Effects of different vectors of forces applied by combined headgear

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The effects of various directed forces applied by combined headgear were evaluated in this study. The study material consisted of 30 patients with Class II dental relationships and steep mandibular plane angles. Three groups of 10 patients each were formed. In the first treatment group, forces of 150 gm per side were used for the high-pull component and the cervical component. In the second treatment group, forces of 200 gm per side for the high-pull component and 100 gm per side for the cervical component were applied. In the third treatment group, forces of 100 gm per side were applied for the high-pull component and 200 gm per side for the cervical component. Distal tipping of upper molar was greatest in the third treatment group. Intrusion of the upper molar in the second treatment group and extrusion of the upper molar in the third treatment group were statistically significant. Changes in occlusal and mandibular plane angles showed significant differences between the groups. (Am J Orthod Dentofacial Orthop 1998;113:316-23.)

In the treatment of Class II malocclusions, extraoral force to the maxillary denture has been used to distalize upper molars or to restrict the forward migration of the maxillary denture.[1-5] These forces are more understandable when represented by vectors. It is possible to determine a resultant vector from two or more forces with a common point of application on a tooth. In addition, this resultant force can be resolved into the components parallel and perpendicular to the tooth axis in order to determine the magnitude of force in each of these directions.[6,7] Combined headgear that used different vectors produced by cervical and high-pull headgear are based on this basic physics principle.

It seems apparent that there is an optimum direction for the application of extraoral force. Generally, molars that have been tipped back during distalization relapse to the original position in a very short time unless occlusal forces upright the teeth. A direction of pull through the center of resistance is needed to move the upper molars' bodily.[1,7] Some researchers showed that with cervical headgear application, the line of force causes an extrusion of the upper molars and an undesirable opening of the mandible.[1,8,9] Lindgren and Lagerström[10] reported that extrusion did not occur with outer arms bent downward 15°. Baumrind et al.[11,12] stated that mandibular plane angle did not show any significant difference as a result of the increase in ramus height. On the contrary, occipital traction (the method of choice for patients with open bite tendencies) seems less capable of affecting maxillary structures in anteroposterior direction than cervical traction.[13,14]

Therefore the cervical and high-pull headgears were not efficient enough in the treatment of Class II malocclusion cases with high mandibular plane angles. The expected resultant force vectors obtained by combined headgear might eliminate the disadvantages of these appliances. The purpose of this study was to evaluate the effects of different vectors of forces applied by combined headgear.

MATERIAL AND METHODS

The study material consisted of 30 patients with Class II dental relationship and steep mandibular plane angle. All patients were matched according to their ANB and SN/GoGn angles, so three groups were constructed with 10 patients in each group. Pretreatment values showed no significant difference between the groups (Table I). All of the patients stayed with the study. At the beginning of the treatment, the mean ages were 10 years 10 months for the first group, 10 years 4 months for the second group, and 10 years 6 months for the third group. No control subjects are considered in this article because the main purpose of this study is to compare the treatment effects of different force vectors.

All the patients were treated only with extraoral combined traction to the maxillary first molars. Stainless steel wires (0.9) were soldered on molar bands in order to determine the angulation easily.

In the first treatment group (1:1), a force of 150 gm per side was adjusted for the high-pull component and a

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Table I. Comparison of pretreatment values among groups

