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Original Article

Cephalometric comparison of treatment effects of Twin block and Bionator appliance with an untreated Class II sample

ABSTRACT

Objective: Skeletal class II malocclusion is commonly seen in the Indian clinical scenario among the growing population. In the background of newer functional appliances in recent times, Twin block and Bionator still remain widely used in clinical practice. Thus, a prospective clinical trial was designed to study various skeletal and dental effects of these appliances, as well as changes that occur in the control population.

Materials and Methods: A sample size of 30 growing individuals with an age range of 9–14 years, showing class II division 1 malocclusion were selected. They were divided into three groups of 10 patients each, of which 10 were controls and 10 patients each for twin block and bionator groups. The average treatment duration was 6 months. Lateral cephalograms were taken before and after the treatment with functional appliances, and selected parameters were compared.

Results: There were considerable skeletal and dental changes brought about by both the appliances when compared with controls, however, there were no significant differences in changes brought about by both the appliances when compared with each other.

Conclusion: Both Twin block and Bionator appliances can be effectively used for the correction of skeletal class II malocclusion in growing individuals.

Keywords: Bionator, cephalometric, treatment effects, twin block, untreated class II

INTRODUCTION

Class II Division 1 malocclusion is undoubtedly the most frequent clinically encountered skeletal discrepancy, of which, the mandibular skeletal deficiency is the single most common characteristic feature.[1]

Treatment of skeletal class II with the deficient mandible in growing children with functional appliance therapy has gained interest and popularity but generated heated controversies as well over the past three decades. The expected effects of these appliances include alteration of maxillary growth, a possible change in mandibular growth and position, and an improvement in the dental and muscular relationships. It has been claimed that forward growth of maxilla may be either inhibited, redirected downward, or unaffected. Many studies agree that the most significant treatment effects are dentoalveolar rather than skeletal.[1,2]

All the functional appliances that have evolved from the Monobloc share the limitation that the upper and lower

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components are joined together. As a result, the patient cannot eat, speak, or function normally with the appliance in the mouth. The goal in developing newer functional appliances such as Balter's Bionator and Clarks Twin block was to produce a system that is simple, comfortable, and esthetically acceptable to the patient.[3,4]

Many studies have investigated the effect of the Twin block and Bionator appliance on the dental and skeletal variables. However, very few studies have provided a direct comparison of the treatment changes of these appliances as compared to normal growth changes in an untreated Class II sample.

The purpose of the present study was to compare cephalometrically the treatment effects of the Twin block and Bionator appliance on the skeletal and dentoalveolar components. The results of both treatment groups were compared with the untreated Class II sample monitored during a similar period.

MATERIALS AND METHODS

The total sample consisted of 30 subjects with Class II division 1 malocclusion, of which 13 were male and 17 were female in the age range of 9–14 years. The appropriate ethical approval was obtained from the institutional ethics committee before the study was commenced. Procedures followed were in accordance with the ethical standards of the institutional committee and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all the patients. The criteria for case selection were as follows:

1. Each subject had a full cusp Class II or end-on molar relationship bilaterally with a convex facial profile
2. The overjet was not <5 mm
3. VTO improved with anterior positioning of mandible
4. A pretreatment cephalometric analysis revealed an ANB angle of >4° with favorable functional analysis and favorable (horizontal) growth pattern
5. Subjects who were in prepubertal growth spurt (MP3-G stage) were included in the study.

Samples were divided randomly (block method) into treatment groups and the control group. The treatment group consisted of 20 patients with 10 patients (6 males, 4 females) for Twin block appliance and 10 patients (4 males, 6 females) for Bionator appliance therapy. The control group consisted of 10 patients (3 males, 7 females) and was followed along with the treatment group for 6 months. No orthodontic treatment was performed during this period on the control group.

For the Twin block appliance, wax construction bite was taken with the mandible 3 mm distal to the most protrusive position. Vertically, the bite was registered 2–3 mm beyond the postural rest position of the mandible, which opened the mandible 5–7 mm in the molar region.[4] A modification of Twin block appliance described by Clark was used. Angulation given to the inclined plane was 70°. The upper bite block was trimmed for the eruption of the mandibular molar at the first visit after appliance delivery.[4]

The construction bite for Bionator was taken with incisors into the edge-to-edge relationship.[3] The vertical opening was kept 1–2 mm in the incisal region. The standard Bionator given by Balters was used for the study.[3]

Analysis of lateral cephalograms

Lateral cephalograms were taken in centric occlusion before the start of the treatment (T_1) and after 6 months of the completion of treatment (T_2). All the cephalograms were taken using a single machine PLANMECA (PM-2002) with an anode to mid subject distance of 5 feet. The tube voltage used for all the patients was 70 kvp, current 10 mA, and exposure time of 1.8 s.

