Original Article

Treatment Effects of Twin-Block and Mandibular Protraction Appliance-IV in the Correction of Class II Malocclusion

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ABSTRACT

Objective: To evaluate the treatment effects of twin-block and Mandibular Protraction Appliance-IV (MPA-IV) in the treatment of Class II division 1 malocclusion.

Methods: Fifty North Indian girls with Class II division 1 malocclusion, in the age range of 9–13 years, were chosen. The subjects were divided among a control group (n = 10), a twin-block group (n = 25), and an MPA group (n = 15). Pre–follow-up and post–follow-up lateral cephalograms of control subjects and pretreatment and posttreatment lateral cephalograms of the treatment subjects were traced manually and subjected to a pitchfork analysis.

Results: Neither twin-block nor MPA-IV significantly restricted the forward growth of maxilla. Mandibular growth and improvement in the sagittal skeletal relation were significantly greater in the twin-block subjects. Distal movement of the maxillary dentition and mesial movement of the mandibular dentition were more prominent in the MPA-IV subjects. Molar correction and overjet reductions were significantly greater in the treatment subjects ($P < .001$).

Conclusion: Twin-block and MPA-IV were effective in correcting the molar relationships and reducing the overjet in Class II division 1 malocclusion subjects. However, twin-block contributed more skeletal effects than MPA-IV for the correction of Class II malocclusion. (*Angle Orthod.* 2010;80:485–491.)

KEY WORDS: Treatment effects; Twin-block; MPA; Class II malocclusion

INTRODUCTION

The goal of functional appliance therapy is to encourage or to redirect the growth in a favorable direction. Several functional appliances are presented in the literature for the correction of Class II division 1 malocclusion. The major differences in the effects between various orthopedic appliances are mainly related to the technique of fabrication, construction bites, and hours of wear. Among various removable and fixed functional appliances, the twin-block and Herbst appliance, respectively, are most efficient in correcting a Class II malocclusion.[1] Moreover, removable appliances are considered uncomfortable and unesthetic by many patients and require patient compliance. Consequently, a primary advantage of fixed functional appliances is independence from the need for patient cooperation.

For advancement of the mandible along with multibonded fixed appliances, various clinicians have designed many fixed functional appliances.[2–7] The mandibular protraction appliance (MPA) is a recently developed noncompliant rigid fixed functional appliance that holds the mandible anteriorly and corrects the Class II anteroposterior discrepancy.[3–6] The MPA-IV is the latest version of an MPA and has many advantages over its three previous versions and also over other fixed functional appliances.[6] Although few case reports[3–6] and a single study[8] are in the literature mentioning the nature of Class II correction with MPA-I, II, and III, there is not a single study mentioning the effects of MPA-IV. Thus, the present study was designed to evaluate the treatment effects of MPA-IV and to compare its effects with those of one of the most popular removable functional appliances, the twin-block appliance, in the treatment of Class II division 1 malocclusion.

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Accepted: August 2009. Submitted: June 2009.

MATERIALS AND METHODS

The subjects for the control and twin-block groups were selected from the Orthodontic Department, Centre for Dental Education and Research, All India Institute of Medical Sciences, New Delhi, India, and subjects for the MPA group were chosen from the Orthodontic Department, RAMA Dental College, Kanpur, India. A total 50 North Indian girls in the age range of 9–12 years were included in the study. Each included subject met the following selection criteria:

- Class II division 1 malocclusion with normal maxilla and retrognathic mandible
- Angle's Class II molar relationship bilaterally
- FMA in the range of 20–25 degrees
- Minimal or no crowding or spacing in either arch
- Overjet of 6–10 mm

Each subject in the control and twin-block groups was either in the late mixed dentition or the early permanent dentition stage, but all subjects in the MPA group were in the early permanent dentition stage. Subjects with a history of orthodontic treatment, anterior open bite, severe proclination of anterior teeth, or any systemic disease affecting bone and general growth were excluded from the study.

The control group comprised 10 subjects; they received no treatment but were followed until the end of the study. The twin-block group comprised 25 subjects, and the remaining 15 subjects comprised the MPA group.

