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CONE BEAM COMPUTED TOMOGRAGHIC EVALUATION OF THE EFFECTS OF TWIN BLOCK APPLIANCE USED FOR CORRECTION OF SKELETAL CLASS II GROWING PATIENTS

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ABSTRACT

Introduction: SkeletalClass II malocclusion repair is a frequent orthodonticstrategy, and the twin block appliance has been used more and more frequently to treat Class II malocclusions in growing children. In order to solve Class II division 1 malocclusion in developing patients with a retrognathic mandible, this study was planned to evaluate the dental, skeletal, and soft tissue implications of employing the twin block appliance.

Materials and methods: A treatment group comprising fifteen skeletal Class II developing patients with retrognathic mandibles, who were planned for treatment utilizing the twin block appliance had cone beam computed tomographic radiographs taken before (T1) and after (T2) the correction of skeletal class II malocclusion. Their mean age was 10.8 ±1.2 years. A second skeletal Class I control group with matching ages to the experimental group (11±1.1 years) had two CBCT radiographs with an interval period matching to T1 and T2 of the first group. Using a paired t-test, dental, skeletal and soft tissue changes were compared at T1 and at T2 for both groups. Unpaired T-test was utilized to compare between both groups.

Results: The skeletal Class II relation was significantly improved by the twin block therapy, indicated by the significant changes of ANB angle that decreased by 3.85 degrees and the AO-BO measurement that decreased by 3.96 mm. The length of the mandibular body (Go-Me) showed similar increase in both groups (P=0.37). The articular angle showed a significant decrease in the treatment group compared to the control group (P<0.001). The ratio of the posterior to the anterior facial height increased by 4.1% in the treatment group. There was significantoverjet reduction (P=0.001) accompanied by significant upper incisor retroclination (P=0.3) and lower incisor proclination (P=0.02) by the twin block therapy.The soft tissue convexity angle (n-Sn-Pog') had significant increase of 4.43 degrees in the treatment group (P=0.001).

Conclusion: Growing patients with skeletal Class II malocclusion characterized by retruded mandiblecan be efficiently treated with the twin block device. Both Jaws have undergone skeletal and dentoalveolar alterations, which together account for thisefficacy. The soft tissue profile was also enhanced.

KEY WORDS: Skeletal Class II, Twin block appliance, Cone Beam Computed Tomography

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INTRODUCTION

The primary goals and objectives of orthodontic therapy encompass the enhancement of aesthetics, the attainment of stability and the optimization of functional outcomes. The achievement of effective therapy necessitates a significant level of diagnostic proficiency and meticulous implementation of therapeutic techniques.

Skeletal Class II malocclusion, a prevalent issue affecting around 33% of individuals, is frequently accompanied by mandibular retrusion [1]. Hence, the effective regulation of mandibular development in actively growing patients plays a crucial role in the treatment of Class II malocclusion.

The primary motivation behind pursuing orthodontic treatment for Class II malocclusions is the enhancement of aesthetic appearance. The treatment options for malocclusions of skeletal origin vary depending on the age of the patient. The utilization of growth modification treatment approaches has been shown to yield more favorable outcomes for patients who have substantial potential for growth [2].

The monoblock developed by Robin is often regarded as the precursor to various forms of functional appliance therapy, whereas the activator designed by Andresen is widely recognized as the initial functional appliance. The introduction of modifications to the Activator and the introduction of several new appliance systems were documented[3,4].

Numerous functional treatment modalities have been implemented to facilitate the progression of mandibular growth. The Twin blockappliance is a well-established treatment modality for correcting skeletal Class II malocclusion by promoting sagittal growth of the mandible [5].

The determination of a positive clinical outcome following the initiation of twin block therapy is achieved by assessing the pterygoid response, which becomes evident within a timeframe of 6 to 8 weeks [6, 7].

Several studies in the literature evaluated the outcomes of utilizing the twin block functional appliance therapy relying on lateral cephalometric radiographs [1,2,5,7]. Disadvantages of the 2D lateral cephalometry comprise distortion, failure to distinguish bilateral anatomical landmarks and superimposition.[8, 9, 10]

Accordingly, the aim of this study was to assess the effects of the twin block appliance used for correction of skeletal class II growing patients by cone beam computed tomography.

The null hypothesis was that there would be no differences in the skeletal and dental outcomes between the patients treated with the twin block appliance a control group with matching ages.

