Dentoskeletal effects of Twin Block appliance in patients with Class II malocclusion

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Abstract

Background and aim. Class II malocclusions are most commonly seen in orthodontic practice and in the recent times Twin Block appliance has been the most popular and widely used among removable functional appliances for the correction of Class II malocclusion in growing patients. The aim of this retrospective study was to evaluate the dentoskeletal effects produced by the Twin Block appliance for the correction of Class II division 1 malocclusion with retrognathic mandible.

Methods. Pre-treatment (T1) and post-treatment (T2) lateral cephalograms of 30 patients treated with Twin Block appliance (mean age = 10.8 ± 1.2 years) for the correction of class II division 1 malocclusion were compared with the 30 untreated class II control patients (mean age 11.2 ± 0.8 years) who did not undergo any treatment during this period. Both the groups were evaluated for the dentoskeletal changes using 24 angular and linear cephalometric measurements. The differences between the pre and post-treatment were calculated using a paired t-test.

Results. The cephalometric analysis revealed that the Twin Block appliance stimulated mandibular growth and statistically significant differences were found between the two groups. Twin Block patients showed a statistically very high significant (p<0.001) increase in mandibular length (6.02 mm) compared with the control group (0.3 mm). “Headgear effect” on the maxilla, increase in lower anterior facial height, significant reduction of overjet, overbite and Class I molar relationship were achieved in the Twin Block group. However, no significant changes appeared in the control group.

Conclusion. The results of the present study conclude that the Twin Block appliance is effective in the treatment of Class II malocclusion and this is due to a combination of skeletal and dentoalveolar changes in both the arches.

Keywords: Twin Block, Class II division 1 malocclusion, functional appliances, dentoskeletal effect, cephalometry

Introduction

Class II malocclusions are most commonly seen in orthodontic practice; they may be either skeletal or dental, presenting with different clinical manifestations. Globally, an approximate estimation shows over 20% prevalence of Class II malocclusion in North America, Europe and North Africa [1]. In 1981, McNamara study found that 60% of the Class II malocclusion occurred in children having retrognathic mandible [2]. The goal of the present-day orthodontic treatment is to attain optimal facial esthetics in addition to normal dental occlusion. This is achievable only if the underlying jaw bases are in harmony with each other.

Functional appliances have been in use from many years; several varieties of removable functional appliances like Activator, Bionator, Frankel, and Twin Block are used for the correction of Class II malocclusions [3]. The primary objective of using these functional appliances is to
modify or redirect mandibular growth to correct a skeletal discrepancy [4].

Multiple evidence-based studies of functional appliances have reported the varying degrees of dentoskeletal effects in the treatment of Class II malocclusions [5-9]. In the recent times, Twin Block developed by William J. Clark is the most popular and widely used removable functional appliances for the correction of Class II malocclusion in growing patients due to increased patients acceptance and compliance, the separate upper and lower two-piece design of the appliance allows freedom of speech and mastication [10-15]. Several randomized controlled trials and systematic reviews have described the role of the Twin Block appliance on skeletal, dental and soft tissue structures in the treatment of Class II malocclusions [16-18].

Therefore this study aimed to retrospectively evaluate the dentoskeletal effects of Twin Block appliance in patients with Class II division 1 malocclusion.

**Methods**

This study was approved by the Institutional Ethical Committee of Institutional Ethical Committee of YDC/05-08/03. Two groups of 30 subjects in each were considered for this retrospective cross-sectional study, records of the patients who had been treated with the Twin Block appliance were compared with the records of untreated children with Class II malocclusion. All the records were obtained from 5 different private dental offices based on the following inclusion criteria:

1) Skeletal Class II malocclusion (ANB 5° or greater)
2) Mandibular retrognathism
3) Average or horizontal growth pattern.
4) Full-cusp Angle Class II molar relationship on both sides
5) Overjet of 6 to10 mm
6) The age group of 9 to 12 years
7) All the subjects with same bite recording technique and standard Twin Block appliance design and treatment protocol suggested by Dr Clark.

The subjects excluded from the study were patients with severe maxillary prognathism, severe dental crowding (more than 5 mm), history of previous orthodontic treatment.

**Twin Block Group:** consisted of 30 patients (13 boys and 17 girls) with age between 9 to 12 years. The average age of the patients was 10 years 8 months at the time of the initial film. **Control group:** 30 untreated Class II subjects (12 boys and 18 girls) who received no treatment but were followed until the end of the study, records were selected based on the similarity of ages with the Twin Block group. The average age of this sample group was 11 years 2 months.