The subjects of the twin-block group were treated with a standard twin-block appliance. Single-step mandibular advancement was carried out during the waxbite registration. An edge-to-edge incisor relationship with a 2- to 3-mm bite opening between the central incisors was maintained for all of the subjects. The patients were instructed to wear the appliance 24 hours/day, especially during mealtimes. All of the subjects were followed once every 4 weeks until the end of active appliance therapy. Interocclusal acrylic was trimmed in all of the subjects, and the labial bow was kept passive during the treatment. Appliance use was discontinued when overjet and overbite were reduced to 1–2 mm. Duration of appliance therapy varied greatly depending on the level of patient cooperation.

All subjects in the MPA-IV group were treated with preadjusted edgewise appliance (Roth prescription, 0.022″). Both of the arches were leveled up to 0.021″ × 0.025″ stainless steel archwire, and then the MPA-IV was ligated for mandibular advancement. The mandible was advanced to an edge-to-edge incisor position. All subjects were reviewed at 4-week intervals for a period of approximately 6 months, when the MPA-IV was removed and the occlusion finished with the same multibonded appliance.

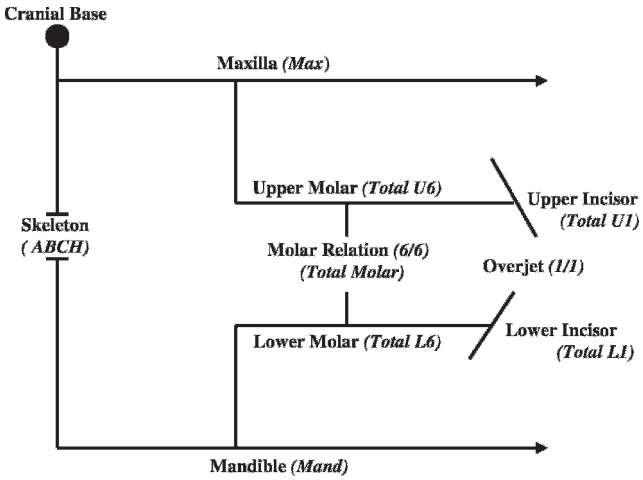

Figure 1. The Pitchfork diagram. Cranial base indicates base of the cranium; maxilla, maxillary change in relation to the cranial base; mandible, mandibular change in relation to the cranial base; ABCH, antero-posterior change in the relationship between maxilla and mandible; total U6, total upper molar movement; total L6, total lower molar movement; total molar, ABCH + total U6 + total L6, the change in molar relationship; total U1, total upper incisor movement; total L1, total lower incisor movement; overjet, ABCH + total U1 + total L1, the change in incisor relationship.

In the control subjects, lateral cephalograms were obtained at the beginning and end of the observation period. In the twin-block subjects, lateral cephalograms were obtained before the start of treatment and at the end of active twin-block therapy. In MPA-IV subjects, the lateral cephalograms recorded before ligation of MPA-IV and immediately after removal of MPA-IV were considered for analysis.

For evaluation of skeletal and dentoalveolar changes that contributed to the Class II correction, pitchfork analysis[9] was used. Measurements are defined as positive if they contribute to Class II correction and negative if they aggravate the Class II relationship. The pitchfork diagram is shown in Figure 1. All measurements of changes were measured manually using an electronic digital caliper.

Statistical Method

A master file was created, and the data were statistically analyzed on a computer with SPSS software. The data were subjected to descriptive analysis for mean, standard deviation, and 95% confidence interval for the mean of all variables. One-way analysis of variance and the Student-Newman-Keuls test for multiple comparisons were used. A *P* value of .05 was considered statistically significant.

RESULTS

The mean age of the subjects at the beginning of the study and the duration of the study are described in

Table 1. Mean Ages and Duration of Study Among Control, Twin-Block, and MPA Groups[a]

	Control Group (n = 10)	Twin-Block Group (n = 25)	MPA Group (n = 15)
	Mean ± SD	Mean ± SD	Mean ± SD
Age at the start of treatment, y	10.97 ± 0.46	11.40 ± 0.90	11.28 ± 0.52
Duration of study, mo	16.37 ± 0.94	13.18 ± 3.17	6.08 ± 0.61

[a] MPA indicates mandibular protraction appliance.

Table 1. The results of all of the measurements in the pitchfork analysis are shown in Table 2 and Figures 2 to 4. Positive values are those that contributed to the correction of the Class II malocclusion, and negative values are those that aggravated the Class II relationship.