MATERIAL AND METHODS

This study was approved by the ethical committee of the Faculty of Dentistry- Minia University-Egypt (Number 863, 2023). The current research was conducted at the Department of Orthodontics, Faculty of Dentistry, MiniaUniversity;Egypt. Two groups of patients were embraced. The first treatment group consisted of fifteen growing patients, (9 males and 6 females) planned for treatment with the twin block appliance (Figure 1 A). They had a mean age of 10.8±1.2 years .

The inclusion criteria included:

- Skeletal Class II pattern with ANB angle exceeding 5° and Wits appraisal of 2 mm or more.
- Mandibular deficiency (SNB angle less than 77°).
- No prior orthodontic intervention.
- The vertical skeletal classification showing horizontal or neutral growth pattern (Maxillomandibular plane angle<30°).

The exclusion criteria were:

- Developmental abnormalities with atypical or irregular patterns of growth and maturation.
- Any indications or manifestations, as well as any prior medical records, of tempro-mandibular disorders, such as the presence of clicking, pain, limitations, or deviations.

The second control group included 15 skeletal Class I growing patients (8 males and 7 females) with matching ages to the treatment group (mean= 11±1.1 years).

In order to detect a standard deviation difference of 0.2 degrees of the SNB angle and an overall mean difference of 1 degree, the sample size was determined using Pass software (version 11.9; NCSS LLC, Kaysville, UT). A power of 80% was used, and the alpha was set at 0.05. Consequently, thirteen pairs served as the basis for the evaluation. Thus, fifteen patients were included for each group to compensate for the drop-out.

Treatment protocols of the treatment group:

Cone beam computed tomograghic examination (CBCT): Full face CBCT examination was performed for each patient in the treatment group before starting orthodontic therapy.

To guard against dispersed radiation, each patient wore a 0.25 mm lead apron over their bodies. Scanora® 3D with auto-switch TM (soredex, Helsinki, Finland) with 85 kvp, 15 mA, and a field of view (FOV) of 4 cm was used and on demand 3D T.M software (cybermedinc., Seoul, Korea) was used to manipulate the CBCT images. During radiograph taking, patients were told to sit upright while maintaining the Frankfort plane parallel to the ground. The data was introduced to the blue sky plan software version 4.9.4 by Blue Sky Bio, LLC. The image's creation of a DICOM file allowed the accessibility to identify the anatomical features and subsequently determine the best locations. All landmarks were established after thorough inspection in all three dimensions of space. Furthermore, all landmarks were positioned with identical cross-sectional perspectives in order to attain standardization.

Twin block construction: For each patient, upper and lower rubber base impressions(*Zhermack BadiaPolesine (RO), Italy) were taken and then poured into hard stone (©GC America Inc., USA) in 15 minutes to confirm dimensional accuracy.

Functional bite registration was accomplished using softened pink wax(Cavex, Neterlands) while the patient biting in incisal edge-to-edge relationship with a minimum of 3mm inter-incisalseparation. Attention was necessary to certify that lateral displacement did not ensue.

Laboratory Construction

- The wax bite was used to mount the casts to a basic hinge articulator. A 3-4 mm gap was left in the outer inter-occlusion to simulate the vertical opening and provide enough thickness for the occlusal bite blocks to be constructed.
- Adams clasps, ball ended clasps, and maxillary labial bows were fabricated from stainless steel wire with a diameter of 0.7 mm.
- The acrylic plates for the upper and lower jaws were made with self-cure acrylic resin(©GC America Inc., USA).
- The occlusal plane, which was situated mesial to the permanent molars on the upper and lower jaws in the region of the second premolar or second primary molar, forms an interlocking angle of seventy degrees with the inclined planes of the upper and lower jaws.
- When the mandibular bite block was put over the mandibular premolars or primary molars, the jaw was repositioned into an edge-to-edge relationship. Figure 2 show that the mandibular permanent molars were touched by the maxillary flat occlusal bite block, which extended posteriorly beyond the remaining posterior teeth of the maxilla.

