Dentofacial Effects of Asymmetric Headgear and Cervical Headgear with Removable Plate on Unilateral Molar Distalization

Handan Altug[a]; A. Osman Bengi[b]; Erol Akın;[c] Seniz Karacay[d]

Abstract: Cervical headgear (CHG) is used widely in the treatment of Class II anomalies. Asymmetric headgear (AHG) is an alternative treatment for the correction of unilateral Class II dental relationships. The purpose of this investigation was to compare the effects of AHG with those of a CHG combined with a removable plate in unilateral first molar distalization. The study consisted of 20 patients with unilateral Class II molar relationship (12 girls and eight boys). One group of 10 patients was treated with an AHG, and a second group of 10 patients was treated with a CHG and a removable plate. Lateral cephalograms and basilar radiographs were taken before and after molar distalization. It was found that distalization and distal tipping of molar on the passive side was less in the CHG and removable plate (CHG-RP) group. Distalization and distal tipping of the second premolar on the distalization side was also reduced in this group. Incisors were retruded in both groups but were retruded more in the CHG-RP group. (*Angle Orthod* 2005;75:584–592.)

Key Words: Class II malocclusion; Asymmetric headgear; Cetlin therapy; Unilateral molar distalization

INTRODUCTION

Headgears were first used in the early 1800s, and modifications have been made throughout time. Cervical headgear (CHG) therapy has been studied extensively for the last 50 years, but treatment results have varied greatly because of modifications of the appliance. Extraoral traction has been used successfully to correct skeletal or dental Class II malocclusion by restraining the forward growth of the maxilla or by distalizing the maxillary molars. The effects of CHG on the craniofacial complex have been evaluated by numerous experimental and clinical studies.[1–8] However, extraoral cervical traction requires considerable patient compliance to obtain successful results.[5,9–11]

In recent years, methods have been sought for correcting Class II malocclusions without the need for strict patient compliance. Different treatment modalities have been suggested to distalize maxillary molars including palatal bars,[12] repelling magnets,[13–16] Nitinol coil springs,[17–18] K-loops,[19] superelastic wires,[20] Wilson arches,[21] Jones jig appliances,[22,23] pendulum appliances,[24] distal jet appliances,[25] three-dimensional bimetric maxillary distalizing arches,[26] and intraoral bodily molar distalizer.[27,28]

In the early 1980s, Cetlin and Ten Hoeve[29] introduced a nonextraction treatment method for Class II division 1 malocclusion, which corrected the molar relationship with the use of a distalizing plate combined with extraoral traction. Extraoral traction should be worn 10 to 12 hours a day and produce a force of 150 to 200 g/side, or more, for an orthopedic effect on the maxilla.

Orthodontic treatment often requires an extraoral facebow that will predictably deliver a greater distal force to one side of the dental arch. Facebows provid-

[a] Specialist, Department of Orthodontics, Dental Science Center, Gulhane Military Medical Academy, Ankara, Turkey.
[b] Associate Professor, Department of Orthodontics, Dental Science Center, Gulhane Military Medical Academy, Ankara, Turkey.
[c] Assistant Professor, Department of Orthodontics, Dental Sciences Center, Gulhane Military Medical Academy, Ankara, Turkey.
[d] Assistant Professor, Department of Orthodontics, Dental Science Center, Gulhane Military Medical Academy, Ankara, Turkey.
Corresponding author: Erol Akın, DDS, PhD, Department of Orthodontics, Dental Science Center, Gulhane Military Medical Academy, Gn. Tevfik Saglam Cad., Ankara, Etlik 06018, Turkey (e-mail: erol1akin@hotmail.com)

Accepted: November 2004. Submitted: August 2004.

FIGURE 1. Points and planes used in the cephalometric analysis: (1) Ud6, inserting point of the marker at distalization side; (2) Up6, inserting point at passive side; (3) U5, distal point of the maxillary second bicuspid at distalization side; (4) Ud6o, lower point of the maxillary first molar at distalization side; (5) Up6o, lower point at passive side; (6) U5o, lower point of the maxillary second bicuspid at the distalization side; (7) U1i, incisal point of the maxillary incisor; (8) Ud6a, long axis of the marker at distalization side; (9) Up6a, long axis of the marker at passive side.