Variable	Treatment group 1 n = 10 (1:1) X	Treatment group 1 n = 10 (1:1) Sx	Treatment group 2 n = 10 (2:1) X	Treatment group 2 n = 10 (2:1) Sx	Treatment group 3 n = 10 (1:2) X	Treatment group 3 n = 10 (1:2) Sx	p	1-2	1-3	2-3
1. SNA	76.1	0.97	78.5	0.89	77.9	0.95	0.183			
2. SNB	70.8	0.96	72.9	0.87	72.4	0.77	0.211			
3. ANB	5.4	0.49	5.4	0.49	5.6	0.42	0.937			
4. SN/Go-Gn	41.3	0.98	40.9	0.89	41.4	1.02	0.932			
5. MP/N-Ar	57.2	0.83	56.7	1.22	56.9	1.2	0.959			
6. SN-OP	21.4	1.17	21.1	1.12	22.9	0.94	0.442			
7. *6*/ANSPNS∘	75.5	2.08	76.4	0.74	79.8	0.95	0.083			
8. *6* ⊥ANSPNS mm	22.5	0.38	21.8	0.52	21.9	0.66	0.634			
9. *6*/MP°	83.7	2.1	86.2	1.45	85.4	1.72	0.615			
10. *6* ⊥MP mm	30.1	0.64	29.9	0.4	31.7	0.82	0.133			
11. R6BP	72.9	3.97	71.7	3.1	67.8	2.38	0.509			
12. L6BP	76.4	3.04	72.9	3.38	71.4	2.08	0.458			
13. R6MD	90.1	5.04	89.9	6.18	96.7	5.15	0.613			
14. L6MD	86.2	3.57	96.5	4.9	95.3	5.09	0.234			
15. T6	47.7	0.68	49.9	0.98	50.1	1.02	0.067			
16. T3	33.1	1.12	30.9	0.69	34.1	0.99	0.071			
17. Chronological age	10.9	0.34	10.3	0.28	10.5	0.32	0.441			

force of 150 gm per side for the cervical component. In the second treatment group (2:1), a force adjustment of 200 gm per side was made for the high-pull component and 100 gm per side for the cervical component, and in the third treatment group (1:2), a force of 100 gm per side was adjusted for the high-pull component and 200 gm per side for the cervical component. The inner bow of the headgear was not expanded. The patients were instructed to wear the appliance 20 hours each day until the molar relationship was corrected. The treatment time was between 2 and 9 months for the first group, 3 and 7 months for the second group, and 2 and 7 months for the third group.

Lateral cephalograms and anteroposterior and basilar radiographs were taken before and after treatment. All angular measurements were read to the nearest 0.5°, and all linear measurements were read to the nearest 0.5 mm by standard protractor and scale, respectively. All measurements were obtained by hand.

Thirty lateral cephalometric, 30 anteroposterior, and 30 basilar radiographs were retraced and recalculated. Method error coefficients were calculated according to these values (Table II).[15] All coefficients were within acceptable limits.

The following eight angular measurements were obtained from lateral cephalograms: SNA angle *(1)*, SNB angle *(2)*, ANB angle *(3)*, SN/Go-Gn *(4)*, MP/N-Ar *(5)*, SN/OP *(6)*, upper molar ANS-PNS *(7)*, lower molar/MP *(9)*. The two linear measurements recorded were upper molar ANS-PNS *(8)*, lower molar MP *(10)* (Fig. 1). The measurements obtained from posteroanterior radiographs were R6BP *(11)* and L6BP *(12)* (Fig. 2). The measurements obtained from basilar radiographs were R6MD *(13)*, L6MD *(14)*, T6 *(15)*, T3 *(16)* (Fig. 3).

Table II. Method error coefficients

Variable	r
1. SNA	0.99
2. SNB	0.99
3. ANB	0.99
4. SN/Go-Gn	0.97
5. MP/N-Ar	0.99
6. SN-⊥OP	0.99
7. *6*/ANSPNS°	0.99
8. *6* ⊥ANSPNS mm	0.99
9. *6*/MP°	0.99
10. *6* ⊥MP mm	0.99
11. R6BP	0.99
12. L6BP	0.99
13. R6MD	0.99
14. L6MD	0.99
15. T6	0.99
16. T3	0.99
18. *6*C (∘-*)x	0.99
19. *6*C (∘-*)y	0.99
20. *6*C (*-•)x	0.99
21. *6*C (*-•)y	0.99
22. *6*C (∘-•)x	0.99
23. *6*C (∘-•)y	0.99
24. *6*A (∘-*)x	0.99
25. *6*A (∘-*)y	0.99
26. *6*A (*-•)x	0.99
27. *6*A (*-•)y	0.99
28. *6*A (∘-*)x	0.99
29. *6*A (∘-*)y	0.99

Superimposition

To differentiate orthodontic and orthopedic effects, the tracings of lateral cephalograms obtained before and after the treatment were superimposed on the best fit of palatal structures. Upper molar cusp and apex were transferred from the tracing of the pretreatment radio-