Various skeletal changes among the subjects of control, twin-block, and MPA groups are shown in Table 2 and Figure 5. The mean forward movement of the maxilla was comparable among the three groups. The mandibular position change was significantly greater in twin-block subjects ($P < .01$) and was comparable between control and MPA-IV subjects. The ABCH was significantly greater in the twin-block subjects than in the control subjects ($P < .001$) and MPA-IV subjects ($P < .01$).

All dentoalveolar changes are shown in Table 2 and Figure 6. The movement of the U6 was significantly different among the three groups ($P < .001$). The forward movement of the L6 was significantly greater in the treatment subjects ($P < .001$) but was comparable between the two treatment groups. Molar correction was significantly greater ($P < .001$) in the treatment groups. The palatal movements of U1 and the labial movement of L1 were significantly greater ($P < .001$) in the treatment subjects. The movement of L1 in the MPA-IV subjects was greater than in the twin-block subjects ($P < .05$). The overjet correction was significantly greater in the treatment subjects ($P < .001$). In twin-block subjects, ABCH contributed the maximum for molar correction and overjet reduction. In MPA-IV subjects, movement of U6 and L6 and movement U1 and L1 contributed to a greater extent to molar correction and overjet reduction, respectively.

DISCUSSION

The result of the present study showed that the forward growth of maxilla was slightly less in treated subjects than in controls. When the mandible was postured forward by the functional appliances, a reciprocal force acted distally on the maxilla and restricted its forward growth. Many previous studies also reported restriction in the forward growth of maxilla by twin-block,[10–14] by other mandibular protraction appliances,[8] and also by many other functional appliances.[10,12,15] However, few studies reported no restraint effect in the forward movement of maxilla by the removable[16,17] and fixed functional appliances.[7,18] Thus, the design of the appliance was not a major factor in the headgear effect of functional appliance therapy.

Lengthening of the mandible by functional appliance therapy is one of the major controversies in orthodontics. Many authors claimed extra mandibular growth by various removable[10,11,14,19,20] and fixed functional appliances.[7,21] We found 1.98 mm extra mandibular growth in the twin-block subjects compared with the control subjects. Many authors also reported significant extra mandibular growth with twin-block appliance.[10,11,14,22] We observed only 0.31 mm extra mandibular growth in MPA-IV subjects. The MPA-IV delivered an anterior force component on the mandible through the dental arch rather than skeletal base and thus resulted in minimal extra mandibular growth. Siqueira et al[8] also reported no extra mandibular growth with other MPAs. Also, many previous studies reported no extra mandibular growth with other fixed functional appliances.[23–25] The ABCH value represents the maxillomandibular differential. A positive value indicates the mandible outgrew the maxilla, and a negative value means that the maxilla outgrew the mandible. In our study, the outgrowth of the mandible was significantly greater in the twin-block subjects, whereas the orthopedic action of the MPA-IV was mostly due to the restriction in the forward growth of maxilla. This observation was in agreement with the results of many previous stud-

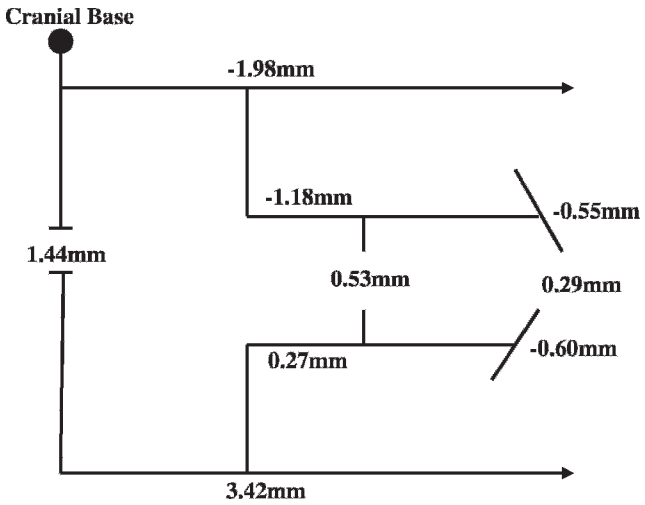

Figure 2. Pitchfork changes in the control group.