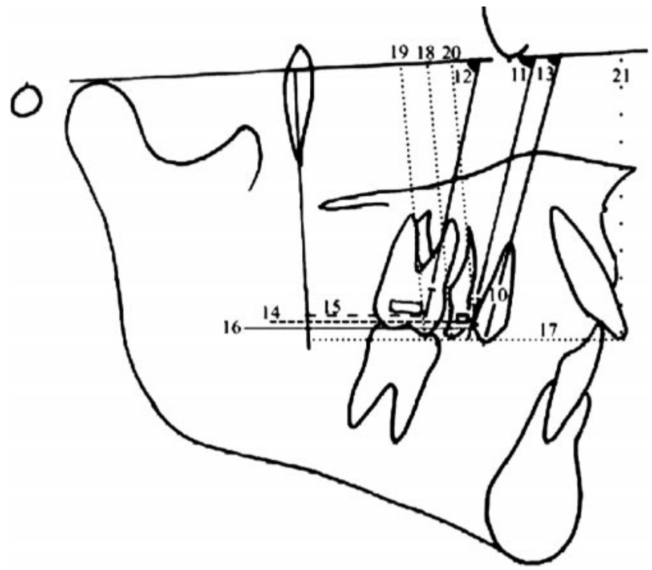

FIGURE 2. Measurements used in the cephalometric analysis: (10) U5a, long axis of the maxillary second bicuspid at the distalization side; (11) Ud6a/FH; (12) Up6a/FH; (13) U5a/FH; (14) Ud6-PtV; (15) Up6-PtV; (16) U5-PtV; (17) U1i-PtV; (18) Ud6o-FH; (19) Up6o-FH; (20) U5o-FH; (21) U1i-FH.

ing an asymmetric distal force to their inner-bow terminals are termed unilateral facebows.

Studies describing the dentoskeletal changes associated with the Cetlin method have been rare. The aim of this study was to evaluate and to compare the dentoskeletal changes produced by a CHG used with a removable plate (CHG-RP) with those effects produced by an asymmetric headgear (AHG).

MATERIALS AND METHODS

This prospective study consisted of 20 patients (12 girls and eight boys) divided randomly into two groups. Group I (AHG group) comprised 10 children (seven girls and three boys) with a mean age of 14.1 years, and group II (CHG-RP group) comprised 10 children (five girls and five boys) with a mean age of 14.6 years. Cases were selected with inclusion criteria as: (1) skeletal Class I, unilateral dental Class II molar relationship, (2) normal growth pattern and direction, (3) lower midline coincident with the midsagittal plane (MSR), (4) minimal or no dentoalveolar discrepancies in the lower arch, (5) normal overbite, (6) erupted upper second molars, and (7) absence of any shape or size anomalies or congenital missing tooth or teeth.

The study was carried out after the institutional approval for the use of humans was obtained from ethics committee of Gulhane Military Medical Academy. The maxillary first molars were unilaterally distalized using 250 g of force in both groups. Records of all the patients were obtained before treatment (T1) and after molar distalization (T2). Distalization was considered adequate when a super Class I molar relationship was obtained. The appliances were removed at the end of distalization, and a passive transpalatal arch was inserted for retention.

Radiographic evaluation

Lateral and basilar radiographs were obtained before and after the distalization period. Molar positions were identified on the radiographs by the use of individual vertically oriented guiding markers (0.41 $\times$ 0.56 mm Blue Elgiloy) placed in the rectangular double buccal tubes of molar bands while obtaining the radiographs. Occlusal radiographs were taken for evidence of sutural opening.

One investigator (Dr Altug) traced the radiographs, and the landmarks were verified by the other three investigators. Suspicious structures and landmarks were retraced to the mutual satisfaction of the investigators. A single average tracing was made in instances of bilateral structures. Twenty-three landmarks and 32 parameters were used in the study.

The parameters were measured by one investigator (Dr Altug) once more at another time to evaluate measurement errors. Measurements used in the study are shown in Figures 1–4 and Tables 1 and 2. The fre-