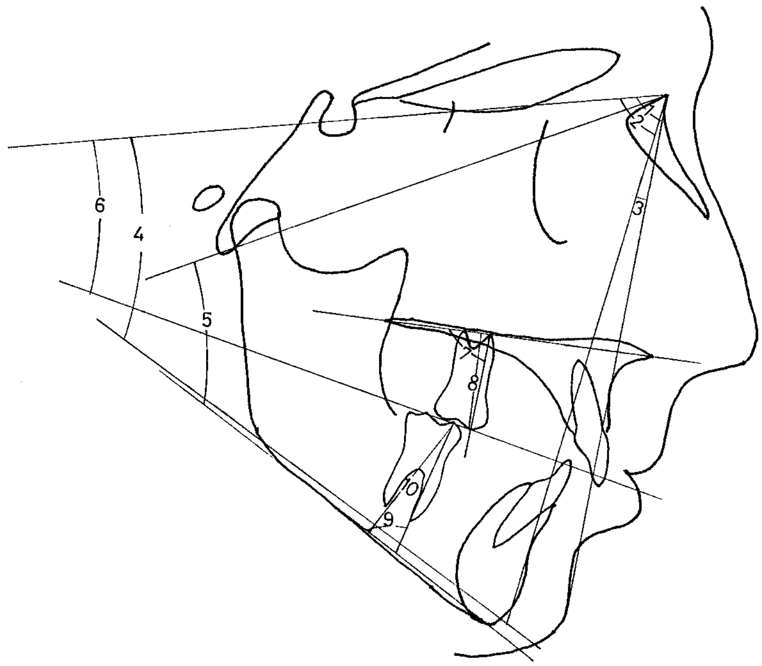

Fig. 1. Cephalometric tracing illustrates eight angular and two linear measurements (see text).

graph onto the tracing of the posttreatment radiograph. The posttreatment positions of the landmarks were marked by black dots (·), the pretreatment positions were marked by asterisks (*) (Fig. 4). Next this tracing and the tracing of the pretreatment radiograph were superimposed on the best fit of anterior cranial base. The pretreatment positions of the landmarks were transferred onto the first superimposition and marked by white dots (◦). The occlusal plane of the first film was used as the horizontal axis, and the pretreatment landmarks were accepted as the origin of the coordinate system. The distance between the white dots and the asterisks represents orthopedic displacement. The distance between the asterisks and the black dots represents orthodontic displacement. The distance between the white dots and the black dots represents total displacement; x represents horizontal displacement, y represents vertical displacement (Fig. 4).

A paired *t* test was used to determine the differences of mean changes within each treatment group. For the comparison of the differences between the groups, variance analysis and Duncan tests were used.

RESULTS

Changes Through the Treatment (Tables III, IV, and V)

There was a significant decrease in ANB angle in all groups. SNB angle showed a significant increase in the first (1:1) and the second (2:1) treatment groups. The decrease in SN/GoGn was found statistically significant in the second treatment group (2:1).

SN/OP increased significantly in the second treatment group (2:1) and decreased significantly in the third treatment group (1:2). The upper molar/ANS-PNS angle decreased significantly in the third treatment group (1:2). In the first (1:1) and the second (2:1) treatment groups, the upper molar/ANS-PNS (mm) showed a statistically significant decrease. In the third treatment group (1:2), the same variable showed a statistically significant increase. There was a significant increase in lower molar MP (mm) in the first treatment group (1:1).

The decrease of R6BP in the first treatment group (1:1) and L6BP in the third treatment group (1:2) was found statistically significant. The R6MD and L6MD angles increased significantly in the second treatment group (2:1). T3 showed a statistically significant increase in all groups.

Comparison Between the Groups (Table VI)

The decrease in SN/GoGn angle in the second treatment group (2:1) showed significant difference compared with the others, and MP/N-Ar exhibited a statistically significant difference between the second (2:1) and the third (1:2) treatment group.