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**Figure 1 (left).** Cephalometric reference planes: 1) S-N plane; 2) Vertical reference plane (VRP); 3) Horizontal reference plane (HRP).

**Figure 2 (right).** Dentoskeletal parameters: 1) UI-SN; 2) UI-VRP; 3) UI-HRP; 4) U6-VRP; 5) U6-HRP; 6) IMPA; 7) L1-VRP; 8) L1-HRP; 9) L6-VRP; 10) L6-HRP.

**Palatal plane:** the plane formed by joining ANS and PNS was used as a Horizontal Reference Plane (HRP) for maxillary teeth; **Mandibular plane:** the plane formed by joining Gonion and Menton. (HRP for mandibular teeth); **Vertical reference plane (VRP):** the reference plane constructed through sella turcica perpendicular to the palatal plane.
Cephalometric analysis
In this study, pre-treatment (T1) and post-treatment (T2, post appliance removal / equivalent time frame in controls) records of 30 patients treated with standard Twin Block appliance design and treatment protocol suggested by Dr Clark and control group (30 patients) were evaluated before and after functional therapy. All the pre-treatment and post-treatment cephalograms were traced on matte acetate paper, using a 0.03” lead pencil by one investigator with verification of anatomic outlines and landmarks by the two more investigators. A single average tracing was made in instances of bilateral structures. The cephalometric landmarks, reference planes and angular measurements were used as defined by Alexander Jacobson [19] and Thomas Rakosi [20].

The following Cephalometric reference planes (Figure 1) and Denteskeletal parameters were used (Figure 2).

The horizontal movement of the maxillary teeth was measured from VRP, whereas vertical changes were measured relative to the palatal plane. Similarly, the mandibular plane and vertical reference plane were used to determine the mandibular teeth movement.

Statistical analysis
Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) software version 22 (SPSS Inc, Chicago, Illinois, USA). The differences between pre and post-treatment were calculated using a paired t-test. When data were not normally distributed, Wilcoxon signed-rank test was used. Man-Whitney U test was used to compare the changes between the two groups. The comparison was tested at 5% level of significance (P-value < 0.05 was considered statistically significant).

Results
Descriptive information and pre and post-treatment comparison between Twin Block and control groups are shown in table I. Whereas, group differences, in the percentage of changes between the two groups are presented in table II.

Table I. Descriptive information and pre (T1) and post-treatment (T2) comparison between Twin Block and Control groups.