Linear and angular measurements given by Mills and McCulloch[5] were evaluated for each subject at pretreatment and after 6 months as shown in Figures 1 and 2. A vertical reference plane constructed through sella, perpendicular to the palatal plane, provided a series of horizontal measurements made from various landmarks perpendicular to the vertical reference plane. In addition, vertical measurements were made from the various dental landmarks perpendicular to either palatal plane or mandibular plane.[5]

Statistical analysis

The data were tabulated and analyzed by SPSS software version 16.0, IBM company, USA. Means and standard

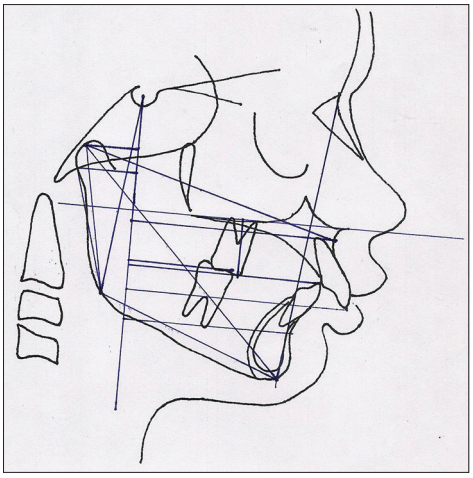

Figure 1: Linear cephalometric measurements

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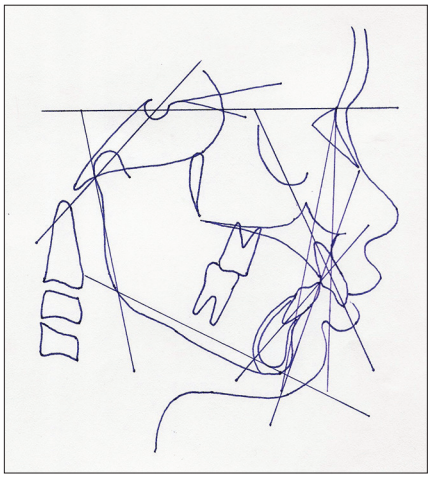

Figure 2: Angular cephalometric measurements

deviations for the three groups were calculated for all cephalometric variables at T1 and T2. Inter-group comparison of variables was made using unpaired *t*-test. Paired *t*-test was used to assess the intra-group difference in the rate of change of the different variables in the treatment group and control group. Significance was determined at the 0.05 and 0.01 levels of confidence.

RESULTS

At the beginning of treatment statistically significant difference was seen for point A to the reference plane, upper incisor to reference plane, lower incisor to reference plane and upper molar to reference plane between the Control and Twin block group and the Control and Bionator group. The comparison between the Control and Twin block groups also showed a statistically significant difference for gonial angle (<Ar-Go-Gn) and mandibular unit length (Co-Gn). B point to the reference plane and lower molar to reference plane showed a statistically significant difference between the Control and Bionator group. Twin block and Bionator group showed no statistically significant difference except for the articular angle, which was significant [Table 1].

With angles SNB and ANB a statistically significant difference was seen between the Control and Twin block group and Control and Bionator group in the posttreatment period after an interval of 6 months. Anterior face height (N-Me) and facial convexity angle showed a statistically significant difference between Control and Twin block group and Control and Bionator group [Tables 2 and 3]. Posterior face height showed a statistically significant difference between Control and Twin block groups. There existed a statistically significant difference in the mandibular plane angle between Control and Bionator group [Table 3].

There existed a statistically significant difference in mandibular unit length, mandibular body length and B point to reference plane between Control and Twin block group and Control and Bionator group. Ramus height showed a statistically significant difference between Control and Twin block groups [Table 3].

Dental changes

Lower incisor to the mandibular plane, upper incisor to SN plane, upper incisor to reference plane, lower incisor to the reference plane, and incisor overjet showed statistically significant difference between Control and Twin block group and Control and Bionator group. Molar overjet, lower molar to reference plane, and lower molar to mandibular plane showed a statistically highly significant difference between Control and Twin block group and Control and Bionator group [Table 3].