Table 2. Treatment Changes for All Measurements Among Control, Twin-Block, and MPA Groups[a]

	Control Group (n = 10)		Twin-Block Group (n = 25)		MPA Group (n = 15)			Intergroup Comparison		
Parameter	Mean ± SD	95% CI for Mean	Mean ± SD	95% CI for Mean	Mean ± SD	95% CI for Mean	*P* Value	C-TB	C-MPA	TB-MPA
Maxilla	−1.98 ± 0.60	−2.41 to −1.55	−1.33 ± 1.77	−2.07 to −0.60	−1.46 ± 0.87	−1.95 to −0.98	.462	NS	NS	NS
Mandible	3.42 ± 0.57	3.02 to 3.83	5.40 ± 1.78	4.66 to 6.14	3.73 ± 1.30	3.00 to 4.45	.000	**	NS	**
ABCH	1.44 ± 0.43	1.07 to 1.69	4.07 ± 1.53	3.05 to 4.32	2.26 ± 1.01	1.70 to 2.82	.000	***	NS	**
Total U6 (U6)	−1.18 ± 0.53	−1.56 to −0.80	0.07 ± 1.21	−0.43 to 0.57	1.72 ± 0.49	1.45 to 2.00	.000	***	***	***
Total L6 (L6)	0.27 ± 1.05	−0.48 to 1.02	1.46 ± 1.26	0.93 to 1.98	1.89 ± 0.36	1.69 to 2.10	.001	**	***	NS
Molar correction	0.53 ± 0.80	−.09 to 1.04	5.60 ± 1.78	4.63 to 6.10	5.87 ± 1.00	5.38 to 6.49	.000	***	***	NS
Total U1 (U1)	−0.55 ± 0.51	−0.92 to −0.18	1.45 ± 1.33	0.90 to 2.00	1.72 ± 0.49	1.45 to 2.00	.000	***	***	NS
Total L1 (L1)	−0.60 ± 0.24	−0.77 to −0.43	1.27 ± 0.96	0.87 to 1.67	1.89 ± 0.36	1.69 to 2.10	.000	***	***	*
Overjet	0.29 ± 0.71	−0.28 to 0.74	6.79 ± 1.71	5.74 to 7.15	5.87 ± 1.00	5.38 to 6.49	.000	***	***	NS

[a] C indicates control group; TB, twin-block group; MPA, mandibular protraction appliance group; NS, nonsignificant.
* $P < .05$; ** $P < .01$; *** $P < .001$.

ies.[7,8,15,18,21,23] Thus, the twin-block was more efficient than MPA-IV in correcting the maxillomandibular skeletal relationship in Class II subjects.

Distal movement of the maxillary molars (U6) and mesial movement of the mandibular molars (L6), as the maxilla moves forward, are ideal conditions for the correction of a Class II molar relationship. We observed that the twin-block restricted forward movement of the U6. Tumor and Gultan[26] also made a similar observation. Many studies, however, reported distal movement of U6 with the twin-block appliance[10,16] and the headgear effect caused relative distal movement during treatment.[11] The primary change with the mandibular protraction appliances consisted of distal movement of the maxillary dentoalveolar process.[3–6,8] The distal movement was because the reciprocal force acted distally on the maxillary dental arch when the mandible was postured forward by the appliance. Siqueira et al[8] also reported distal movement of the maxillary molars with the MPAs. Thus, the present study showed that the twin-block was effective in restraining the forward movement of maxillary molars whereas MPA-IV caused distal movement of the maxillary molars. The greater forward movement of the L6 in the treatment subjects was a major factor contributing to the Class II molar correction. In twin-block subjects, Mills and McCulloch[11] reported more mesial eruption of the mandibular molars. Lund and Sandler[27] noted substantial (2.4 mm) forward movement of L6 compared with the controls (0.1 mm), whereas Toth and McNamara[10] found equal forward movement of L6 in the twin-block and control groups. The significantly greater mesial movement of the L6 in MPA-IV subjects was because of the mesial vector of force by the appliance when it postured the mandible forward. However, in contrast to our study, Siqueira et al[8] reported slightly more mesial movement of the L6 with other MPAs. The molar correction in the control subjects was only 0.53 mm. Thus, in untreated sub-