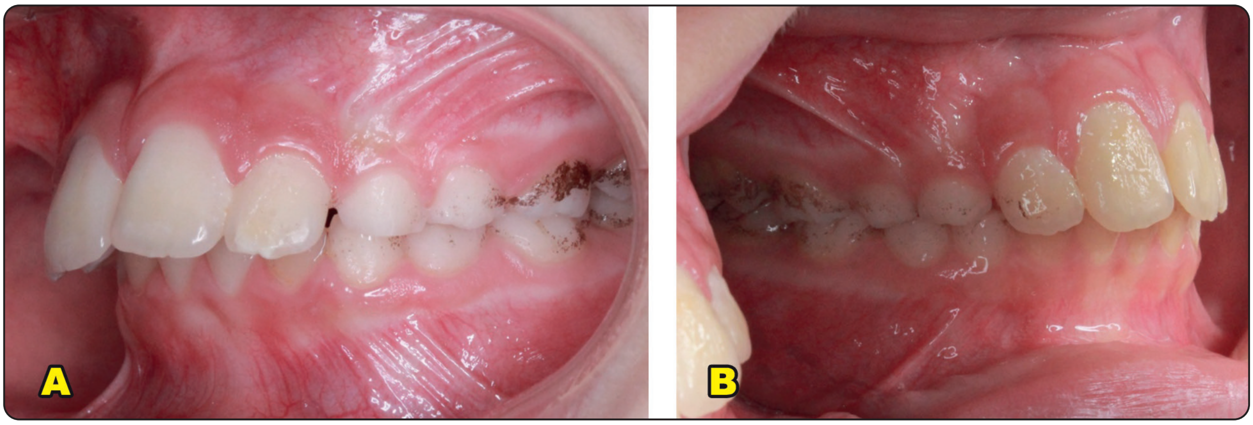

Fig. (1 A) Intraoral photograph for a skeletal class II case (B) Intraoral photograph after achieving 1mm overjet

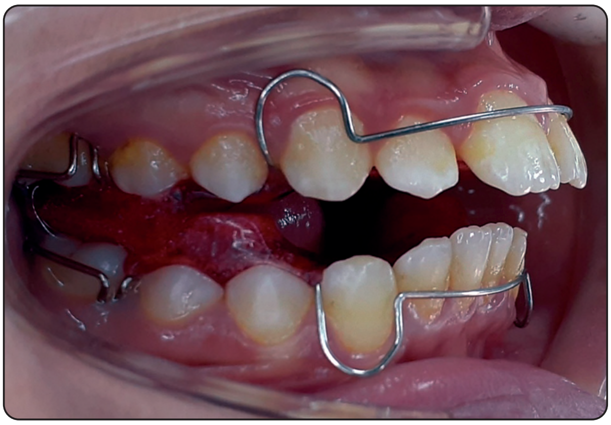

Fig. (2) Intraoral photograph for a skeletal class II case wearing the twin block functional appliance

Tables 1 and 2 show the different landmarks, planes, and measurements derived from the CBCT.

A second cone beam computed tomographic images were accomplished for all patients in the treatment group after achieving 1mm overjet.

Every patient of the control group had 2 CBCT scans taken at time intervals matching with the treatment group.

TABLE (1) Description of 3D measurements

SNA	The angle created by the junction of the sella-nasion and nasion-A lines.
SNB	The angle created by the intersection of the sella-nasion and nasion-B lines.
ANB	The angle created by the junction of the lines nasion-A and nasion-B.
AO-BO	The distance between perpendiculars from points A and B onto the occlusal plane. The points of contact of the perpendiculars onto the occlusal plane are labeled AO and BO, respectively.
Overjet	The horizontal distance between U1 incisal edge and L1 incisal edge.
Go-Me	The distance between gonion and menton points.
NSAr	The angle formed between nasion, sella and articulare points
PFH/AFH (SGo/NMe)	The distance between S and Go points divided by the distance between the N and Me points × 100
Y-axis (SGn/NMe)	The angle between the SGn and the PoOr lines
U1/SN	The angle between the upper incisor long axis and the SN line
U1/Mx	The angle between the upper incisor long axis and the palatal plane
L1/MP	The angle between the lower incisor long axis and the mandibular plane
n-Sn-Pog’	The angle created by the junction of the lines n-Sn and Sn-Pog’

It should be noted that all landmarks were positioned while being observed from all three spatial dimensions. Furthermore, all landmarks were positioned utilizing an identical cross-sectional perspective to ensure uniformity.

End of treatment

When 1mm over jet was achieved, retention was employed for 3 months by removing the twin block acrylic blocks bilaterally to offer satisfactory time for posterior teeth to over erupt (Figure 1 B).

