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Changes in the Skeletodental, Soft tissue and TMJ of Class II Division.1 Malocclusion Patient Following Orthodontic Treatment with Twin block Appliance: A Prospective Clinical Study

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Abstract **Original Research Article**

The purpose of this study was to evaluate the treatment outcome of Twin Block functional appliance and to determine the skeletodental, soft tissue and TMJ changes concurrent with the treatment. Ten subjects 5 males and 5 females with age ranged from 9 to 11 years were used in this study. All the cases showed Angle's Class II division 1 malocclusion due to mandibular retrusion. For each case out of the ten, lateral Cephalometric x-ray, right and left tomographic X-ray were done before and after treatment. On the base of the data obtained from this study both skeletodental and soft tissue improvement were detected after treatment. Also a significant reduction of the posterior joint space with significant increase of the condylar head thickness was seen. These outcomes make the appliance very effective in cases with retrognathic mandible, orthognathic maxilla and normal incisors inclination.

Keywords: Twin block, Skeletal Class II, Mandibular growth.

INTRODUCTION

Skeletal Class II malocclusion is one of the most common problems in orthodontic practice that are often due to mandibular deficiency. For the treatment of those patients with mandibular retrognathia, different removable or fixed functional appliances have been used to improve and /or redirect mandibular growth in a favorable direction [1].

The term functional appliances refers to a variety of appliances designed to alter the arrangement and activity of various muscle groups that influence the position of the mandible in order to transmit forces to the dentition and basal bone. Typically these muscular forces are generated by altering the mandibular position sagitally and vertically resulting in both dental and skeletal changes [2].

Several clinical studies have been carried out to evaluate the skeletal and dento-alveolar changes associated with Twin block appliances subsequentto treatment of Class II malocclusion [3].

The influence of functional appliance on mandibular growth is a controversial issue. The primary question is whether treatment with functional appliance can provide a clinical significant increase in mandibular growth that would create a better-looking face than traditional orthodontic therapy. Much of the work demonstrating the ability of functional appliances to stimulate mandibular growth is based on animal experiments. Discrepancies between animal and human studies are expected since animal experimentation frequently involves the use of fixed appliances that exert continuous forces. These types of forces usually are impractical except the Herbst appliance and often undesirable in most clinical situation, therefore treatment results can expected to be less effective [2].

Johnston (1986), after reviewing a series of experimental studies, concluded that condylar growth could be altered by unloading or distracting the condyle. According to Broderick (1986), changes in the magnitude of condylar growth are the result of the altered condylar position rather than the altered muscular function [4].

Clinical studies on patients treated with functional appliance indicate that growth of the mandible can be altered, but in a much less predictable way. In human beings McNamara (1984), found an increase in mandibular growth over the controls of 1.2 mm/year [5, 6].Creekmore and Radney (1983), found

an increase of 1.1 mm/year [7] and Baumrind et al. (1983), found 0.71 mm/year increase [8].McNamara et al. (1985), found that although mandibular growth had increased, the majority of it was expressed vertically because of the backward rotation of the mandible, in another words, the primary expression of mandibular skeletal change with functional appliance therapy was a longer anterior facial height. Therefore, low mandibular plane angle seemed to be essential for the selection of cases indicated for functional appliance [9].

In Class II division 1 malocclusion that results from mandibular retrognathia, or mandibular dentoalveolar retrusion, the appropriate treatment may include advancement of the mandibular components through teeth movement, mandibular repositioning or orthognathic surgery depending on the timing of the treatment

.

The twin block appliance was developed more than 40 years ago by Dr. William Clark [10] in Scotland; it has recently gained popularity in North America. Little has been reported in the literature, however, with regards to the effectiveness of this widely used functional appliance. It is one of the functional appliances that deals with the mandibular advancement during the growth period in Class II division 1 cases due to mandibular retrusion [10].

Toth and McNamara compared the treatment effects produced in 40 patients treated with the Twin-block appliance to those seen in a matched sample of 40 children treated with the FR-2 appliance of Frankel as well as to changes undergone in 40 untreated Class II Controls from the University of Michigan Elementary and Secondary school growth study. The average starting ages to the Twin-block, Frankel, and control group were 10 years 5 months, 10 years 2 months, and 9 years 11 months. The observation period for all groups was 12 months. The Twin-block patients achieved an additional 3.2 mm of mandibular length; whereas the Frankel group increased 1.9 mm more than did the controls. The Twin-block patients achieved greater increase in lower anterior facial height than the Frankel patients.