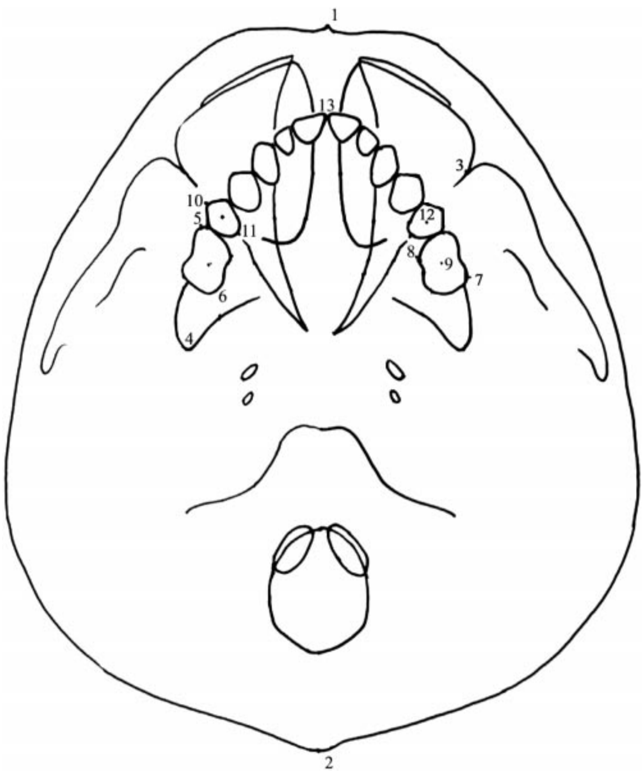

FIGURE 3. Points used in the basilar analysis; (1) GI; (2) PPCB, tip of the posterior border of cranium; 3. SOR and SOL, intersection between the ala minor of the sphenoid bone and lateral wall of the orbit at the right and left sides; 4. MADD and MAPD: distal point of alveolar bone at distalization and passive side; 6. DPD and DPD, distopalatal corner at distalization and passive side; 7. DBD and DBP, distobuccal corner at distalization and passive side; 8. MPD and DPP, mesiopalatal corner at distalization and passive side; 9. MPC and MPC, the intersection point between the planes connecting MB to DP and MP to DB at distalization and passive side; 10. PVD and PVP, vestibule point of the maxillary second bicuspid at tdistalization and passive side; 11. PPD and PPP, palatal point of the maxillary second bicuspid at distalization and passive side; 12. PDC and PPC, midpoint of the plane connecting PVB to PPD; (13) I, contact point of maxillary of maxillary incisors.

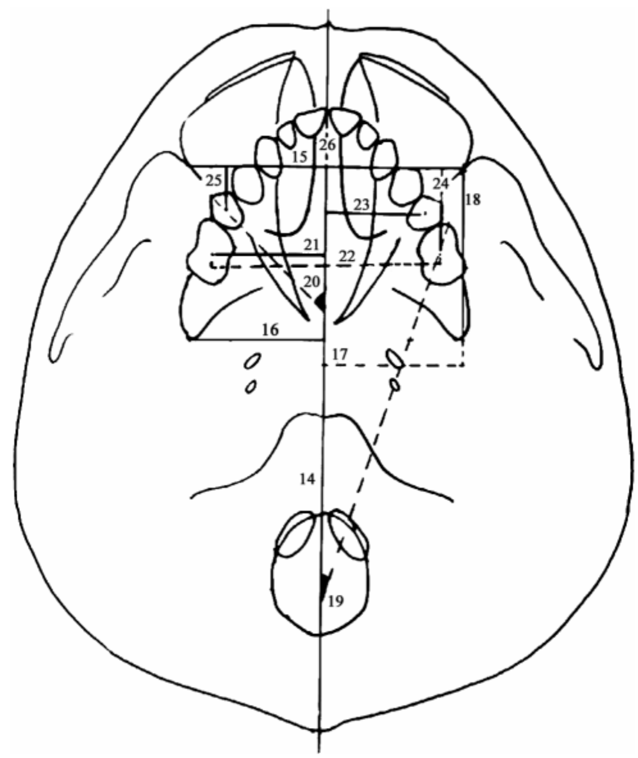

FIGURE 4. Measurements used in the basilar analysis: (14) midsagittal plane (MSR), plane connecting Gl to PPCB; (15) transversal plane (TP), plane connecting SOR to SOL; 16. MADD-MSR; 17. MADD-MAPD; 18. MADD-TP; 19. MBD-DPD/MSR and MBP-DPP/MSR; 20. PVD-PVP/MSR and PVP-PPP/MSR; 21. MPC-MSR and MPC-MSR; 22. MDC-MPC; 23. PDC-MSR; 24. MDC-TP; 25. PDC-TP; 26. I-TP.

quently used points and measurements are not shown in the figures.

Statistical method

Thirty-two lateral and basilar radiographs were chosen randomly for examination of the measurement error. The reliability of a single measurement was calculated by using Dahlberg's formula of method error. The method error did not exceed 0.395.