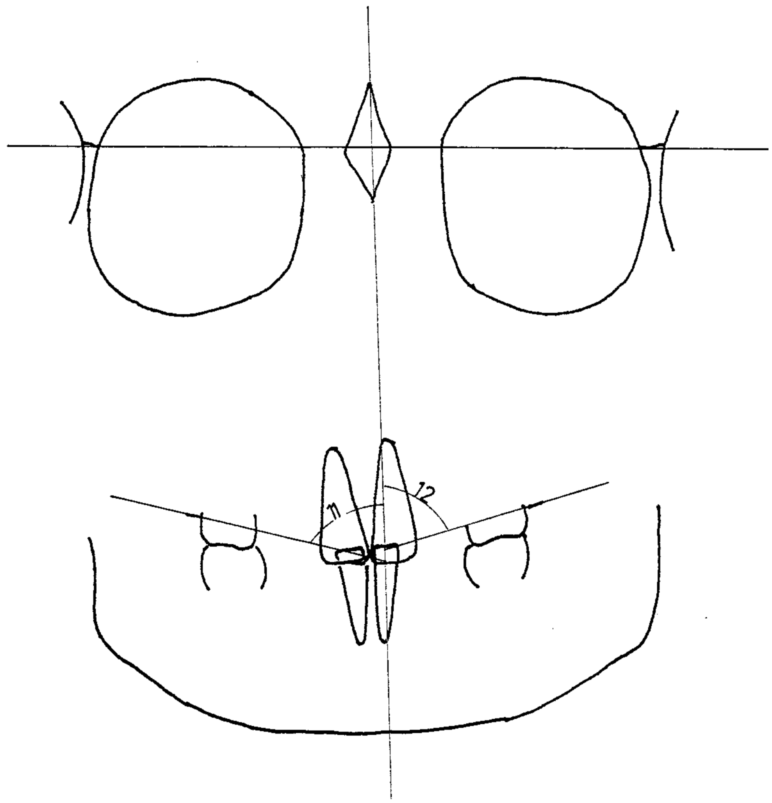

Fig. 2. Posteroanterior cephalometric tracing shows R6BP (*11*, right upper molar buccopalatinal tipping) and L6BP (*12*, left upper molar buccopalatinal tipping).

The differences between the first (1:1) and the third (1:2) treatment groups were statistically significant for SN/OP, upper molar/ANS-PNS∘, upper molar⊥ANS-PNS mm, and T3. The differences between the second (2:1) and the third (1:2) treatment groups were statistically significant for SN/OP, upper molar/ANS-PNS∘, upper molar⊥ANS-PNS mm, lower molar/MP∘, and T3. The increase of lower molar/MP∘ in the first treatment group (1:1) was statistically significant compared with the decrease in the second treatment group (2:1).

Vertical orthopedic displacement of upper molar cusp (*6* C[∘-∗]y) and apex (*6* A[∘-∗]y) showed a statistically significant difference between the first (1:1) and the third (1:2) treatment groups. Downward orthodontic (*6* C[∗-·]y) (*6* A[∗-·]y) and total (*6* C[∘-·]y) (*6*A[∘-·]y) displacement of the upper molar cusp and apex in the third treatment group (1:2) exhibited a statistically significant difference compared with the first (1:1) and the second (2:1) treatment groups (Table VII). Forward orthodontic (*6* A[∗-·]x) and total (*6*A[∘-·]x) displacement of upper molar apex in the third treatment group (1:2) showed significant difference compared with the other groups (Table VII).

DISCUSSION

This study showed that the maxilla is displaced backward only in the third treatment group (1:2). Several investigators[16-18] found a posterior repositioning of point A by cervical headgear application. Because in all groups the mandible was displaced forward by growth, the decrease in ANB angle showed no significant difference between the groups. This finding of this study agrees with those of O'Reilly et al.[19] and Boecler[4] who studied different types of headgears. However, Brown[13] stated that cervical headgear was more effective in reducing ANB than high-pull headgear.

Evaluation of superimpositions showed that the upper first molar was distalized 3.6 to 4.0 mm. It was obvious that upper molar distalization had a great role at the correction of molar relation in all groups.

Baumrind et al.[3] stated that orthodontic horizontal displacement of the upper molar was greater in high-pull headgear group than cervical headgear group. Contrary in an experimental study it was reported that the least distalization was observed by high-pull headgear application.[10] In the present study, the amount of sagittal displacement of the