AIM OF THE STUDY

The aim of this study was to evaluate the treatment outcome of Twin Block appliance and to determine the following:

1. Skeletodental changes.
2. Soft tissue morphological change.
3. Changes of temporomandibular Joint.

MATERIALS AND METHODS

The study protocol was approved by Scientific Research and Ethics Committee at University Of Tripoli (SREC-UOT) (Ref No: SREC-UOT 04-2021). This prospective study was carried out from April 2020 to May 2021 on a total sample of 10 patients, ranged in age from 9-11 years, showing Angle's Class II division 1 malocclusion who were selected from the Dental Department, High Institute For Medical Professions, AL-Baida, Libya. The objectives of study and the treatment plan were explained for patients and their guardians and informed written consents were signed before commencing the study.

The patients selected for this study had met the following criteria

1. All the cases showed skeletal Class II relationship due to mandibular retrusion depending on clinical Judge.
2. None of the patients showed severe crowding or severe proclination of the lower anterior teeth.
3. The skeletal age (maturation) in all the cases was matching as far as possible the chronological age.

The following exclusion criteria were applied

1. The subjects who have any mandibular shift.
2. The signs or symptoms of tempromandibular dysfunction.
3. All subjects who have any syndrome or perioral habits that might affect craniofacial growth.
4. The subjects had ever received any orthopedic or orthodontic treatment before.

Out of the selected subjects only ten subjects (5 male and 5 female) were selected according to the following Cephalometric measurements.

i) SNA was in range of 77 – 83 degree.
ii) SNB was in range of 67 – 76 degree.
iii) ANB was in range of 6 - 10 degree.
iv) FMA (Frankfort to mandibular plane angle) was in range of 16 – 27 degree (low angle cases).

The male subjects were considered as group 1 and female subjects were considered as group 2.

Records

For each case enrolled in this study the following records were taken just before and a year after the treatment using Twin-block appliance. The post treatment records were taken two weeks after appliance removal.

1 - Lateral Cephalometricx-ray

Lateral Cephalograms were taken for each subject before and after treatment using PLANMECA X-ray machine with an exposure time of 3 seconds and the K.V.P was 75.

The Cephalometric landmarks were undertaken prior to Cephalometric analysis.

I- Skeletal measurements

SNA, SNB, ANB, SNPg, Facial angle, Angle of convexity, Gonial angle, FH to Mand.Plane, Y-axis

to FH, Wits appraisal, and Mandibular corpuses (CD-GO, GO-GN, GN-CD).

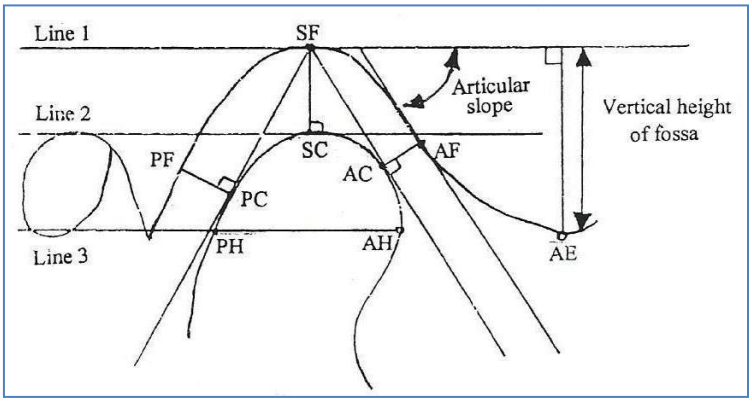

Fig-1: Temporomandibular joint's landmarks and measurements

II- Dental measurements

1to $\bar{1}$ angle, $\bar{1}$ to mandibular plane, $\bar{1}$ to NB angle, $\bar{1}$ to NB mm, 1 to FH angle, 1 to NA angle, 1 to NA mm.

III- Soft tissue measurements

Upper lip to E- line, Lower lip to E - line, Naso-labial angle

2-Left hand and wrist x-ray

For the purpose of determining the skeletal age left hand and wrist x-ray was used. Four maturity indicators were used, onset of ossification and shape of the epiphyasis of the carpal and metacarpal bones, appearance of individual bones e.g. adductor sesamoid bone, phalanges maturity stages as proximal of the fingers and stages of fusion of epiphysis e.g. distal end of radius.