Statistical analyses were performed with a statistical package (SPSS Inc, Chicago, Ill), and the results are shown as a mean $\pm$ standard deviation. After the parametric assumptions were tested and if the variables were suitable for parametric tests, the differences between the T1 and T2 measurements were evaluated with the paired-samples *t*-test. The differences between the two groups were evaluated using Student's *t*-test. P values $\leq$.05 were considered statistically significant.

RESULTS

The T1 to T2 changes of the groups in the cephalometric and basilar radiographs are shown in Tables 3 through 6. The y-axis ($P < .01$ for AHG and $P < .05$ for CHG-RP), palatal plane ($P < .05$ for AHG and $P < .01$ for CHG-RP), mandibular plane ($P < .01$ for both groups), and occlusal plane ($P < .01$ for AHG and $P < .05$ for CHG-RP) all revealed posterior rotation. Anterior and lower face heights ($P < .01$ for both groups) and posterior face height ($P < 05$ for AHG and $P < .01$ for CHG-RP) were increased.

Upper molars and central incisors were extruded in both groups, and it was denoted by increases in the cephalometric variables Ud6o-FH, Up6o-FH, and U1i-FH ($P < .01$ for AHG and $P < .05$ for CHG-RP). Extrusion of the second premolars was observed only in AHG group (U5o-FH was increased by $P < .01$).

Distopalatal rotation of the first molars and second premolars was determined by increases in basilar var-

TABLE 1. Explanation of the Abbreviations Used in the Cephalometric Analysis, Figures, and Tables

Ud6	Inserting point of the marker to the tube on the maxillary first molar at distalization side
Up6	Inserting point of the marker to the tube on the maxillary first molar at passive side
U5	Distal point of the maxillary second bicuspid at distalization side
Ud6o	Lower point of the maxillary first molar at distalization side
Up6o	Lower point at passive side
U5o	Lower point of the maxillary second bicuspid at the distalization side
U1i	Incisal point of the maxillary incisor
Ud6a	Long axis of the marker at distalization side
Up6a	Long axis of the marker at passive side
U5a	Long axis of the maxillary second bicuspid at the distalization side
Ud6a/FH	The lower, inner angle between Ud6 and Frankfort Horizontal plane
Up6a/FH	The lower, inner angle between Up6 and Frankfort Horizontal plane
U5a/FH	The lower, inner angle between U5 and Frankfort Horizontal plane
Ud6-PtV	The perpendicular distance between Ud6 and Pterygoid Verticale plane
Up6-PtV	The perpendicular distance between Up6 and Pterygoid Verticale plane
U5-PtV	The perpendicular distance between U5 and Pterygoid Verticale plane
U1i-PtV	The perpendicular distance between U1 and Pterygoid Verticale plane
Ud6o-FH	The perpendicular distance between Ud6 and Frankfort Horizontal plane
Up6o-FH	The perpendicular distance between Up6 and Frankfort Horizontal plane
U5o-FH	The perpendicular distance between U5 and Frankfort Horizontal plane
U1i-FH	The perpendicular distance between U1 and Frankfort Horizontal plane

iables MBD-DPD/MSR, MBP-DPP/MSR, PVP-PPP/MSR ($P < .01$ for both groups), and PVD-PPD/MSR ($P < .01$ for AHG and $P < .05$ for CHG-RP), whereas the expansion of these teeth was shown by increases in MDC-MSR, MDC-MPC, PDC-MSR ($P < .01$ for both groups), and MPC-MSR, PPC-MSR ($P < .01$ for AHG and $P < .05$ for CHG-RP).

Distalization of molars and premolars was denoted by increases in basilar variables MDC–Transversal Plane (TP), MPC-TP, PDC-TP ($P < .01$ for both groups) and PPC-TP ($P < .01$ for AHG and $P < .05$ for CHG-RP). Cephalometric findings also revealed distalization and distal tipping of these teeth by decreases in the variables Ud6a/FH, Up6a/FH, U5a/FH, Ud6-Ptv, Up6-Ptv, and U5-Ptv ($P < .01$ for both groups).

Upper incisors were retruded in both groups (U1i-Ptv was decreased by $P < .01$ for AHG and $P < .05$ for CHG-RP), and they were also distally tipped in CHG-RP group (U1a/SN was decreased by $P < .05$ and I-TP was decreased by $P < .01$).

Significant increases in the basilar variables MADD-MSR, MAPD-MSR, MADD-MAPD, MADD-TP, and MAPD-Trans ($P < .01$) showed the displacement of the alveolar bone in both groups.