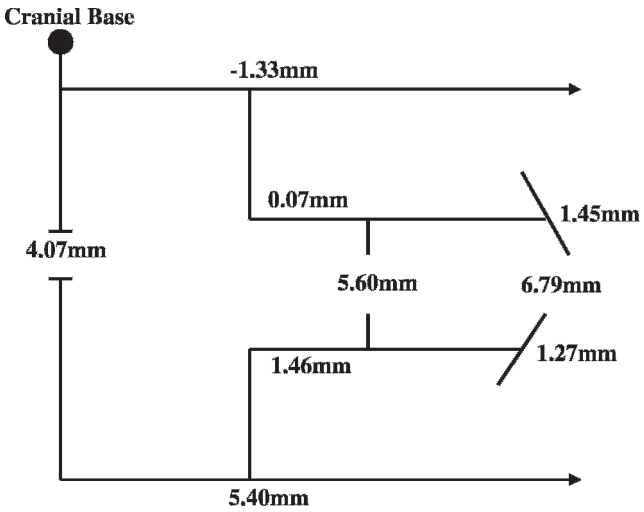

Figure 3. Pitchfork changes in the twin-block group.

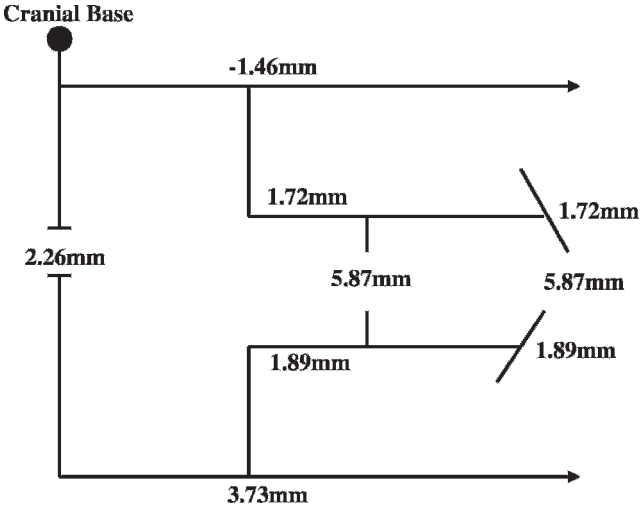

Figure 4. Pitchfork changes in the mandibular protraction appliance group.