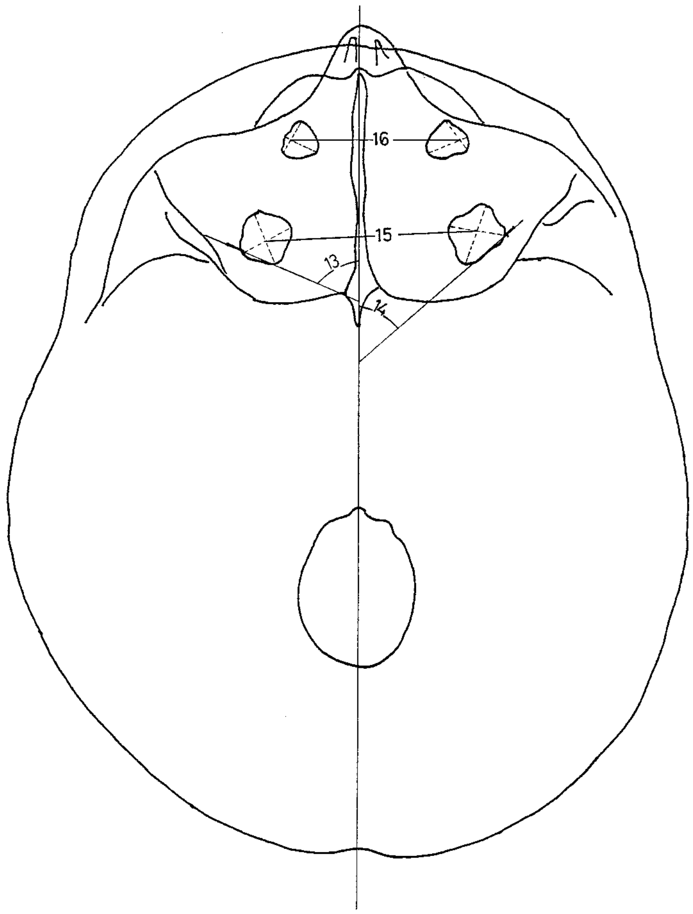

Fig. 3. Basilar cephalometric tracing shows R6MD (*13*, right upper molar mesiodistal tipping) L6MD (*14*, left upper molar mesiodistal tipping), T6 (*15*, intermolar width), and T3 (*16*, intercanine width).

Table III. Changes in first treatment group (1:1)

Variable	*Pretreatment*		*Posttreatment*		*p*
	X1	*Sx*	*X2*	*Sx*	
1. SNA	76.1	0.97	76.2	1.03	0.770
2. SNB	70.8	0.96	71.8	1.05	0.025*
3. ANB	5.4	0.49	4.4	0.56	0.000‡
4. SN/Go-Gn	41.3	0.98	41.3	1.33	1.000
5. MP/N-Ar	57.2	0.83	56.9	1.12	0.460
6. SN-OP	21.4	1.17	22.7	1.09	0.160
7. *6*/ANSPNS°	75.5	2.08	68.6	2.07	0.002†
8. *6* ⊥ANSPNS mm	22.5	0.38	21.6	0.50	0.028*
9. *6*/MP°	83.7	2.10	85.0	1.95	0.082
10. *6* ⊥MP mm	30.1	0.64	31.0	0.54	0.024*
11. R6BP	72.9	3.97	68.2	4.06	0.013*
12. L6BP	76.4	3.04	73.2	3.18	0.083
13. R6MD	90.1	5.04	91.2	5.05	0.290
14. L6MD	86.2	3.57	86.9	3.85	0.270
15. T6	47.7	0.68	48.6	0.69	0.100
16. T3	33.1	1.12	34.2	1.14	0.004†
17. Chronological age	10.9	0.34	11.3	0.35	0.000‡

*$p < 0.05$.
†$p < 0.01$.
‡$p < 0.001$.

Table IV. Changes in second treatment group (2:1)

Variable	*Pretreatment*		*Posttreatment*		*p*
	X	*Sx*	*X*	*Sx*	
1. SNA	78.5	0.89	78.8	0.85	0.480
2. SNB	72.9	0.87	73.8	0.74	0.028*
3. ANB	5.4	0.49	5.0	0.42	0.008†
4. SN/Go-Gn	40.9	0.89	39.2	0.97	0.002**
5. MP/N-Ar	56.7	1.22	55.5	1.39	0.081
6. SN-OP	21.1	1.12	22.1	1.19	0.007†
7. 6/ANSPNS°	76.4	0.74	72.8	0.84	0.050
8. *6* ⊥ANSPNS mm	21.8	0.52	20.4	0.59	0.000‡
9. *6*/MP°	86.2	1.45	85.3	1.52	0.210
10. *6* ⊥MP mm	29.9	0.40	30.4	0.43	0.210
11. R6BP	71.7	3.10	70.0	3.54	0.460
12. L6BP	72.9	3.38	71.0	3.64	0.200
13. R6MD	89.9	6.18	94.5	5.27	0.024*
14. L6MD	96.5	4.90	98.8	4.95	0.041*
15. T6	49.9	0.98	50.5	1.02	0.500
16. T3	30.9	0.69	31.9	0.77	0.037*
17. Chronological age	10.3	0.28	10.7	0.31	0.000‡