When the means of the groups were compared, significant changes were found in variables Up6a/FH, Up6-Ptv, and U5-Ptv ($P < .05$) and U5a/FH ($P < .01$) showing more distalization and distal tipping of molar at the passive side and of second premolar at the distalization side in AHG group (Table 7).

DISCUSSION

Alternative intraoral molar distalization modalities have been sought to create noncompliance therapies. Because the most unavoidable effect of intraoral molar distalization is the undesirable alterations in the alveolar bone and the anchor teeth, these appliances were suggested for use before eruption of the second molars.[15,16,20,22,24] Several AHG forms have been used for unilateral molar distalization.[30–32] An undesirable effect of the AHG is the derangement of the upper molars in the sagittal and transverse planes because of lateral forces.[31] In this study, a removable plate with a screw and a CHG combination was used to eliminate these lateral forces.

Studies of distalization were conducted usually on bilateral maxillary molars. Several authors have investigated unilateral molar distalization with intraoral appliances. In the literature, despite the investigations explaining the biomechanics of extraoral unilateral molar distalization, the number of clinical trials is few. The direction of vertical force could be controlled with the angulation of outer arms of the facebow, but in this situation, a decreased amount of molar distalization should be expected. Our first target was to obtain rapid molar distalization, so angular alterations were not performed to the outer arms and 250 g of force was applied in our study.

In bilateral CHG applications, force lines intersect at the posterior of the neck on the MSR at an illusive point. The force vector occurs as the bisector of the angle formed by the force lines passes through the MSR and the midpoint of the distance between the upper molars. When the geometric configurations of the unilateral CHG were evaluated, the angle formed by the force lines is also at the posterior of the neck but is positioned to the side that is to be stable. In this condition, the force component runs in a direction that

TABLE 2. Explanation of the Abbreviations Used in the Basilar Analysis, Figures, and Tables

GI	Giabella
PPCB	Tip of the posterior border of cranium
SOR	Intersection between the ala minor of the sphenoid bone and lateral wall of the orbit at the right side
SOL	Intersection between the ala minor of the sphenoid bone and lateral wall of the orbit at the left side
MADD	Distal point of alveolar bone at distalization side
MAPD	Distal point of alveolar bone at passive side
MBD	Point constituting the mesiobuccal corner of the maxillary first molar at distalization side
MBP	Point constituting the mesiobuccal corner of the maxillary first molar at passive side
DPD	Point constituting the distopalatal corner of the maxillary first molar at distalization side
DPP	Point constituting the distopalatal corner of the maxillary first molar at passive side
DBD	Point constituting the distobuccal corner of the maxillary first molar at distalization side
DBP	Point constituting the distobuccal corner of the maxillary first molar at passive side
MPD	Point constituting the mesiopalatal corner of the maxillary first molar at passive side
DPP	Point constituting the mesiopalatal corner of the maxillary first molar at passive side
MDC	The intersection point between the planes connecting MB to DP and MP to DB at distalization side
MPC	The intersection point between the planes connecting MB to DP and MP to DB at passive side
PVD	Vestibule point of the maxillary second bicuspid at distalization side
PVP	Vestibule point of the maxillary second bicuspid at passive side
PPD	Palatal point of the maxillary second bicuspid at distalization side
PPP	Palatal point of the maxillary second bicuspid at passive side
PDC	Midpoint of the plane connecting PVD to PPD at distalization side
PPC	Midpoint of the plane connecting PVP to PPP at passive side
I	Contact point of maxillary central incisors
MSR	Midsagittal plane: plane connecting GI to PPCB
TP	Transversal plane: plane connecting SOR to SOL
MADD-MSR	The perpendicular distance with the distal point of alveolar bone at distalization side and MSR
MADD-MAPD	The perpendicular distance with the distal point of alveolar bone at passive side and MSR
MADD-TP	The perpendicular distance with the distal point of alveolar bone at distalization side and TP
MAPD-TP	The perpendicular distance with the distal point of alveolar bone at passive side and TP
MBD-DPD/MSR	The angle between the plane connecting MBD to DPD and MSR at distalization side
MBP-DPP/MSR	The angle between the plane connecting MBP to DPP and MSR at passive side
PVD-PVP/MSR	The angle between the plane connecting PVD to PVP and MSR at distalization side
PVP-PPP/MSR	The angle between the plane connecting PVP to PPP and MSR at passive side
MDC-MSR	The perpendicular distance from MDC to MSR
MPC-MSR	The perpendicular distance from MPC to MSR
MDC-MPC	The distance between MDC and MPC
PDC-MSR	The perpendicular distance from PDC to MSR
MDC-TP	The perpendicular distance from MDC to TP
PDC-TP	The perpendicular distance from PDC to TP
I-TP	The perpendicular distance from I to TP

crosses the MSR and comes close to the upper molar desired to be distalized.