DISCUSSION

Class II malocclusion, which is the most common of all malocclusions, can result from many contributing components, both dental and skeletal. Although maxillary protrusion and mandibular retrusion are both found to be possible causative factors, according to McNamara,[1] the most common component in a Class II sample population is mandibular retrusion. For Class II patients in whom the mandible is retrognathic, the ideal means of correction is to target the source and try to alter the amount or direction of growth in that jaw, which is best achieved by functional appliance therapy.

This study was planned to evaluate the effects of two different full time wear functional appliances, i.e., Twin block and Bionator on craniofacial and dentoalveolar structures. Mills and McCulloch[5] cephalometric measurements were used to evaluate and compare the skeletal and dentoalveolar effects of Twin block and Bionator with each other and with the control.

Maxillary skeletal effects

The results of this study reveal a minimal effect on maxillary skeletal structures in the functional appliance groups. Changes in angle SNA, Co to point A and point A to reference plane did not differ among the Twin block, Bionator, and untreated samples. The results did not show any significant headgear effect associated with functional appliance therapy. This conclusion is in agreement with studies of other functional appliances and contradicts the conclusions of other investigators.[6-9]

Mandibular skeletal effects

Measurements of angle SNB showed forward shift of point B by a mean of 2.3° in Twin block group and 2° in the

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Table 1: Pretreatment comparison of the mean values of cephalometric analysis between control, twin block and bionator group

Measurements	X±SD			Comparison		
	Control group (C) (*n*=10)	Twin bloc (T) (*n*=10)	Bionator (B) (*n*=10)	C and T	C and B	T and B
Cranial base measurement						
< N-S-Ar	128.5±7.48	126±4.85	125.5±4.74	NS	NS	NS
< S-Ar-Go	141.6±5.81	136.5±6.29	142.1±7.34	NS	NS	S
< Ar-Go-Gn	119.9±5.46	128.85±5.20	123.8±5.82	S	NS	NS
Anteroposterior skeletal measurements						
< SNA	80.5±3.29	82.85±2.01	83.2±3.38	NS	NS	NS
< SNB	73.4±4.74	76.15±2.92	76.15±3.90	NS	NS	NS
< ANB	7.10±2.25	6.70±1.73	7.05±2.03	NS	NS	NS
Vertical skeletal measurements						
Na-Me (mm)	108.05±4.05	109.3±5.92	110.8±3.18	NS	NS	NS
S-Go (mm)	71.4±4.65	72.35±4.14	74.25±4.98	NS	NS	NS
Maxillary length measurements						
Co- A pt. (mm)	82.65±4.03	88.1±4.7	84.35±4.40	HS	NS	NS
A pt. - ref. pl. (mm)	67.70±3.23	70.45±4.65	70.4±3.39	S	S	NS
Mandibular length measurements						
Co-Gn (mm)	100.05±5.56	107.1±6.74	105.8±6.81	S	NS	NS
Ar-Go (mm)	42.1±3.35	43.1±3.38	44.7±4.32	NS	NS	NS
B pt. to ref. pl. (mm)	53.25±5.33	59.05±8.26	60.1±6.07	NS	S	NS
Incisor measurements						
U1-ref. pl. (mm)	74.8±2.65	78.90±5.4	78.15±3.87	S	S	NS
L1-ref. pl. (mm)	66.0±4.35	69.4±5.36	69.85±4.75	S	S	NS
Incisor overjet (mm)	8.80±2.92	9.50±1.97	8.30±1.58	NS	NS	NS
Molar measurements						
U6 - ref. pl. (mm)	38.6±4.44	41.55±5.33	42.3±3.86	S	S	NS
L6 - ref. pl. (mm)	36.55±4.39	39.4±6.05	40.55±4.45	NS	S	NS
Molar overjet (mm)	2.20±0.75	2.05±1.38	1.75±1.60	NS	NS	NS

SD: Standard deviation, S: Significant, HS: Highly significant, NS: Not significant

Bionator group when compared with the control group. This difference was statistically highly significant. This finding is in accordance with the other twin block studies.[5,10-12] Lange *et al*.[13] and De Almeida *et al*.[14] reported an increase in angle SNB with Bionator therapy.

A statistically significant increase in mandibular length and B point to reference plane compared to the Control group was observed in the Twin block and Bionator group. Similar findings were reported in other studies.[5,6,10,13,15-17]

In our study, mandibular body length (Go-Gn) was increased significantly in the treatment group. The increase in mandibular body length was 1.2 mm in the Twin block group and 1.1 mm in the Bionator group compared to the control group. Mills and McCulloch[5] and Baccetti *et al*.[15] also reported similar findings. Ramus height in the Twin block group (Co-Go and Ar-Go) was significantly increased (1.6 mm and 1.8 mm, respectively) as compared to the control group. Mills and McCulloch[5] reported similar findings noting a significant increase in ramus height with Twin block appliance (Ar-Go 2.5 mm and Co-Go 2.9 mm).