*$p < 0.05$.
†$p < 0.01$.
‡$p < 0.001$.

Table V. Changes in third treatment group (1:2)

Variable	*Pretreatment*		*Posttreatment*		*p*
	X1	*Sx*	*X2*	*Sx*	
1. SNA	77.9	0.95	77.5	1.02	0.110
2. SNB	72.4	0.77	72.6	0.75	0.140
3. ANB	5.6	0.42	4.9	0.48	0.016*
4. SN/Go-Gn	41.4	1.02	41.9	1.11	0.063
5. MP/N-Ar	56.9	1.20	57.4	1.37	0.095
6. SN-OP	22.9	0.94	20.7	1.05	0.000‡
7. *6*/ANSPNS°	79.8	0.95	63.7	1.57	0.000‡
8. *6* ⊥ANSPNS mm	21.9	0.66	23.2	0.77	0.000‡
9. *6*/MP°	85.4	1.72	86.8	1.71	0.110
10. *6* ⊥MP mm	31.7	0.82	31.6	0.93	0.850
11. R6BP	67.8	2.38	64.7	2.50	0.210
12. L6BP	71.4	2.08	67.4	2.38	0.003†
13. R6MD	96.7	5.15	98.8	5.38	0.280
14. L6MD	95.3	5.09	98.4	4.91	0.076
15. T6	50.1	1.02	50.4	1.29	0.680
16. T3	34.1	0.99	36.7	0.74	0.001†
17. Chronological age	10.5	0.32	10.9	0.31	0.000‡

*$p < 0.05$.
†$p < 0.01$.
‡$p < 0.001$.

upper molars showed no significant difference between the groups.

However, changes in the direction of pull were effective on the degree of upper first molar tipping and vertical displacement. The decrease in the angulation of the upper molar and mesial displacement of the upper molar apex in the third treatment group (1:2) were significantly different compared with other groups. This is in accord with the findings of Baumrind et al.[3] In addition, Badell[2] found a 10.6° distal tipping with combined headgear treatment. Although a slight distal tipping was observed in the second treatment group, it seems that this force system was more convenient for bodily movement.

Extrusion of the upper molar in the third treatment group (1:2) was similar to the findings of cervical headgear investigations.[1,20-22] This was expected because the downward component of force was greater in the third treatment group (1:2). Intrusion of the upper molars in the first (1:1) and second (2:1) treatment groups was in accord with the findings of some studies on high-pull headgear treatment.[3,13,23]

Occlusal plane inclination was increased in the first (1:1) and second (2:1) treatment groups. It was found statistically significant only in the second treatment group (2:1). This finding is similar to that reported by Badell[2] on combined headgear and Watson[24] on high-pull headgear. In the 1:2 force system with a more downward force component, the occlusal plane angle showed a significant decrease. Burke and Jacobson[25] stated that either posterior maxillary dentoalveolar development was stimulated with cervically directed forces or posterior maxillary dentoalveolar development was inhibited