Hershey et al[32] determined that increase in the asymmetry of the unilateral headgear leads to an increase in lateral force vector. In our study, short arm of the ACH was at the level of upper bicuspids. The intraoral molar distalization techniques were often introduced in the literature, so the results of our study were compared with these investigations.

The y-axis, SN-PP, SN-MP, SN-Occ, N-Me, ANS-Me, and S-Go variables showed statistically significant increases in both groups. These alterations revealed the changes in the relationship of maxilla and mandible against the cranial base and posterior rotation of the chin because of orthopedic and dentoalveolar effects of extraoral appliances. Therefore, anterior face height/posterior face height ratio changed and the facial height parameters increased. Statistically significant differences were found in the variables MADD-MSR, MAPD-MSR, MADD-MAPD, MADD-TP, and MAPD-TP. According to these findings, we concluded that the alveolar bone moved distally.

When the dentoalveolar effects of the appliances were evaluated, statistically significant differences were found in the amount of distalization of the upper molars. Maxillary molars on the passive side were also distalized in both groups. This finding was in accordance with Hershey et al[32] and Baldini.[31] The between-group difference for this parameter was statistically significant. The distalization was more in the AHG group. This finding was a result of the plate that facilitates the distalization in one side because of the screw and tightens the contralateral against the distalization force of the headgear.

Significant alteration in the Ud6a/FH and Up6a/FH showed the tipping of the molars. This finding was sim-

TABLE 3. Descriptive Statistics of Skeletal/Dental Measurements of Lateral Cephalometric Radiographs at T1[a], T2, and T2–T1 for the Asymmetric Headgear Group

	T1		T2		T2 − T1			
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	*P*	Significance
y-axis	60.200	2.974	61.400	3.062	1.200	0.919	.010	**
SN/PP	12.200	3.360	12.900	3.784	0.700	0.823	.038	*
SN/MP	36.800	6.143	38.100	5.934	1.300	1.059	.010	**
SN/Occ	15.900	4.533	17.200	4.662	1.300	0.949	.010	**
N-Me	122.100	8.569	124.200	8.690	2.100	0.994	.007	**
ANS-Me	67.600	7.834	69.500	7.531	1.900	1.100	.007	**
S-Go	77.900	8.962	78.900	8.530	1.000	1.155	.028	*
Ud6a/FH	80.500	6.346	69.300	6.560	−11.200	4.962	.005	**
Up6a/FH	81.500	7.091	73.700	5.143	−7.800	2.573	.005	**
U5a/FH	84.200	4.940	76.300	4.832	−7.900	3.784	.005	**
Ud6-Ptv	25.800	4.872	19.200	5.160	−6.600	2.675	.004	**
Up6-Ptv	23.300	3.268	19.200	3.425	−4.100	0.994	.005	**
U5-Ptv	25.500	4.007	22.100	4.067	−3.400	0.843	.004	**
U1i-Ptv	54.600	5.125	52.900	5.322	−1.700	0.675	.004	**
Ud6o-FH	49.200	4.662	51.000	4.595	1.800	1.033	.007	**
Up6o-FH	46.900	4.581	48.800	4.417	1.900	0.994	.004	**
U5o-FH	49.300	3.973	52.200	3.795	2.900	1.595	.004	**
U1i-FH	54.000	4.190	55.800	4.185	1.800	0.919	.007	**

[a] T1 indicates before treatment; T2, after treatment.
*$P < .05$; **$P < .01$.

TABLE 4. Descriptive Statistics of Measurements of Basilar Radiographs at T1, T2, and T2 − T1 for the Asymmetric Headgear Group[a]