Toth and McNamara[6] found an increase in condylion to gonion distance in the Twin block group. Schaefer *et al*.[17] reported a larger increase in the height of the mandibular ramus in the Twin block group compared to the Herbst group. Ramus height was also increased with other functional appliances.[18,19]

Maxillo-mandibular skeletal effects

The maxillo-mandibular skeletal effects were assessed by angle ANB and facial convexity. A reduction in ANB angle by a mean value of 2.3° in the Twin block and 2.2° in Bionator was observed when compared with the control group. The reduction in the ANB angle was mainly due to an increase in mandibular length (Co-Gn), as no significant restrictive effect on maxilla was seen in both the appliance group.

Mills and McCulloch,[5] Tümer and Gültan,[11] and Schaefer *et al*.[17] reported similar results with the Twin block appliance. Similarly, Lange *et al*.[13] and De Almeida *et al*.[14] found a decrease in the ANB angle with Bionator. Similar findings were found by other authors.[19]

The facial convexity angle was significantly reduced in Twin block (3.6°) and to a lesser extent in bionator (2.8°) compared

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Table 2: Comparison of the mean values of cephalometric analysis between control, twin block and bionator group after 6 months

Measurements	X±SD			Comparison		
	Control group (C) *n*=10	Twin block (T) *n*=10	Bionator (B) *n*=10	C and T	C and B	T and B
Cranial base measurement						
< N-S-Ar	129.25±6.89	125.45±3.93	126.3±4.11	NS	NS	NS
< S-Ar-Go	141.0±5.98	135.75±5.94	142.0±6.59	NS	NS	S
< Ar-Go-Gn	119.5±5.83	125.3±6.49	123.45±5.67	S	NS	NS
Anteroposterior skeletal measurements						
< SNA	80.5±3.14	82.75±2.58	83.05±2.87	NS	NS	NS
< SNB	73.4±4.48	78.4±2.69	78.10±3.18	HS	S	NS
< ANB	7.10±2.17	4.35±1.43	5.15±1.52	HS	S	NS
Vertical skeletal measurements						
Na-Me (mm)	108.2±4.19	111.55±5.72	113.6±4.45	S	S	NS
S-Go (mm)	72.39±4.18	74.9±4.35	75.8±4.20	NS	NS	NS
Maxillary length measurements						
Co- A pt. (mm)	82.8±4.04	88.00±5.09	84.42±4.35	S	NS	NS
A pt. - ref. pl. (mm)	68.15±3.64	71.05±4.43	70.5±3.36	S	S	NS
Mandibular length measurements						
Co-Gn (mm)	100.85±6.04	109.8±7.26	108.75±5.96	HS	HS	NS
Ar-Go (mm)	42.85±3.79	45.65±4.21	46.05±3.45	NS	NS	NS
B pt. to ref. pl. (mm)	53.75±5.72	62.75±7.04	62.1±5.85	HS	HS	NS
Incisor measurements						
U1-ref. pl. (mm)	74.9±3.35	77.20±6.05	76.65±3.71	S	S	NS
L1-ref. pl. (mm)	67.0±4.69	72.25±5.21	72.3±4.08	HS	HS	NS
Incisor overjet (mm)	7.8±2.05	6.15±2.26	4.50±1.90	NS	HS	NS
Molar measurements						
U6 - ref. pl. (mm)	39.55±4.56	42.0±5.42	42.35±3.05	S	S	NS
L6 - ref. pl. (mm)	37.2±4.23	42.8±5.78	43.25±3.6	HS	HS	NS
Molar overjet (mm)	1.75±1.31	−0.5±2.10	−0.85±1.65	S	HS	NS

SD: Standard deviation, S: Significant, HS: Highly significant, NS: Not significant

to the control group. The reduction in facial convexity angle was due to the forward growth of the mandible. Similar findings were reported by other Twin block and Bionator studies.[5,11,13] The effects of other functional appliances showed similar findings.[19]

Vertical effects

Anterior face height increased by 2.15 mm in the Twin block group and 2.55 mm in the bionator group compared to the control group. This difference was statistically significant. Agreement in findings was reported by different authors in their Twin block study.[5,6,8-10] Lange *et al*.,[13] and Bolmgren and Moshiri[20] found an increase in anterior face height with Bionator therapy. Illing *et al*.[16] found a greater increase in anterior face height in the Twin block group than Bionator group.