3- Tomographic X-ray

Tomograms were made in centric occlusion using the PLANMECA X-ray unites. The right and left tomographic X-ray films were traced on acetate tracing paper for outline of the condyle and glenoid fossa. The following measurements (Fig. 1) were taken for each side and then the mean of both were taken:

1. Anterior joint space as the distance between AC and AF.
2. Posterior joint space as the distance between PC and PF.
3. Superior joint space as the distance between SC and SF.
4. A-P thickness of condylar head as the distance between AH and PH.
5. Vertical height of articular fossa as the measurement of aperpendicular line extending from AE to linel.
6. Angle of articular slope as the angular measurement of the articularsurface along the inner aspect of the anterior portion of the fossa.
7. Ratio of posterior to anterior joint space (P to A) as posterior jointspace measurement divided by anterior joint space measurement whereby a perfectly centered condyle would be expressed as:
8. Percentage of posterior to anterior joint space, expressed as:

$$\frac{Posterior\ joint\ space - anterior\ joint\ space}{Posterior\ joint\ space + anterior\ joint\ space} \times 100\%$$

This formula represents condylar position as percent displacement from absolute concentricity, whereby a perfectly centered condyle would be expressed as 0%. A positive value would indicate anterior condylar positioning and a negative value would indicate posterior condylar positioning [12].

Reliability test

Intra-examiner reliability test was performed by tracing the lateral cephalometric radiographs and Tomographic X-ray at two different time periods of 1 week apart.

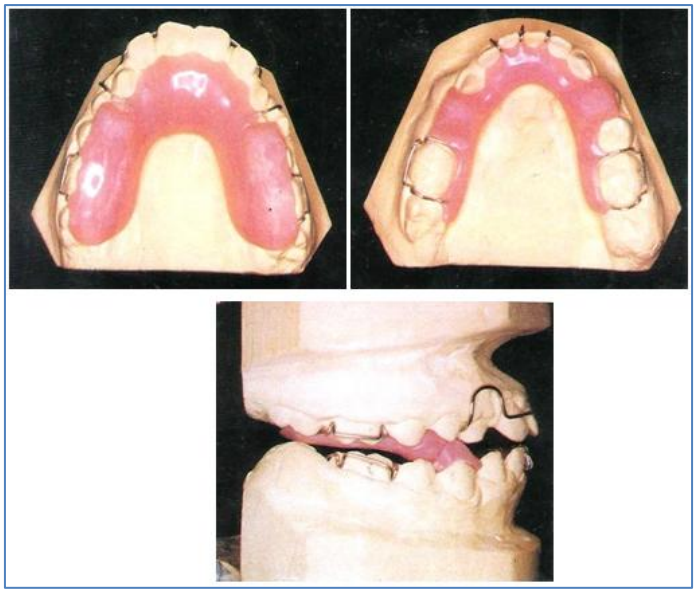

Fig-2: Upper and Lower Parts of Twin-block appliance

Fig-3: Intra- Oral View Before and After Treatment

Fig-4: Facial photographs Before and After Treatment

Table-1: Comparison of Cephalometric of skeletal and dental analysis before and after Twin-block treatment

Parameter	Pre-treatment N =10		Post-treatment N=10		t-value
	mean	SD	mean	SD	
SNA°	82.3	2.336	82.2	2.185	-0.243
SNB°	75.05	2.139	76.73	2.137	7.148*
ANB°	7.15	1.52	5.33	1.86	6.33*
SNPg°	76.23	2.36	77.78	2.34	5.91*
Facial°	85.55	2.28	87.70	2.79	3.87*
Gonial°	122.65	5.42	124.6	5.06	3.64*
FMA°	25.60	3.62	25.85	3.94	0.40
Y-axis°	59.95	2.28	59.55	2.72	-0.77
Wits(mm)	4.18	1.84	0.95	1.61	7.42*
A.of convex	13.60	4.76	11.2	4.11	3.29*

Parameter	Pre-treatment N =10		Post-treatment N=10		t-value
	mean	SD	mean	SD	
Occ.to SN°	18.95	4.67	20.05	3.93	1.6
Ba-B(mm)	93.55	3.99	96.70	4.33	5.38*
CD-GO(mm)	51.65	3.91	52.45	3.19	1.666
GO-GN(mm)	69.60	3.03	70.70	3.44	2
GN-CD(mm)	106.50	4.3	109.50	4.47	6.666*
1 to 1°	114.30	7.36	117.75	8.24	2.18*
1 to Mand°	99.90	6.70	103.90	7.22	3.45*
1 to NB°	29.90	4.39	35.10	5.93	6.26*
1 to NB (mm)	6.70	2.03	8.50	2.26	7.26*
1 to FH°	119.65	5.04	112.75	4.47	6.71*
1 to NA°	28.75	5.22	20.65	4.68	8.7*
1 to NA (mm)	7.00	2.176	4.27	2.14	4.73*