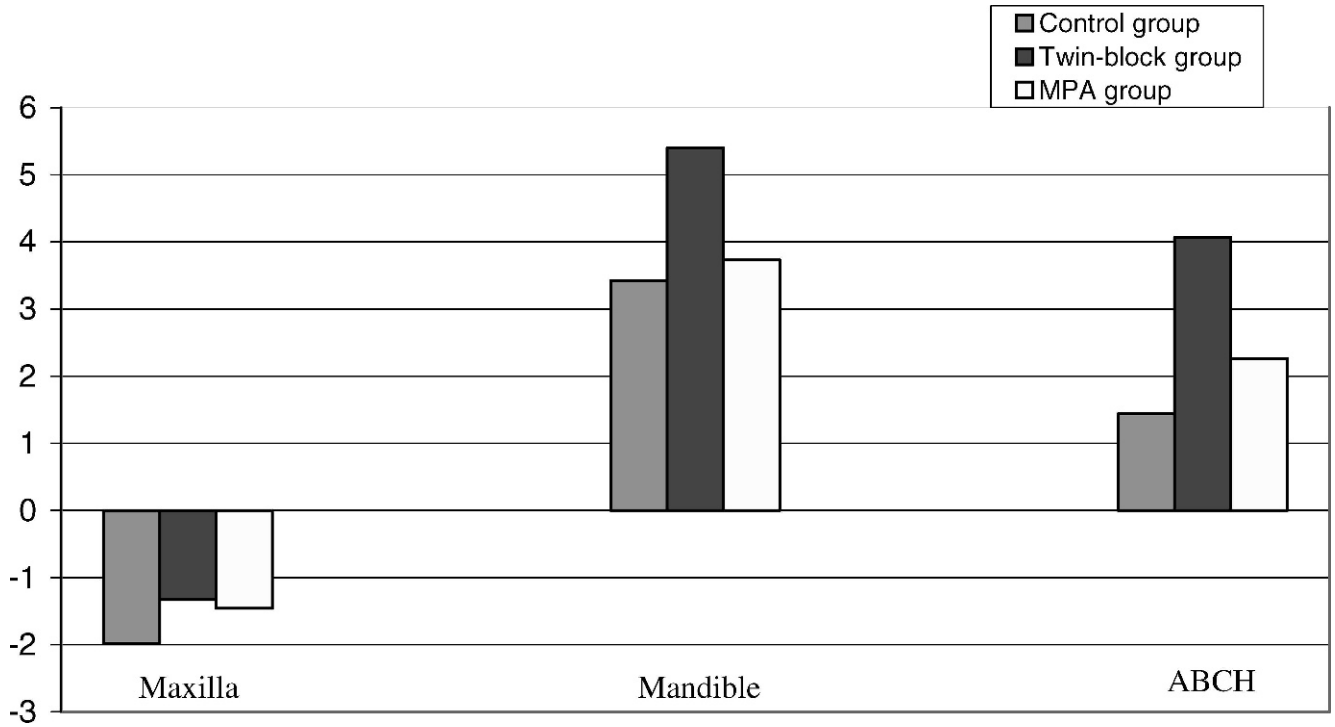

Figure 5. Comparison of skeletal changes among the three groups.

jects, although mandibular growth was greater than maxillary growth, dentoalveolar compensation appeared to have kept the buccal segment relationship fairly static. The molar correction in the twin-block subjects was largely due to the mandible outgrowing the maxilla, whereas in MPA subjects, the molar correction was largely due to the movements of molars rather than ABCH. In the present study, 72.67% and 38.50% of the molar correction was contributed by skeletal change in the twin-block and MPA-IV subjects, respectively. O'Brien et al[13] found only a 41% skeletal contribution to molar correction with the twin-block appliance. Thus, the present study showed that the skeletal contribution of MPA-IV in the correction of the Class II molar relationship was less than that by twin-block appliance, and rapid dentoalveolar changes contributed to molar correction in a short period of treatment time.

Retroclination of the maxillary incisors (U1) and proclination of mandibular incisors (L1) are a widely accepted consensus with various functional appliances.* In our study, the retroclination of U1 in the twin-block subjects could be due to the so-called headgear effect of the labial bow appliance. Toth and McNamara[10] concluded that lingual tipping of the U1 was due to the contact of lip musculature during twin-block treatment. This lingual tipping could also be due to the labial wire in the appliance, which might come into contact with the incisors during sleep, causing them to retract.[28] Lund and Sandler[27] achieved significant U1 retraction using a maxillary labial bow, in contrast to Mills and McCulloch,[11] who did not use a labial bow and found little change in U1 position. The palatal movement of the U1 in MPA-IV subjects was due to the reciprocal force that acted distally on the maxillary dental arch. In contrast to our finding, Siqueira et al[8] reported much more palatal movement of the U1 with other MPAs. Thus, the present study showed that the palatal movement of the U1 by MPA-IV was greater as compared with the twin-block appliance but was smaller as comparison with other MPAs.[8] The most prominent dentoalveolar effect in treatment subjects was proclination of mandibular incisors. This could be due to the mesial force on the L1 induced by the forward posture of the mandible. This finding was in accordance with the effects of other functional appliances.[8,10,17,18,21,29] We found lingual movement of the L1 in the control subjects. Such uprighting of the L1 was due to the restraining effect of the lower lip.[14] Many previous studies also reported uprighting of the L1 in the untreated Class II control subjects.[7,23] The change in overjet is the total change in incisor relationship and is the algebraic sum of the ABCH + total U1 + total L1. As a result of treatment, overjet was decreased significantly in both appliance groups. In twin-block subjects, additional mandibular growth was the major factor contributing to overjet correction. Mills and McCulloch[11] reported that 50% of overjet correction was due to skeletal changes with the twin-block appliance. However, O'Brien et al[30] reported