Statistical Analysis

- Statistical analysis was conducted using various software packages, including SPSS 20% (Statistical Package for Social Science) developed by IBM in the United States, Graph Pad Prism developed by Graph Pad Technologies in the United States, and Microsoft Excel 2016 developed by Microsoft Corporation in the United States.
- The normality of the data was assessed using the Shapiro-Wilk Normality test that revealed normal distribution of all variables. The results were reported as mean (M) and standard deviation (SD) values.
- A paired-samples t-test was utilized to examine the differences between T1 and T2.
- An unpaired t-test was used to assess the differences between the treatment and control groups.
- The statistical significance was assessed at the significance levels of P<0.05.

TABLE (2) The descriptive data and the comparative statistics of CBCT measurements for the control group

Measurements	T1(M±SD)	T2(M±SD)	T2-T1 (M±SD)	P (T2-T1)
SNA (°)	80.60 ± 2.12	80.73 ± 2.82	0.13± 2.62	0.19
SNB (°)	76.51 ± 3.52	76.95 ± 3.52	0.44±0.32	0.17
ANB (°)	4.09 ± 1.50	3.62 ± 1.65	-0.3±0.2	0.23
AO-BO	1.15 ± 1.02	0.86 ± 0.94	-0.28 ± 0.2	**0.035**
Overjet	3.81 ± 1.76	3.24 ± 1.5	-0.53 ± 0.84	0.68
Go-Me (mm)	71.73 ± 2.98	74.90 ± 3.92	3.17± 3.02	**0.01**
NSAr	123.16 ± 3.06	122.8 ± 3.62	-0.36± 3.45	0.75
PFH/AFH (%)	72.7 ± 6.27	73.74 ± 6.07	1.04±6.04	0.85
Y-axis	62.57 ± 4.16	63.64 ± 3.9	1.12 ± 0.78	0.42
UI/Mx	116.02±3.60	115.82±4.60	-0.2±0.21	0.94
LI/MP	96.82±4.10	97.22±4.34	0.4±0.12	0.72
n-Sn-Pog’	136.36 ± 7.28	137.12 ± 6.41	0.89 ± 0.5	0.09

Data are presented as mean + SD; T1: before treatment, T2: completion of treatment; P(T2-T1): the difference of CBCT measurements before and after treatment, significant; *P<0.05;

TABLE (3) The descriptive data and the comparative statistics of CBCT measurements for the treatment group

Measurements	T1 (M±SD)	T2 (M±SD)	T2-T1 (M±SD)	P-value (T2-T1)
SNA (°)	80.82 ± 2.73	79.73 ± 3.82	-1.09± 2.16	0.072
SNB (°)	73.85 ± 2.44	76.61 ± 3.52	2.87±1.73	**0.005**
ANB (°)	6.9 ± 0.81	3.12 ± 1.7	-3.85±1.56	**<0.001**
AO-BO	5.13 ± 1.5	0.99 ± 0.71	-3.96 ± 1.28	**<0.001**
Overjet	7.36 ± 2.03	1.7 ±0.49	-5.41 ± 1.86	**0.001**
Go-Me (mm)	69.37 ± 3.6	73.73 ± 4.98	4.37± 2.13	**<0.001**
NSAr	124.19 ± 3.52	122.93 ± 3.06	-1.27± 1.75	0.67
PFH/LAFH (%)	70.55 ± 5.8	74.70 ± 6.07	4.14±2.93	**0.014**
Y-axis	61.63 ± 5.09	66.87 ± 5.66	5.16 ± 2.2	**0.001**
UI/Mx	115.97±4.83	113.92±4.86	-1.95±1.67	**0.03**
LI/MP	94.03±4.6	97.2±4.51	3.17±2.21	**0.02**
n-Sn-Pog’	133.48 ± 6.55	137.74 ± 7.2	4.43 ± 1.78	**0.001**

*Data are presented as mean + SD; T1: before treatment (figure3), T2: completion of treatment (figure 4); P(T2-T1): the difference of CBCT measurements before and after treatment, significant; *P<0.05.*