| Cephalometric Parameter | Twin Block (TB) | Control (C) |
|-------------------------|----------------|-------------|
|                         | Pre treatment (T1) Mean± SD | Post treatment (T2) Mean± SD | p-value | Pre treatment (T1) Mean± SD | Post treatment (T2) Mean± SD | p-Value |
| SNA                     | 81.44±3.01 | 80.75±3.65 | 0.01 * | 82.33±3.0 | 81.95±3.55 | 0.106 NS |
| SNB                     | 74.35±3.16 | 76.65±3.28 | <0.001 | 74.20±2.50 | 74.54±2.57 | 0.111 NS |
| ANB                     | 6.06±1.36 | 4.06±2.04 | <0.001 | 6.60±2.00 | 6.10±2.01 | 0.16NS |
| MAX length              | 89.90±3.90 | 90.50±4.79 | 0.160 NS | 87.80±3.80 | 88.50±4.69 | 0.158 NS |
| MAND length             | 107.20±5.17 | 113.22±4.32 | <0.001 | 109.90±5.09 | 110.20±5.01 | 0.178 NS |
| WITS                    | 4.88±1.52 | 2.14±1.94 | <0.001 | 4.20±1.29 | 3.97±1.25 | 0.15 NS |
| BETA angle              | 22.16±3.54 | 27.00±3.14 | <0.001 | 21.29±1.66 | 21.69±1.79 | 0.18 NS |
| AFH                     | 110.20±5.17 | 116.22±4.33 | <0.001 | 109.93±5.09 | 110.18±5.02 | 0.179 NS |
| PFH                     | 73.36±3.74 | 76.30±3.86 | <0.001 | 72.07±4.14 | 72.36±4.19 | 0.065 NS |
| Facial Convexity        | 9.36±4.97 | 6.22±6.33 | <0.001 | 9.86±4.01 | 9.88±4.19 | 0.081 NS |
| U1-SN                   | 116.00±6.61 | 108.74±7.20 | <0.001 | 109.92±8.76 | 110.00±8.66 | 0.701 NS |
| U1-HPR                  | 26.64±2.87 | 28.22±3.71 | 0.022* | 27.62±2.85 | 28.14±3.15 | 0.002 * |
| U1-VRP                  | 77.16±3.89 | 74.96±4.63 | <0.001 | 74.97±5.44 | 74.98±5.62 | 0.924 NS |
| U6-HPR                  | 20.60±1.89 | 20.83±2.02 | 0.114 NS | 20.61±2.04 | 20.84±2.17 | 0.115 NS |
| U6-VRP                  | 40.60±3.76 | 39.66±3.82 | 0.037* | 40.12±3.90 | 40.09±3.85 | 0.068 NS |
| L1-NB                   | 7.64±2.18 | 8.88±2.34 | <0.001 | 7.49±1.99 | 7.57±2.10 | 0.566NS |
| IMPA                    | 101.56±5.75 | 103.72±6.10 | 0.037* | 99.46±4.71 | 100.04±4.80 | 0.059 * |
| L1-HPR                  | 41.32±2.72 | 39.90±3.02 | 0.011 ** | 39.76±3.40 | 39.84±4.29 | 0.566 NS |
| L1-VRP                  | 68.20±3.57 | 71.36±4.00 | <0.001 | 69.36±4.58 | 69.92±4.57 | 0.51NS |
| L6-HPR                  | 28.66±2.11 | 30.14±2.96 | <0.001 | 30.32±2.88 | 30.86±2.92 | <0.001 |
| L6-VRP                  | 39.04±3.34 | 43.48±4.09 | <0.001 | 40.80±4.45 | 41.12±4.41 | <0.001 |
| Overjet                 | 9.40±2.13 | 3.68±1.74 | <0.001 | 8.08±1.30 | 7.70±1.21 | <0.001 |
| Overbite                | 4.70±1.05 | 2.68±1.09 | <0.001 | 4.44±0.92 | 4.18±1.00 | 0.003 ** |
| Interincisal angle      | 110.76±7.28 | 114.60±9.29 | 0.033* | 109.74±6.02 | 109.88±6.24 | 0.327 NS |

Abbreviations: TB: Twin Block, C: Control, SD: Standard Deviation, AFH: Anterior Facial Height, PFH: Posterior Facial height, U1-HPR: Upper 1 to Horizontal reference plane, IMPA: Incisal Mandibular plane Angle, U1-VRP: Upper 1 to Vertical reference plane, U6-VRP: Upper 6 to Vertical reference plane, L1-HPR: Lower 1 to Horizontal Reference plane, L1-VRP: Lower 1 to Vertical Reference plane, L6-HPR: Lower 6 to Horizontal Reference Plane, L6-VRP: Lower 6 to Vertical Reference plane, U1-SN: Upper 1 to SN plane, HRP: Horizontal Reference Plane, VRP: Vertical Reference Plane.

Notes: p > 0.05 = NS, * p < 0.05 = Significant, ** p < 0.01 = Highly Significant, *** p< 0.001 = Very highly significant.
Cephalometric findings
A Class I molar relationship, significant reduction of overjet and overbite were observed in Twin Block therapy patients. Cephalometric findings of the Twin Block group and the control group are presented in Table I.

Skeletal effects
A statistically significant increase in the mandibular length (6.02 mm) and SNB angle (2.3°) was observed in the Twin Block group compared with the control group 0.3 mm and 0.3° respectively. The Twin Block group experienced “Headgear effect” producing slight inhibition of forwarding maxillary growth as evidenced by the reduction seen in angle SNA (-0.7°) as compared with the small increase seen in angle SNA in the control subjects.

The ANB angle demonstrated a significant decrease when the two groups were compared. (SNA decreased, and SNB and Go-Me increased). In Twin-block group the ANB angle reduced by 2°, Wits reduced by 2.74 mm and increase in Beta angle by 4.8°, but there were only minor changes in the untreated control group and these differences were statistically significant. The skeletal vertical cephalometric variables showed an increase in the lower anterior facial height and posterior facial height in Twin Block group. Overall, Twin Block therapy produced a larger effect on the growth of the mandible than with untreated control subjects.