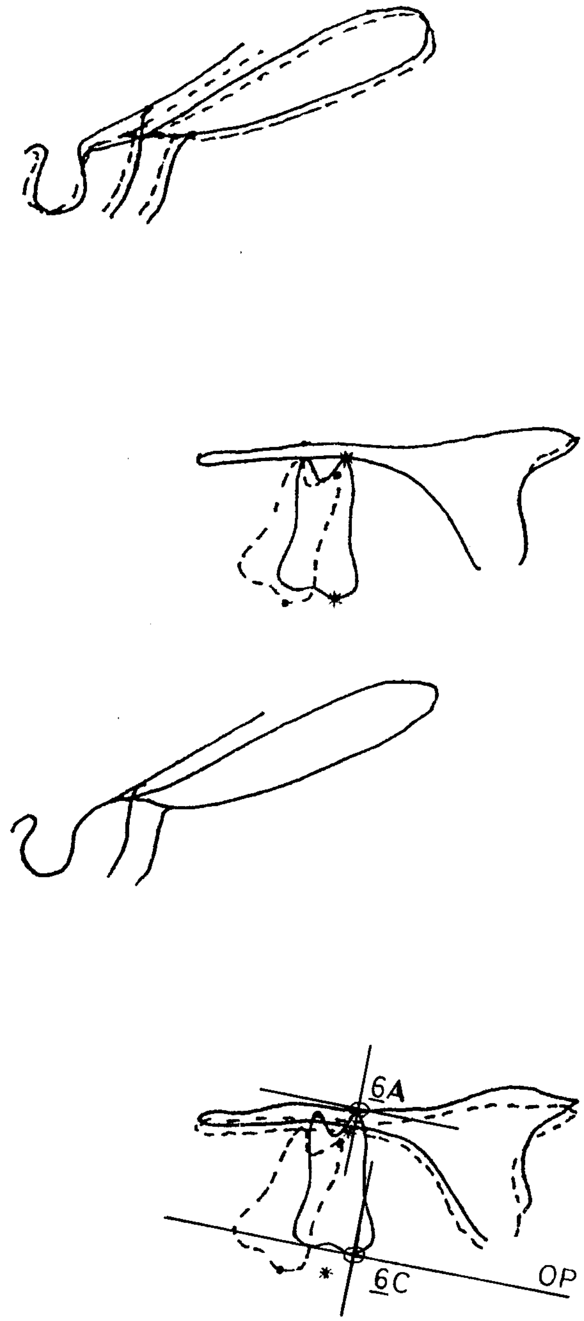

Fig. 4. (*Top*) Superimposition of pretreatment and posttreatment tracings on best fit of palatal structures. (*Bottom*) Superimposition of pretreatment tracing and first superimposition on best fit of anterior cranial base.

Table VI. Comparison of changes among groups

	Treatment group 1 n = 10 (1:1)		Treatment group 2 (n = 10 (2:1)		Treatment group 3 n = 10 (1:2)		p	1-2	1-3	2-3
Variable	D	SD	D	SD	D	SD				
1. SNA	0.1	0.33	0.3	0.34	−0.5	0.25	0.258			
2. SNB	1.1	0.39	0.9	0.33	0.2	0.15	0.178			
3. ANB	−1.1	0.22	−0.6	0.18	−0.7	0.24	0.307			
4. SN/Go-Gn	0.0	0.51	−1.8	0.40	0.5	0.24	0.001	†		†
5. MP/N-Ar	−0.3	0.39	−1.2	0.61	0.5	0.24	0.044			*
6. SN-OP	1.3	0.85	1.0	0.29	−2.3	0.44	0.006		†	†
7. 6/ANSPNS°	−6.9	1.61	−3.6	0.99	−16.1	1.87	0.001		†	†
8. 6 ⊥ANSPNS mm	−0.9	0.33	−1.4	0.27	1.3	0.17	0.001		†	†
9. 6/MP°	1.3	0.64	−0.9	0.66	1.4	0.78	0.048	*		*
10. 6 ⊥MP mm	0.9	0.33	0.5	0.34	−0.1	0.26	0.118			
11. R6BP	−4.8	1.56	−1.7	2.16	−3.1	2.31	0.556			
12. L6BP	−3.2	1.64	−2.0	1.41	−4.0	0.99	0.588			
13. R6MD	1.1	0.93	4.6	1.68	2.1	1.82	0.269			
14. L6MD	0.7	0.59	2.3	0.97	3.1	1.55	0.311			
15. T6	0.9	0.46	0.6	0.85	0.4	0.82	0.891			
16. T3	1.1	0.30	1.0	0.41	2.6	0.54	0.003		†	†
17. Chronological age	0.4	0.06	0.4	0.04	0.4	0.04	0.888			

*$p < 0.05$.
†$p < 0.01$.