	T1		T2		T2 − T1			
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	*P*	Significance
MADD-MSR	26.600	3.438	32.100	4.332	5.500	1.509	.005	**
MAPD-MSR	27.800	3.553	30.700	2.946	2.900	1.729	.007	**
MADD-MAPD	54.400	5.910	63.100	6.226	8.700	2.791	.005	**
MADD-TP	31.800	8.176	35.500	7.821	3.700	1.636	.005	**
MAPD-TP	32.000	9.741	35.900	8.875	3.900	1.663	.005	**
MBD-BPD	32.100	5.782	43.800	5.827	11.700	1.946	.004	**
MBP-DPP	34.200	5.138	40.900	6.208	6.700	1.636	.005	**
PVD-PPD	68.700	6.165	75.500	6.721	6.800	2.700	.005	**
PVP-PPP	69.500	5.462	74.200	5.554	4.700	3.498	.005	**
MDC	22.900	2.644	28.400	3.062	5.500	1.650	.005	**
MPC	23.600	3.134	26.200	3.048	2.600	0.966	.004	**
MDC	46.400	4.881	54.600	5.929	8.200	3.048	.005	**
PDC	20.500	3.206	23.200	3.048	2.700	1.703	.007	**
PPC	21.900	1.853	23.800	2.044	1.900	1.449	.009	**
MDC	17.700	6.000	23.600	6.186	5.900	1.370	.004	**
MPC	19.200	5.827	22.900	5.130	3.700	2.111	.006	**
PDC	11.200	4.460	14.800	5.266	3.600	1.265	.005	**
PPC	11.800	3.584	14.700	3.093	2.900	1.197	.004	**
I-TP	18.700	4.523	18.000	4.273	−0.700	0.789	.038	*

[a] T1 indicates before treatment; T2, after treatment.
*$P < .05$; **$P < .01$.

ilar to other investigations evaluating intraoral molar distalization. On the other hand, Keles and Sayinsu[27] and Keles et al[28] advocated bodily tooth movement. The between-group differences revealed a significant alteration for the variable Up6a/FH and showed less distal tipping of the molar in the passive side of CHG-RP group. The variables describing the extrusion of the molars increased significantly in both groups, and no statistically significance was found between the groups. Extrusion of molars is in accordance with Greenspan[6] and Baalack and Poulsen[4] but conflicts with Ringenberg and Butts.[8]

In the evaluation of the basilar radiographs, it was found that rotation of the molars was statistically significant in both groups. Rotation was more in the AHG group, but the between-group differences were statis-

TABLE 5. Descriptive Statistics of Skeletal/Dental Measurements of Lateral Cephalometric Radiographs at T1, T2, and T2 − T1 for the Cervical Headgear with Removable Plate Group

	T1		T2		T2 − T1			
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	*P*	Significance
y-axis	60.700	2.057	61.900	2.183	1.200	1.619	.039	*
SN/PP	8.100	2.807	9.900	2.807	1.800	1.398	.010	**
SN/MP	33.800	4.158	36.100	3.784	2.300	1.159	.007	**
SN/Occ	16.600	3.950	17.600	4.005	1.000	0.943	.023	*
N-Me	124.500	5.558	127.200	4.984	2.700	1.946	.005	**
ANS-Me	71.500	3.628	73.300	3.129	1.800	1.135	.007	**
S-Go	79.200	3.994	80.600	3.688	1.400	0.966	.010	**
Ud6a/FH	84.200	3.824	72.200	6.015	−12.000	3.399	.005	**
Up6a/FH	80.900	4.358	77.600	4.088	−3.300	1.059	.004	**
U5a/FH	87.300	3.683	84.100	3.755	−3.200	1.619	.005	**
U1a/SN	102.000	3.393	98.500	3.659	−1.700	1.337	.011	*
Ud6-Ptv	27.600	3.565	21.000	3.464	−6.600	1.776	.004	**
Up6-Ptv	25.100	4.557	22.800	4.442	−2.300	0.949	.005	**
U5-Ptv	28.000	4.136	26.000	3.682	−2.000	1.414	.007	**
U1i-Ptv	56.400	4.142	55.000	3.830	−1.400	1.265	.016	*
Ud6o-FH	51.300	4.448	52.500	4.428	1.200	0.919	.014	*
Up6o-FH	50.300	3.713	51.100	3.604	0.800	0.919	.033	*
U5o-FH	52.600	3.718	53.500	3.026	0.900	1.025	.033	*
U1i-FH	56.200	4.185	57.400	3.777	1.200	1.135	.016	*

[a] T1 indicates before treatment; T2, after treatment.
*$P < .05$; **$P < .01$.