Dental effects
In Twin Block group maxillary incisors were retroclined, extruded, and distally tipped (U1/SN and U1-VRP decreased, U1-HRP increased), whereas the mandibular incisors were proclined (2.3°), intruded, and labially tipped (L1-NB, IMPA increased, and L1-MP decreased). Maxillary molar teeth were distalized (1 mm) and extruded (decreased U6-VRP and increased U6-HRP), contrarily, lower molars were moved mesially (4.5 mm) and extruded (L6-VRP and L6-MP increased) whereas in control group maxillary molar teeth were distalized (0.3 mm), and lower molars were moved mesially (0.5 mm). Significant decrease in overjet (5.72 mm) and overbite were observed at the end of treatment in the Twin Block patients compared with untreated Class II controls.

Table II. Mean changes between Twin Block vs Control groups.

| Cephalometric Parameter | Twin Block (TB) % change Mean ±SD | Control (C) % change Mean ± SD | TB vs C |
|-------------------------|-----------------------------------|--------------------------------|---------|
| SNA                     | 0.60±2.73                       | 0.46±1.00                      | <0.001  |
| SNB                     | 6.76±1.69                       | 0.51±1.06                      | <0.001  |
| ANB                     | 33.17±44.69                     | 5.21±20.44                     | <0.001  |
| Max length              | 0.66±4.69                       | 0.47±3.56                      | 0.09    |
| Mand length             | 5.55±3.19                       | 0.27±6.09                      | <0.001  |
| WITS                    | 55.18±42.73                     | 6.90±20.44                     | <0.001  |
| BETA angle              | 23.57±16.19                     | 2.40±2.96                      | <0.001  |
| AFH                     | 5.55±3.10                       | 0.24±0.84                      | <0.001  |
| PFH                     | 4.02±1.69                       | 0.41±1.05                      | <0.001  |
| Facial Convexity        | 88.18±186.19                    | 0.39±10.63                     | <0.001  |
| U1-SN                   | 6.16±5.27                       | -0.08±0.94                     | <0.001  |
| U1-HRP                  | 6.42±13.24                      | 1.83±2.76                      | 0.016** |
| U1-VRP                  | 2.86±2.98                       | 0.00±1.00                      | <0.001  |
| U6-HRP                  | 4.14±5.20                       | 1.11±3.46                      | 0.014** |
| U6-VRP                  | -0.50±4.83                      | -0.05±1.83                     | 0.502NS |
| L1-NB                   | 18.65±18.88                     | 7.94±6.99                      | 0.003** |
| IMPA                    | 2.22±4.74                       | 0.58±0.56                      | 0.009** |
| L1-HRP                  | 2.25±4.91                       | 0.23±1.78                      | 0.034*  |
| L1-VRP                  | 4.67±3.40                       | 0.82±0.81                      | <0.001  |
| L6-HRP                  | 8.29±6.83                       | 1.79±1.51                      | <0.001  |
| L6-VRP                  | 11.43±5.85                      | 0.81±1.08                      | <0.001  |
| Overjet                 | 60.76±15.46                     | 4.60±3.58                      | <0.001  |
| Overbite                | 42.96±19.86                     | 6.27±8.74                      | <0.001  |
| Interincisal angle      | -3.63±7.60                      | -0.12±0.64                     | 0.04*   |

Abbreviations: TB: Twin Block, C: Control, SD: Standard Deviation, AFH: Anterior Facial Height, PFH: Posterior Facial height, U1-HRP: Upper 1 to Horizontal reference plane, IMPA: Incisal Mandibular plane Angle, U1-VRP: Upper 1 to Vertical reference plane, U6-VRP: Upper 6 to Vertical reference plane, U6-HRP: Upper 6 to Horizontal reference plane, L1-HRP: Lower 1 to Horizontal Reference plane, L1-VRP: Lower 1 to Vertical Reference plane, L6-HRP: Lower 6 to Horizontal Reference Plane, L6-VRP: Lower 6 to Vertical Reference plane, U1-SN: Upper 1 to SN plane, HRP: Horizontal Reference Plane VRP: Vertical Reference Plane.

Notes: p > 0.05 = NS, * p < 0.05 = Significant, ** p < 0.01 = Highly Significant, *** p< 0.001 = Very highly significant.
Discussion

Functional appliances are used in the treatment of Class II malocclusions caused by a retrognathic mandible. To what extent do these appliances bring about a clinically significant increase in growth still remains questionable, but several clinical studies and systematic reviews reported that their use brings favorable skeletal and dentoalveolar changes. Early correction of maxillary proclination in a severe skeletal Class II division 1 malocclusion may be useful to reduce the risk of trauma to prominent maxillary incisors and will improve the facial esthetics during adolescence [21].