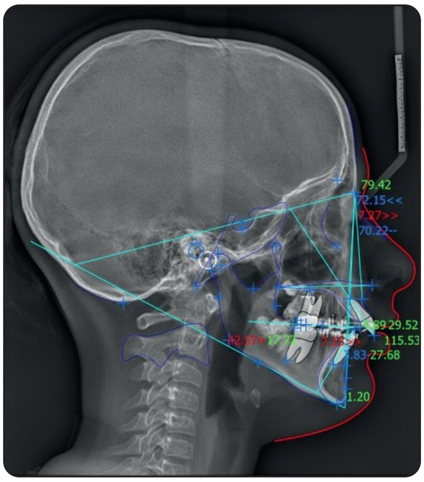

Fig. (3): pre treatment cephalometric measurement generated from CBCT

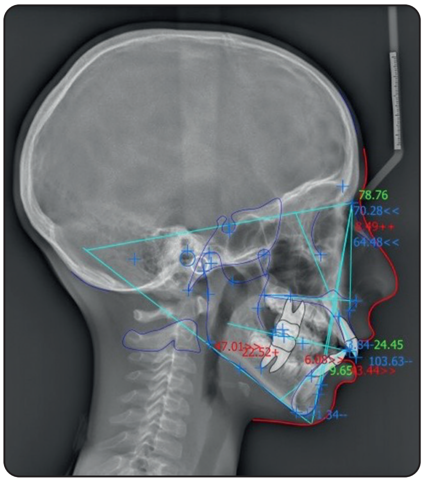

Fig. (4): post treatment cephalometric measurement generated from CBCT

RESULTS

All patients of the treatment group finalized the treatment phase. The difference between T1 and T2 in the treatment and the control groups were 13.1±1.4 months and 13.3±1.5 months respectively with insignificant difference between them (P=0.632).

Tables 3 and 4 display the changes in the different variables between T1 and T2 for the control and the treatment groups respectively. Table 4 illustrates the comparison between the treatment and the control groups.

For the AP position of the maxilla, the SNA angle showed insignificant increase in the control group (P=0.19) and insignificant decrease in the treatment group (P=0.072). However, there was a significant change between both groups (P<0.001).

The SNB angle showed a significant improvement in the treatment group (P=0.005), an

TABLE (4) Comparison between changes of the study group and the control group:

Measurements	Group 1	Group 2	Diff of Means	P
SNA (°)	0.13± 2.62	- 1.09 ± 2.16	-0.96	**<0.001**
SNB (°)	0.44±0.32	2.87 ± 1.73	2.42	**0.015**
ANB (°)	-0.3±0.2	- 3.85 ± 1.56	-3.81	**<0.001**
AO-BO	-0.28±0.2	-3.96±1.28	-3.68	**<0.001**
Overjet	-0.53±0.84	-5.41±1.86	-4.88	**<0.001**
Go-Me (mm)	3.17± 3.02	4.37± 2.13	1.54	0.37
NSAr	-0.36± 3.45	-1.27± 1.75	-2.91	**<0.001**
PFH/LAFH (%)	1.04±6.04	4.14±2.93	3.1	**<0.001**
Y-axis	1.12 ± 0.78	5.16 ± 2.2	4.04	**0.001>**
UI/Mx	-0.2±0.21	-1.95±1.67	-1.75	**0.024**
LI/MP	0.4±0.12	3.17±2.21	2.77	**<0.001**
n-Sn-Pog’	0.89 ± 0.5	4.43 ± 1.78	3.54	**<0.001**

Data are presented as mean + SD; T1: before treatment, T2: completion of treatment; P(T2-T1): the difference of CBCT measurements before and after treatment, significant; *P<0.05.

insignificant increase in the control group (P=0.17), with a significant difference between both groups (P=0.015).

The relative sagittal relation of both jaws showed a mean improvement of 3.85 degrees for the ANB angle and 3.96 mm for the AO-BO difference in the treatment group that were statistically significant. For the control group, only the AO-BO difference showed a significant decrease.

The Go-Me measurement showed an average increases of 3.17 mm in the control group and 4.37 mm in the treatment group, with insignificant difference between them.

The saddle angle (NSAr) decreased insignificantly for both groups (in the control group, mean= 0.36 degree, P=0.75, for the treatment group, mean= 3.27 degree, P= 0.32). There was a significant difference between both groups.

There were insignificant increases in the vertical dimensions (PFH/AFH and Y-axis) in the control group, compared to significant increases in the treatment group. The treatment group had significantly higher vertical parameters than the control group (mean=3.1%, P<0.001 for PFH/AFH, and mean= 4.04 degrees, P<0.001 for Y-axis).