TABLE 6. Descriptive Statistics of Measurements of Basilar Radiographs at T1, T2, and T2 − T1 for the Cervical Headgear with Removable Plate Group[a]

	T1		T2		T2 − T1			
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	*P*	Significance
MADD-MSR	30.000	2.828	32.900	2.885	2.900	1.663	.005	**
MAPD-MSR	30.200	5.095	32.100	5.152	1.900	1.287	.006	**
MADD-MAPD	60.900	7.031	64.100	7.280	3.200	1.813	.007	**
MADD-TP	33.300	7.009	36.700	7.469	3.400	1.075	.005	**
MAPD-TP	34.700	7.364	37.900	7.430	3.200	0.919	.004	**
MBD-DPD/MSR	34.700	3.917	38.500	5.039	3.800	1.813	.005	**
MBP-DPP/MSR	37.900	4.630	40.100	4.999	1.200	0.789	.004	**
PVD-PPD/MSR	71.600	4.427	74.800	5.493	3.200	2.936	.018	*
PVP-PPP/MSR	69.800	9.414	73.300	10.155	3.500	1.650	.005	**
MDC-MSR	26.900	1.912	28.100	1.969	1.200	0.789	.010	**
MPC-MSR	28.300	3.498	28.800	3.425	0.500	0.527	.025	*
MDC-MPC	55.000	4.082	57.000	3.528	2.000	0.943	.004	**
PDC-MSR	23.600	1.897	24.800	1.476	1.200	0.789	.010	**
PPC-MSR	24.600	3.470	26.000	3.197	1.400	1.174	.017	*
MDC-TP	16.800	3.881	22.700	3.945	5.900	1.287	.005	**
MPC-TP	16.400	4.222	18.800	3.706	2.400	1.265	.004	**
PDC-TP	9.000	4.163	13.300	4.084	4.300	1.418	.005	**
PPC-TP	9.900	3.928	11.500	3.240	1.600	1.430	.017	*
I-TP	22.000	4.190	20.600	3.835	−1.400	0.843	.006	**

[a] T1 indicates before treatment; T2, after treatment.
*$P < .05$; **$P < .01$.

tically insignificant. Although the acrylic plate reduced the rotation of the molars to a degree, it could not prevent it completely. Contrary to our findings, Carano and Testa[25] advocated no rotational alterations. Because of the molar rotations, intermolar width showed statistically significant increases in both groups.

When the alterations in the upper bicuspids were evaluated, a significant distal movement, extrusion, and distopalatal rotation were observed in both groups. When the groups were compared, more distalization and distal tipping were found in AHG group. The ball loop and the acrylic were believed to be the

TABLE 7. Comparison of the Between-Group Differences at the End of Distalization[a]

	AHG, T2 − T1		CHG-RP, T2 − T1			
	$\bar{x}$	SD	$\bar{x}$	SD	*P*	Significance
Up6a/FH	−7.800	2.573	−3.300	1.059	.040	*
U5a/FH	−7.900	3.784	−3.200	1.619	.002	**
Up6-Ptv	−4.100	0.994	−2.300	0.949	.040	*
U5-Ptv	−3.400	0.843	−2.000	1.414	.017	*
U5o-FH	2.900	1.595	0.900	1.025	.030	*
I-TP	−0.700	0.789	−1.400	0.843	.006	**

[a] T1 indicates before treatment; T2, after treatment; AHG, assymmetric headgear; and CHG-RP, cervical headgear with removable plate.

$^{*}P < .05$; $^{**}P < .01$.

reason for the decreased distal movement in the CHG-RP. Jones and White[22] and Ucem et al[26] also found distal tipping and distalization in the premolars. Extrusion of the bicuspids was also found in the studies of Ghosh and Nanda[33] and Keles and Sayinsu.[27] However, mesial tipping of the upper bicuspids was observed in most of the intraoral molar distalization techniques because they were used as anchor teeth.

The variables evaluating the effect of the extraoral distalization force on the incisors showed statistically significant alterations. The incisor retrusion was in accordance with the findings of other investigators who used extraoral forces. The proclination of the anterior teeth was reported by several authors who used intraoral molar distalization methods.[22–25] The differences among groups were also statistically significant for these variables. The palatal tipping of the anterior teeth was more in the CHG-RP group. The reason may be the removable plate that transferred the force to the anterior region through the labial arch. Extrusion of the anterior teeth was observed in both groups, which was in accordance with the findings of other investigations.[6,21] Soft tissue changes were not significant in both groups.

CONCLUSIONS

- The unilateral distalization of the maxillary molars was achieved effectively in both groups.
- In the AHG group, the maxillary first molars on the passive and the second premolars on the distalization side were distalized more than those in the CHG-RP group.
- Incisor retrusion was more significant with CHG-RP combination.
- Palatal, occlusal, and mandibular plane angles and anterior and posterior face height were increased in both groups.

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