	−5.64	3.03	−10.97	6.98	<.05
MP-SN (degrees)	1.21	1.56	0.23	1.07	2.10	2.41	<.05
ANS-Me/Na-Me (%)	0.79	2.13	0.57	0.78	1.62	1.12	<.01
Occlusal plane to SN (degrees)	−1.60	2.18	0.12	1.79	0.70	2.36	<.05
SNA (degrees)	−0.12	2.05	0.07	1.12	1.59	3.51	>.05
SNB (degrees)	−0.21	1.66	−0.07	1.10	−0.31	2.54	>.05
ANB (degrees)	0.11	1.60	0.04	1.20	1.83	1.70	<.01
A-Na perpendicular (mm)	1.13	2.56	0.06	2.34	2.02	3.64	>.05
SN-palatal plane (degrees)	0.67	3.77	−0.37	1.79	−0.33	1.70	<.05

ACCO, acrylic cervical occipital appliance; IBMD, intraoral bodily molar distalizer; SD, standard deviation.

DISCUSSION

This study compares the effects of 3 molar distalization appliances: a removable plate and headgear combination (ACCO); an intraoral molar distalization appliance activated by closed coil springs (Keles slider); and another intraoral molar distalization appliance activated by TMA springs (IBMD). Most of the intraoral distalizing devices have an advantageous noncompliance property; however, there is also greater anchorage loss with these appliances. The consolidation of the overjet by the fixed appliances, following the protrusion of incisors with the molar distalizing appliance, is an undesirable treatment response that causes “round-tripping” of the incisors, which may in turn increase the risk of complications.

The literature regarding the effect of distalization appliances mostly focuses on the dental movements. In recent years, however, the trend in orthodontics has been to treat faces; therefore, to define the effect of these appliances from the point of profile changes has become important. There are only a few studies that comparatively investigate the effects of distalization appliances.[9–11] The comparative examination of appliances used in conjunction with extraoral force with those using only intraoral appliances is rare.[9] In the present study, to analyze the effects on patient profile of the 3 appliances, anterior dental measurements and soft tissue profile measurements were taken; additional sagittal and vertical skeletal parameters were assessed to define the dimension of the supporting skeletal changes.

When the data following the removal of distalization appliances was examined, it was evident that the IBMD appliance caused more marked anchorage loss in the incisor region, which produced a more noticeable upper lip protrusion than the other molar distalization

Table 6 Subgroup comparisons with Dunn's test

	ACCO/Keles slider	ACCO/IBMD	Keles slider/IBMD
Upper lip thickness at vermillion (mm)	<.05	>.05	<.01
Upper lip to E-plane (mm)	>.05	<.001	<.01
Lower lip to E-plane (mm)	>.05	<.01	<.001
Lower lip length (mm)	<.05	>.05	<.05
Overbite (mm)	<.01	>.05	<.001
Overjet (mm)	>.05	<.001	<.001
U1-SN (degrees)	>.05	<.05	<.01
Interincisal angle (degrees)	>.05	>.05	<.05
MP-SN (degrees)	>.05	>.05	<.01
ANS-Me/Na-Me (%)	>.05	>.05	<.05
Occlusal plane to SN (degrees)	<.05	<.05	>.05
ANB (degrees)	>.05	<.01	<.01
SN–palatal plane (degrees)	<.05	<.05	>.05

ACCO, acrylic cervical occipital appliance; IBMD, intraoral bodily molar distalizer.

appliances (see Tables 5 and 6). This discrepancy between maxillary and mandibular dental arches created by the IBMD appliance is supported by the changes in ANB and overjet. Yet, in spite of the distinct anchorage loss created by the IBMD appliance, when compared with other distalizing appliances, the IBMD generated a more efficient molar distal movement.[10]

Unlike Ferro's study,[12] which indicated a retraction in the position of A point, the results of this study indicated that the position of A point did not change in any group, even in the ACCO group which had extraoral traction.

The IBMD appliance demonstrated the largest increase in the vertical skeletal parameters, which meant that the chin rotated downward and backward, resulting in the relative protrusion of the upper lip with reference to the E plane. The reason for the excessive opening of the vertical dimension is probably the fixed anterior bite plane, which may promote the eruption of the mandibular posterior teeth. Most intraoral devices for molar distalization seem to produce a small increase in the mandibular plane angle[6,7,10,13–19]; however, there are also studies that report no mandibular plane changes.[11]

The reduction in the overbite with the ACCO and IBMD appliances was greater than that achieved with the Keles slider. This difference may arise from the absence of a bite plane in the Keles slider appliance used in this study. Another parameter that introduced a variation between the appliances is the rotation of the occlusal plane with respect to SN. Among the 3 groups, only the ACCO group displayed a negative value, which indicates a counterclockwise rotation of the occlusal plane. The reason for the counterclockwise rotation with the ACCO appliance was probably the result of molar extrusion caused by the cervical headgear.[1,20]

Although there was not any statistically significant change in the intragroup comparisons with the SN–palatal plane parameter, the inter-group comparison pointed to a statistically significant, but clinically insignificant, difference arising from ACCO group. Once again, this difference might be the result of cervical traction. Although studies have shown that application of cervical traction does not produce a significant downward and forward rotation on the palatal plane,[12,20,22] this study, together with a large number of other studies,[1,23,24] is evidence of the clockwise rotation of the maxillary palatal structures during treatment with cervical headgear.

CONCLUSIONS

Clinically, the ACCO, Keles slider, and IBMD appliances all effectively distalized molars. Reciprocal anchorage loss occurred in the incisor region during distalization. When the reflection of this anchorage loss on the soft tissue profile was evaluated, the most prominent changes were observed with the IBMD. The ACCO and Keles slider generated milder changes on the profile. When selecting the appropriate method for maxillary molar distalization, the initial soft tissue profile should be taken into consideration. Since the ACCO creates the need for more patient compliance, the Keles slider may be the appliance of choice for patients with a prominent profile and compliance problems.

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