Effects on the maxilla

The results of this study revealed a ‘Headgear effect’ on maxilla with the Twin Block group experiencing an inhibition of forwarding maxillary growth as evidenced by a 0.7° decrease in SNA angle as compared with the control subjects (0.3°). The “headgear effect” also was observed dentally as a 1.0 mm distalization effect on the upper molars in the Twin Block group. These results are similar to previous studies [10,11,22-25], but contradict others with no statistically significant reduction in SNA angle and maxillary length [26-30].

Effects on the mandible

In the scientific literature, there is a controversy over the effects of functional appliances on mandibular growth. Several evidence-based studies have reported that functional appliances increase the mandibular length in the treatment of Class II malocclusion. A statistically significant increase in mandibular length was observed in the Twin-block (6.02 mm) compared with the control group (0.3 mm). These findings were similar to previous studies by Mills and McCulloch [23] who reported a 6.5 mm increase in effective mandibular length, Toth and McNamara [27] reported a 3.0 mm increase in mandibular growth. In addition, Giuntini et al. [31], Khoja et al. [32], Pattanaik et al. [33] and Ajami et al. [34] reported similar results of increased mandibular length.

Maxillo-mandibular changes

The sagittal relationship improved in the Twin Block group than in the controls, the greater reduction was seen in Twin-block group (ANB angle reduced by 2°, Wits reduced by 2.7 4mm and increase in Beta angle by 4.8°). Toth and McNamara [27] reported a similar reduction in ANB angle (1.8°), Sharma et al. [25] reported ANB reduction by 2.9°, Khoja et al. [32] found ANB angle reduced by 1.82° and Ajami et al. [35] indicated a mean reduction in ANB angle by 1.76°. This reduction in the ANB angle was primarily due to an increase in SNB angle. This finding is in agreement with results reported by Clark [10,11,22], Illing et al. [16], Lund and Sandler [26], Mills and McCulloch [28] and Trenouth [29].

The result of the present study indicates that skeletal discrepancy in sagittal direction is mainly corrected due to the increase in mandibular length, restriction of maxillary growth as validated by a reduction in ANB angle, reduction in Wits value and increase in Beta angle.

The vertical relationship of the jaws

Relative to the control group, the Twin Block applied a forward and downward force to the mandible and caused an increase in the lower anterior facial height and posterior facial height, which is similar to previous studies [10,23,25-30].

Dentoalveolar changes

In the Twin-block group, the maxillary first molars moved distally (1 mm). Lund and Sandler [26] noted 1.6 mm distal movement, Toth and McNamara [27] reported 1.5 mm, Mills and McCulloch [28] reported the distalization of the maxillary molars during Twin Block appliance treatment. Clark [10] also found distalization of the maxillary molars with the Twin-block appliance. Previous studies of Twin-block treatment indicated ‘headgear effect’ on the maxillary posterior teeth. Our study had a similar observation, in agreement with previous studies [10,22,29].

The mandibular molars in the Twin-block subjects showed extrusion (2.38 mm) and mesial movement (4.5 mm) significantly greater than in the control group (0.5 mm) which is similar to studies by Mills and McCulloch [26], Lund and Sandler [28] and Pattanaik S et al [34]. The effect on mandibular incisors is critical and variable in different studies. The mandibular incisors showed greater proclination 2.3° and were probably a result of the mesial force on the mandibular incisors induced by the protrusion of the mandible [9,16]. Lund and Sandler [26] reported 7.9° proclination, Toth and McNamara [27] by 2.8°, Mills and McCulloch [28] by 3.8°, Trenouth [29] by 1.4°, Khoja et al. [32] reported a significant increase in mandibular incisor proclination despite capping into the Twin Block appliance. A significant decrease in overjet (5.72 mm) and overbite were observed at the end of treatment in the Twin Block group compared with untreated Class II controls. This finding is in accordance with studies by Clark [10], Illing et al. [16], O’Brien et al. [24], Sharma et al. [25], Trenouth [29], Khoja et al. [32] and Ajami et al [34].

Conclusions

Twin Block appliance stimulated the mandibular growth and improved facial esthetics in Class II malocclusion by a combination of changes in the skeletal as well as dentoalveolar structures.

“Headgear effect” was observed with the Twin Block group experiencing restricted maxillary growth and maxillary molar distalization.

Increase in lower anterior facial height, significant reduction in overjet and overbite and Class I molar relationship was achieved at the end of treatment in the Twin Block group, although no significant changes appeared in the control group.
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