*Significant at $p \leq 0.05$,level of significance when t =2.093

Table-1: Comparison of Cephalometric of skeletal and dental analysis before and after Twin-block treatment

Parameter	Pre-treatment N =10		Post-treatment N=10		t-value
	Mean	SD	Mean	SD	
A.J.S. (mm)	1.73	0.55	1.68	0.73	-0.30
P.J.S. (mm)	3.50	1.57	2.00	0.97	5.02*
S.J.S. (mm)	3.48	0.95	3.33	1.31	-0.10
Thickness of condyler head (mm)	11.23	1.08	11.90	1.01	2.38*
Vertical height of articularfossa (mm)	8.35	1.47	7.80	1.79	-1.77
Angle of articular slope°	52.65	9.06	49.55	8.91	-1.26
P.J.S. - A.J.S. P.J.S. + A.J.S.	29.95	20.43	28.85	27.77	-0.191

*Significant at $p \leq 0.05$,level of significance when t=2.093

Twin-Block appliance (Fig.2)

This appliance is relatively small (for a functional appliance) and comfortable. These qualities come from the fact that unlike the other functional appliances, the Twin-block comes as two parts: separate pieces for the upper and lower arches. Clark designed the delta clasp to retain the appliance. The basic design of Twin-block uses clasps on first molars and between first and second maxillary premolars and on the mandibular second premolars. Ball clasps may be placed between the mandibular canines and first premolars for additional retention. This excellent retention enables the patients to accommodate to the appliance quickly allowing full time wear even from the first day [13].

The original upper part of Clark Twin-block appliance has palatal and occlusal pads covering the occlusal surface of the molars, while the lower has a lingual plate ending at the distal of the second bicuspids. In case of mixed dentition, occlusal pads covering the occlusal surface of the primary molars were used. The maxillary and mandibular occlusal pads meet each other at a 70 degrees angle. The inclined occluding surfaces are the functional portion of the appliance. When they meet, they force the mandible into a protrusive position. This stimulates the changes that result in repositioning of the mandible to a Class I posture [10].

STATISTICAL ANALYSIS

Data were collected, coded and analyzed with the Statistical Package for Social Science (SPSS) software for windows (SPSS Version 23, Inc., Chicago, Illinois, USA). Data were statistically described as mean, standard deviation, Paired t-test was used to compare the changes for the sample before and after treatment according to amount of change in the analyzed variables. The significance level was set at $p \leq 0.05$.

RESULTS

In my study, an improvement of overjet, overbite, molars and canines relationships were achieved after treatment using Twin-Block appliance (Fig.3). The great reduction of overjet achieved after treatment helped lips to become competent to each other. The profile and facial esthetics of patients were improved (Fig. 4). So the treatment outcome was very acceptable to the patients and their parents.

After treatment, an acceptable antero-posterior occlusal relationship was observed in all the cases. Some cases showed slight open bite in the posterior segment. The SNA angle was maintained without any significant change while, there was increase in mandibular growth as evident by increasing SNB, SNPg, facial angle, Ba - B and CD - GN. Also there was a significant reduction of ANB angle as a result of increasing SNB angle.

Interestingly there was no significant change of the mandibular plane angle after using the appliance. This makes the use of the appliance indicated in moderate and slightly high angle cases.

Concerning the effects of the appliance upon the dentition, there was significant proclination of the lower incisors and significant retroclination of the upper incisors.

Analysis of tomographic X-rays showed a significant reduction of the posterior joint space with significant increase of condylar head thickness.

No statistically significant difference in the treatment effect between male and female subjects.

DISCUSSION

Removable functional appliances are generally worn part-time and require good cooperation of the patients. Furthermore, the treatment time with these appliances is prolonged over several years. This makes it difficult to differentiate between treatment effects and normal growth changes, especially as suitable untreated control subjects are generally not available for an extended period of time.

McNamara and Carlson's investigations indicated that modification of functional position of the mandible results in an immediate alteration of the neuromuscular activity of the orofacial muscles, particularly noticeable in the lateral pterygoid muscles. It was concluded that as skeletal adaptations occur, the need for compensatory muscle function is reduced [14].

In this study the immediate skeletal, dental, soft tissue, and tempro-mandibular joint changes occurring after one year of wearing TwinBlock appliance was examined in two equal groups with the same type and characteristics of malocclusion.

Treatment effects on maxilla

In this study, no significant change in the SNA angle was observed in the total sample after treatment with Twin-Block appliance. Also, there was no significant difference between male and female subjects.