The parameters U1/Mx, L1MP and overjet expressed insignificant changes in the control group compared to significant decreases in the first and third parameters and significant increases in the second parameter the treatment group.

In the control group, there was soft tissue convexity (n-Sn-Pog’) showed insignificant change (P=0.09). However, in the treatment group, it showed a showed a significant increase (mean= 4.43, SD= ± 1.78, P= 0.001).A significant difference was reported between both groups (P<0.001).

DISCUSSION

This study was accomplishedto identify the efficacy of utilizing the twin block appliance to correct mandibular retrognathism in patients who are still experiencing growth. Comparison of the treatment group with a control skeletal Class I group was mandatory as the changes during the orthodontic therapy in the treatment group was expected to be a combination of normal growth changes together with the consequences of the twin block therapy.

The novel technology provides a significant advantage in the form of three-dimensional cephalometry. Nevertheless, it will require a substantial duration before a pragmatic and functional 3D analytic methodology, derived from recent research, becomes readily available. [8,16].

In the last ten years, there has been a significant increase in the number of research papers on CBCT in academic publications. This technology has been integrated into particular applications in orthodontics for the goal of diagnosing and scheduling treatments for both adult and paediatric patients. CBCT images afford two distinctive characteristics that are highly valuable in orthodontic practice. At first, a single CBCT scan can yieldseveral linear projections (like lateral cephalometric images) or flat curves (like panoramic images) that are frequently utilized in orthodontic diagnosis, cephalometric analysis, and treatment planning. This approach improves clinical efficiency by minimizing the requirement for numerous scans. Moreover, it is important to emphasize that CBCT data can be reconstructed to produce unique images that were previously unachievable. [11]

Cone-beam computed tomography (CBCT) allows for accurate measurement of the capacity of the respiratory airways.[11].

The current investigation entailed doing an edge-to-edge functional bite registration by employing a single-step mandibular advancement. Creating a 3-4a mm space between the premolars was a crucial element of bite registration. This space was essential to augment the separation between the upper and lower teeth, enabling the patient's mandible to advance further from its original position.[12]

However, it is important that the blocks are not too thick to permit patients to speak easily while wearing the appliance. Occlusal blocks of significant thickness facilitate the downward and backward rotation of the jaw, leading to an increased vertical increase in face height. Consequently, the planned improvement of the profile by moving the lower jaw forward is limited, resulting in the formation of a posterior open bite after the treatment. [13]

The outcomes of this research suggest that the utilization of the twin block appliance marks significant reduction in the anteroposteriorgrowth of the maxilla in relation to the cranial base, as assessed by the SNA angle. Functional appliance therapy inhibits forward maxillary growth as described by Cozza et al and Courtney et al. [14, 15]

The effects of the twin block on the advancement of the B point, indicated by the significant increase of the SNB angle are a combination of forward relocation of the glenoid fossa, verified by significant decrease in theNSAr angle and minor increase in the length of the body of the mandible in the treatment group. The mandibular length increase throughout the treatment duration is mainly attributed to the growth changes.

The dental changes involve significant reduction of the overjet, accompanied by significant upper incisor retroclination (about 2 degrees) and significant lower incisorproclination (about 3.17 degrees). Accordingly, this therapy is best indicated for patients with normal or slightly proclined upper incisors and with normal or slightly retroclined lower incisors.

In the vertical dimension, there were significant increases in both PFH/AFH and Y-axis. This can be explained by the characteristic backward mandibular rotation accompanying the mandibular advancement. Cozza et al(14)

The overall treatment influence of the twin block appliance involve a significant increase in the soft tissue convexity angle (n-Sn-Pog'), improving the profile of the patient. This could be attributed to the combined restricted maxillary growth and enhanced anteroposterior mandibular position.

Limitations of this study involved the design of the appliance that depends on the patient's compliance. Additionally, further studies are recommended to reevaluate the treatment effects after the termination of the fixed appliance phase and to assess the nature of the relocation of the glenoid fossa that seems to play an imperative role in skeletal Class II improvement.

CONCLUSIONS

The twin block appliance has been found to effectively promote forward growth of the mandible and improve facial aesthetics in growing individuals with a skeletal Class II malocclusion. In addition, restriction of forward maxillary growth is obtained.

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