* *References 7, 8, 10, 13, 15, 17, 21, 23, 26, 27.*

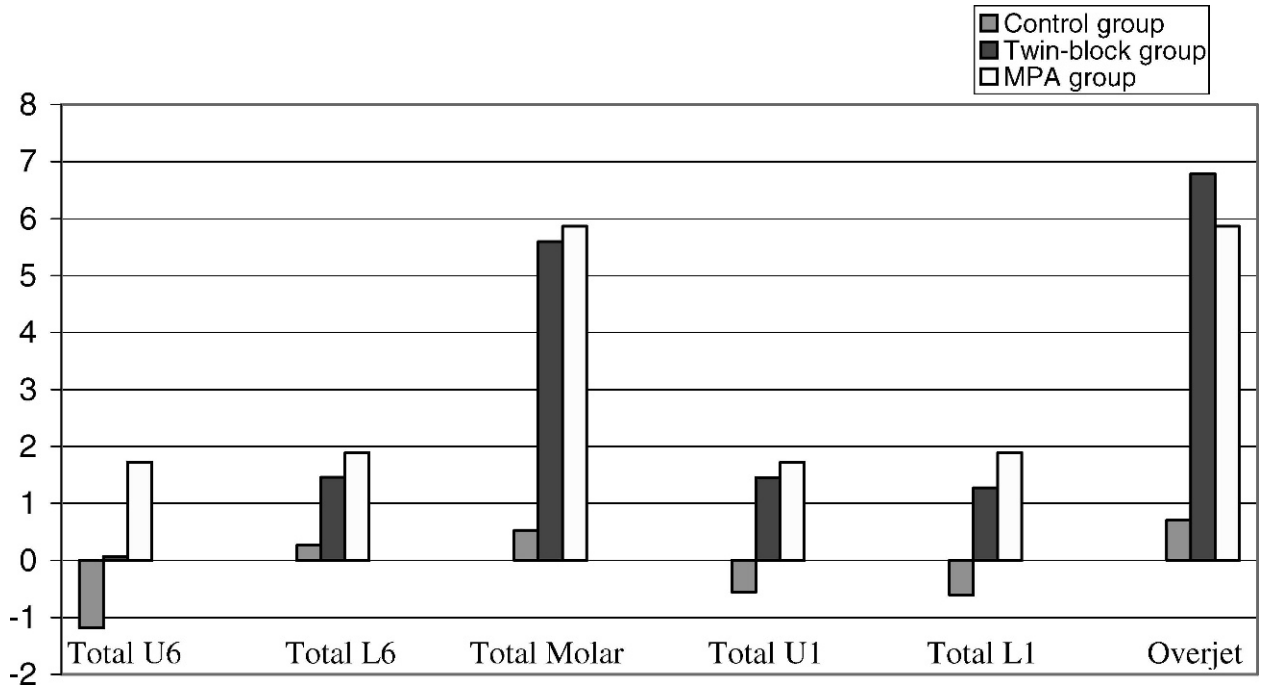

Figure 6. Comparison of dental changes among three groups.

only 27% skeletal change in overjet correction. However, in our study, 59.94% skeletal change was contributed by the overjet correction in the twin-block subjects. The amount of overjet correction with MPA-IV was similar to the overjet correction by other MPAs[8] and Herbst appliances.[21] The combined movements of U1 and L1 contributed more than the ABCH for the overjet correction in the MPA-IV subjects. There was only 38.50% skeletal contribution for the overjet correction in the MPA-IV subjects. Pancherz[21] also reported similar skeletal contribution for overjet correction with Herbst appliance. Thus, the present study showed that the overjet correction with MPA-IV was similar in nature to that of Herbst appliance.

This present study showed that twin-block and MPA-IV were efficient functional appliances in the correction of Class II molar relationship and for the reduction of the overjet in subjects with Class II division 1 malocclusion. The twin-block contributed more skeletal changes for the correction of Class II molar relation and overjet. However, the MPA-IV caused significant effects on the mandibular and maxillary dentoalveolar components that helped in the Class II molar and overjet correction. Thus, subjects who can tolerate greater dentoalveolar compensation for the correction of their Class II malocclusion should be treated with MPA-IV.

CONCLUSIONS

- Neither appliance was efficient in restricting the forward growth of the maxilla.
- Twin-block appliance was more efficient in increasing the extra mandibular length; the extra mandibular growth by MPA-IV was comparable to that in untreated Class II subjects.
- MPA-IV caused distalization of maxillary molars; twin-block restricted the forward movement of the maxillary molars.
- Both appliances produced mesial movement of the mandibular molars.
- Both appliances caused palatal movements of the maxillary incisors; labial movement of the mandibular incisors was greater with MPA-IV.
- Both appliances were effective in molar correction and overjet reduction, but the twin-block had more skeletal contribution than the MPA-IV.

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