The result of the present study contradicts those of Baccetti *et al*.[15] who found no change in the anterior face height. De Almeida *et al*.[14] found no statistically significant increase in anterior face height between Bionator and Control group.

Posterior face height was significantly increased in the Twin block group (2.4 mm) compared to the control group. It was not significant when the Bionator group (1.5 mm) was compared to the controls. Mills and McCulloch,[5] reported an increase in posterior face height by 2.9 mm with a Twin block appliance. Schaefer *et al*.[17] reported an increase in posterior face height in the Twin block group. This can be attributed to the Twin block appliance design, which has a greater vertical activation, compared with stainless steel crown Herbst appliance. Baccetti *et al*.[15] reported no change in posterior face height with twin block appliance. An increase in posterior face height with the Bionator appliance was reported in bionator studies.[13,14,20]

Mandibular plane angle (SN-GoGn) was significantly increased in Bionator (1.3°) compared to the controls, but no significant increase was noted in comparison of the Twin block group with the Control group. A comparison between bionator and twin block group showed more opening of the mandibular plane angle with the Bionator group, but this difference was statistically not significant. The opening of the mandibular plane was attributed to an increase in lower posterior dental

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Table 3: Comparison of differences of cephalometric analysis between the three groups before and after 6 months

Measurements	X±SD			Comparison		
	Control group (C) *n*=10	Twin win block (T) *n*=10	Bionator (B) *n*=10	C and T	C and B	T and B
Cranial base measurement						
< N-S-Ar	0.8±1.22	−0.5±2.01	0.8±1.31	NS	NS	NS
< S-Ar-Go	−0.6±1.17	−0.7±1.49	−0.1±2.6	NS	NS	NS
< Ar-Go-Gn	0.6±2.91	1.4±3.09	−0.35±1.49	NS	NS	NS
Anteroposterior skeletal measurements						
< SNA	−0.1±0.73	−0.1±0.31	−0.2±0.91	NS	NS	NS
< SNB	0.1±0.87	2.4±0.84	2.1±1.49	HS	HS	NS
< ANB	−0.1±0.56	−2.4±0.96	−2.3±1.15	HS	HS	NS
Vertical skeletal measurements						
Na-Me (mm)	0.15±1.19	2.3±2.45	2.7±2.11	S	S	NS
S-Go (mm)	1±1.82	2.5±2.12	1.6±1.95	S	NS	NS
Maxillary length measurements						
Co- A pt. (mm)	0.15±1.28	−0.10±2.30	0.07±2.11	NS	NS	NS
A pt. - ref. pl. (mm)	0.4±1.57	0.7±1.33	0.1±1.79	NS	NS	NS
Mandibular length measurements						
Co-Gn (mm)	1.1±1.52	2.80±2.04	2.95±1.47	S	S	NS
Ar-Go (mm)	0.8±2.14	2.6±2.87	1.4±1.77	S	NS	NS
B pt. to ref. pl. (mm)	0.6±1.83	3.6±3.71	2.00±2.10	S	S	NS
Incisor measurements						
U1-ref. pl. (mm)	0.2±2.44	−1.7±1.84	−1.5±2.05	S	S	NS
L1-ref. pl. (mm)	1±11.01	2.8±1.47	2.4±2.01	S	S	NS
Incisor overjet (mm)	−1±2.40	−4.3±2.18	−4.1±2.12	S	S	NS
Molar measurements						
U6 - ref. pl. (mm)	0.9±1.37	0.4±1.26	−0.05±1.56	NS	NS	NS
L6 - ref. pl. (mm)	0.5±1.50	3.4±1.42	2.7±2.26	HS	S	NS
Molar overjet (mm)	−0.5±1.64	−2.6±1.42	−2.58±2.11	HS	HS	NS

SD: Standard deviation, S: Significant, HS: Highly significant, NS: Not significant

height, which resulted in an increase in anterior face height also. The mandibular plane was not increased in the twin block group. Similar results were reported by Mills and McCulloch[5] and Tümer and Gültan[11] in their twin block study.