Table VII. Comparison of changes among groups in cephalometric superimpositions

	Treatment group 1 n = 10 (1:1)		Treatment group 2 n = 10 (2:1)		Treatment Group 3 n = 10 (1:2)		p	1-2	1-3	2-3
Variable	D	SD	D	SD	D	SD				
1. 6C (◦-*)x	−0.4	0.44	0.0	0.21	−0.2	0.36	0.724			
2. 6C (◦-*)y	0.2	0.24	0.0	0.17	−0.5	0.16	0.032		*	
3. 6C (*-•)x	−3.2	0.36	−3.6	0.46	−3.8	0.65	0.701			
4. 6C (*-•)y	0.5	0.35	1.2	0.15	−1.5	0.17	0.001		†	†
5. 6C (◦-•)x	−3.6	0.55	−3.6	0.46	−4.0	0.60	0.813			
6. 6C (◦-•)y	0.7	0.51	1.2	0.22	−2.1	0.23	0.001		†	†
7. 6A (◦-*)x	0.0	0.24	0.1	0.22	0.1	0.38	0.961			
8. 6A (◦-*)y	0.1	0.21	0.0	0.15	−0.6	0.15	0.009		†	
9. 6A (*-•)x	−0.6	0.33	−1.5	0.26	2.2	0.34	0.001		†	†
10. 6A (*-•)y	0.1	0.21	0.7	0.13	−1.2	0.21	0.001		†	†
11. 6A (◦-•)x	−0.6	0.35	−1.4	0.31	2.3	0.41	0.001		†	†
12. 6A (◦-•)y	0.2	0.28	0.7	0.17	−1.9	0.23	0.001		†	†

*$p < 0.05$.
†$p < 0.01$.

with occipitally directed forces. Possibly a combination of two phenomena was responsible for the changes that occurred in the SN/OP angle. This opinion may account for the difference between the third treatment group (1:2) and the other groups.

Baumrind et al.[26] stated that the mandibular plane angle remained unchanged because of a significant increase in the ramus height as a result of the cervical headgear therapy. The nonsignificant increase of the ramus height observed in the third treatment group (1:2) could be responsible for the nonsignificant change in the MP angle. Though some authors[24,27] showed decrease in mandibular plane angle with high-pull headgear therapy, Thames et al.[28] reported molar extrusion and mandibular plane angle increase. But it must be pointed out that they used Class ll elastics during treatment. Badell[4] showed 0.8° increase in the mandibular plane angle during combined headgear treatment. In the second treatment group (2:1), a 1.8° decrease in the SN/Go-Gn angle was found to be statistically significant. The MP/N-Ar angle also showed a nonsignificant decrease. When the changes between the groups were compared, the SN/Go-Gn angle showed a significant decrease in the second treatment group (2:1). A significant difference was found between the second (2:1) and third (1:2) treatment groups for the MP/N-Ar angle. These findings were in accord with several authors[9,13,24,27,29,30] who studied different type of headgears. In some studies it was reported that there was no significant difference between cervical, high-pull, and combined headgear therapy.[4,12,31] Different vertical growth directions, treatment time, and therapies combined with fixed appliances could explain the differences between the findings.

There were some statistically significant differences in the buccopalatinal and mesiodistal position of the upper molars in some of the groups; possibly because of the buccal position of the force application point. However, changes in the force direction did not cause significant differences between the groups. Mitani and Brodie[32] showed an increase in the intercanine width by cervical headgear therapy. In the present study, an increase for this variable was also observed in all groups. Because the amount of distalization in the third treatment group (1:2) was greater, there was significantly greater increase in intercanine width in this group compared with others.

CONCLUSIONS

1. Mandibular plane angle showed a significant decrease in the second treatment group (2:1) when compared with the third (1:2) treatment group.
2. The occlusal plane inclination in the first (1:1) and second (2:1) treatment groups showed a significant increase when compared with the third (1:2) treatment group.
3. Distal tipping of the upper molar observed in the third treatment group (1:2) was significantly greater than other groups.

It is still valuable to evaluate occlusal plane, mandibular plane, and vertical differences observed at the upper molar when considering treatment choices. It was obvious that for the patients showing vertical growth tendencies, occipitally directed forces applied by combined headgear were more convenient compared with the other types of force systems used in this study. However, the short treatment time of this study and possible occlusal premature contacts as a result of upper molar tipping makes a long-term evaluation necessary.

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