This result was supported by Toth and McNamara [11].when they compared two groups treated with Twin-Block appliance and functional regulator appliance to an untreated control group (average age of 10 years and 11 months). They stated that there was no clinically significant restriction of maxillary growth.

Furthermore, Trenouth [15]. Found that there was an increase of SNA angle in the untreated group (average age of 10 years and 8 months). So, the maintenance of SNA angle without change may be attributed to the restraining effect of the Twin-Block appliance on maxillary growth.

Treatment effect on mandible

In the present study, a significant increase of the mandibular length after Twin-Block therapy was observed. The additional increase of CD – GN length amounted to 3 mm in the total sample. These results are compatible to those of Lund and Scandler [16].and to those of Mills and McCulloch [17].They concluded that there was a significant increase of mandibular length (CD-GN=3mm) when compared with control subjects who revealed 0.7 mm increase of CD-GN.

As revealed from this study, SNB, SNPg, and Facial angles were found to exhibit a significant increase after using Twin-Block appliance in total sample regarding the sex difference in both groups there was no significant difference between male and female subjects. These findings indicated a significant increase of the length of the mandible and this may be referred to the condylar growth activation caused by the Twin-Block appliance.

This is in agreement with McNamara and Bryan [18] who concluded that the advancement of the mandible resulted in cell activity and formation of new matrix in a posterior and posterior-superior direction, hence causing anterior and anterior-inferior displacement of the mandible (anti-clockwise rotation).

The Ba - B linear measurement showed a significant increase after use of Twin-Block appliance in total samples. Since the Ba point is a stable point, therefore, the mandibular growth was supposed to be activated. By evaluating the sex difference, there were no significant difference between males and females. This finding supports the concept that the Twin-Block appliance has an influence on the mandibular development. Vargervik and Harvold [19] found 1 to 2 mm incremental increase in the growth of the mandible after the use of the activator. Whereas Mills and McCulloch [17] concluded that the mandibular growth was probably responsible for the increase in angle SNB in the TwinBlock group with a lesser increase in the control group.

As regard mandibular plane angle, there was no significant change after using Twin-Block therapy in the total sample and also there was no significant change in both male and female subjects. This was in agreement with Mills and McColluch who concluded that the direction of the mandibular growth by using Twin-Block appliance was favorable and contributed to the anteroposterior skeletal correction this result indicated that Twin-Block appliance could be used, to a certain limit, for low, average, and slightly high angle cases.

Treatment effects on temporomandibular joint

The present study showed a backward movement of the condyle into the fossa as there was a statistically significant decrease in the posterior joint space in the total sample. When comparing male and female subjects the posterior joint space was decreased in both groups. Even, when measuring the thickness of the condylar head, it expressed a significant increase after treatment for both groups. Since the bone deposition that occurs during growth is located at the back of the condyle, therefore, this increase might be one of the causes of the decreased posterior joint space hence, it may be concluded that this appliance may cause posterior remodeling of the condyle.

This is in agreement with McNamara [20] who showed that the condyle response was significant posteriorly and postero-superiorly but not superiorly.

In addition, Woodside et al. [21] reported a certain amount of flattening of the condylar head in their study of Herbst appliance therapy. If this finding is interpreted from a functional perspective, it can be assumed that the strain occurring on the articular disc during the protrusion of the mandible create pressure on the condylar head, and this pressure inhibits the superior condylar response.

In contrast, Mirzen et al. [22] found the condyle located anteriorly after functional treatment of skeletal Class II div. 1 using magnetic resonance imaging study.

Dentoalveolar changes after treatment

An average proclination of 4 degrees of the lower incisors after treatment was observed in this study. This lower incisor proclination, although helpful in achieving overjet correction, it is not a goal of functional appliances treatment. The more the lower incisors procline, the less possibility there is for skeletal correction of the overjet.

This is in agreement with Lund and Scandler [16] who reported greater proclination of the lower incisors relative to controls, as did Mills and McCulloch [23].

In contrast, Trenouth [15] found that there were no significant changes in the lower incisors inclination after using Twin-Block appliance.

Clinical recommendations

On the bases of the data obtained from the present study the ideal candidates for treatment with Twin-Block appliance are those patients who have the following features:

1. Reterognathic mandible.
2. Low, moderate, and slightly high mandibular plane angle.
3. Orthognathic maxilla.
4. Normal, or slightly proclined upper incisors especially if it is spaced.
5. Normal, retroclined or slightly proclined lower incisors.

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