Dentoalveolar effects

In this study, the lingual tipping of upper incisors was noticed in both the groups relative to the Control group. The lingual tipping was more with Twin block (2.4°) than Bionator (2.0°) when compared to the Control group. A similar finding was reported by Illing *et al*.[16] They found a reduction in upper incisor proclination greatest in the Twin block group than the Bionator group and the least with Bass appliance group. Other Twin block studies reported similar findings.[5,8,9] De Almeida *et al*.,[14] and Bolmgren and Moshiri[20] reported retroclination of upper incisors with Bionator therapy. According to Tümer and Gültan[11] in the monoblock group, upper incisors demonstrated a greater degree of retrusion. However, within the twin-block group, the lower incisors showed a greater degree of proclination.

Proclination of lower incisors was statistically highly significant in both the treatment groups compared to the control group. It was more in the Twin block group (2.5°) than the Bionator group (1.4°) but was not statistically significant between these 2 groups.

In the similar Twin block study, Mills and MCulloch[5] found 3.8° increase relative to control group, Lund and Sandler[10] found 7.9° increase, while Toth and McNamara[6] found 2.8° increase in proclination of lower incisors relative to control groups. Illing *et al*.[16] reported increase in proclination of the lower incisor more in the Bionator group compared to Twin block group. These observations were corroborated by other functional appliance studies.[18,19]

The results contradict with the study done by Trenouth[12] who found no significant lower incisor proclination with modified Twin block appliance with Southend clasp in lower incisor. Similarly, Bolmgren and Moshiri[20] found no significant proclination of lower incisors with Bionator appliance incisor capping.

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In the present study, overjet was significantly reduced in both the treatment groups compared to Controls. The overjet reduction was 3.3 mm with the Twin block group and 3.1 mm with the Bionator group. This reduction in overjet was a combination of upper incisor lingual tipping, proclination of lower incisors, and correction of the dental base relationship. These findings match the study done by Illing *et al*.[16] Similarly, Mills and McCulloch,[5] Trenouth,[12] and Baccetti *et al*.[15] found a reduction of overjet with Twin block both due to skeletal and dentoalveolar correction.

The upper first molars showed no significant change in both the treatment groups compared to the control group. The vertical eruption of the upper molar was not significantly affected by Twin block and bionator therapy. Similar findings were reported by Mills and McCulloch[5] with Twin block and Bolmgren and Moshiri[20] with Bionator.

Lower molars moved mesially 3.4 mm in the Twin block group and 2.7 mm in the Bionator group. Similar findings were reported in other studies.[5,10,11]

The molar overjet correction in both groups was significant. It was corrected by 2.6 mm in the Twin block and 2.58 mm in Bionator group. Baccetti *et al*.[15] and Mills and McCulloch[5] reported remarkable correction in molar relation with Twin block.

Lower molars erupted 1.8 mm in the Twin block and 1.6 mm in the Bionator group. It was statistically significant compared to the Control group. The eruption of lower molar was due to the trimming of the appliances during treatment.

Mills and McCulloch[5] reported that lower molar erupted on an average 4 times as much in Twin block group as in the Control. Lund and Sandler[10] found mean differences of 0.9 mm in lower molar eruption in Twin block group compared to Control group. Toth and McNamara[6] reported vertical eruption of lower molars greater in Twin block than Frankel groups.

Both the Twin block and Bionator were equally effective in correcting molar relationships and reducing overjet. They did not differ significantly in the dentoalveolar effects.[21,22] However, Spalj *et al*. reported that the Twin block appliance showed predominantly dentoalveolar changes.[23]

On the contrary, in normative growth, growth of the mandible was found to involve an upward and forward rotation, a result of posterior vertical growth exceeding anterior vertical growth. The mandibular plane angle decreased 1.1° during the age period of 14–20 years, suggesting a tendency for a closing rotation of the mandible. The mandibular growth rate was found to be twice as large for the age period 14–16 years as for the age period 16–20 years. Lower incisors were found to tip lingually with increasing age, which could be a probable contributory factor to late incisor mandibular crowding.[24]

CONCLUSION

There was no significant difference in the control group for 6 months. Statistically significant differences were seen in the twin block and Bionator group as compared to the control group, particularly in ANB angle, mandibular body length, and facial convexity. Reduction in ANB angle and angle of facial convexity, increase in mandibular unit length, and body length was seen in both the appliances as compared to control group.

Comparison of Twin block and Bionator groups showed an increase in the mandibular plane angle in the Bionator group, and the overjet correction was predominantly dentoalveolar in this group. Both Bionator and Twin block appliances were effective in the correction of skeletal class II malocclusion, but skeletal effects were more with Twin block appliance however, the difference was statistically insignificant.

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There are no conflicts of interest.

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