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Cephalometric Comparison of Treatment with Twin Block Appliance in Skeletal Class II Div 1 Patients with Normal and Vertical Growth Pattern

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ABSTRACT

Regarding the effects of increase in vertical dimension on the outcomes of treatment with functional appliances, this study was designed to evaluate the differences between the outcome of treatment with twin block appliance in patients with normal and vertical growth pattern. This prospective cohort study was done by counting all (census) method so any patient with class II malocclusion due to mandibular deficiency was entered to the study with an informed consent. Each subject had immediate pre-post treatment lateral cephalograms. There were 11 patients in normal (FMA≤28) & 16 patients in vertical (FMA>28) group. Pre-post treatment lateral cephalograms were digitized and analyzed by Dolphin Imaging software. The data were then subjected to Paired t test & ANKOVA analysis. There was a statistically significant (p<0.05) reduction in overjet, U1-NA, U1-SN, ANB in both groups. Patients with normal growth pattern show a statistically significant (p<0.05) increase in L1-NB, AFH & IMPA. In patients with vertical growth pattern a statistically significant (p<0.05) increase in SNB, L1-NB, Co-Go, Co-Gn, AFH, PFH, PFH/AFH, LAFH & ANS-PNS can be mentioned. In comparison between two groups, there was statistically no significant difference in any variable after treatment. Twin block appliance is effective in correcting skeletal class II malocclusion and there is statistically no significant difference in any variable after treatment between two groups.

Key words: Growth, Orthodontic Appliance, Functional, Cephalometry

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INTRODUCTION

Skeletal class II malocclusion is the most prevalent disorder in orthodontics, which is diagnosed by deficiency and under development of mandible or overgrowth of maxillary arch; Even though most of the class II patients suffer from deficiency in ant-posterior position of mandible [1]. Some studies mentioned that the abnormal position of the jaws or atypical growth pattern of dental and craniofacial structures can effect on pharyngeal dimensions, Physical attractiveness and etc. [2,3]. Whenever a child faces a skeletal problem, the ideal solution is correction by growth modification, in such a way the problem is corrected by overgrowth of one arch relative to the other. There are different methods to correct skeletal class II but the main focus is on the growth modification treatment [4].

In 1980s, functional appliances achieved impressive results in class II correction with mandibular growth stimulation [4]. Growth modification in maxilla, improvement of mandibular growth and position, and changes in dental and muscular relations are the effects, expected from functional appliances [1].

Functional appliances also affect anterior and posterior teeth eruption to correct class II relationship. However, it should be noticed that in patients with mandibular deficiency, posterior teeth eruption helps class II correction only when there is a noticeable growth in vertical dimension. In fact, if mandibular posterior teeth eruption exceeds ramus vertical advancement, the mandibular growth will be more visible in vertical aspect than in forward and help class II correction [4]. Although any effort for growth modification would better be achieved at the peak of pubertal growth; in order to achieve maximum skeletal effects and minimal dentoalveolar changes [3].

Twin block is the most effective appliance in class II malocclusion correction between different types of fix and removable appliances [5].

According to a classification of Charles H. Tweed in 1946, patients were classified into multiple groups regarding their response to the treatment and treatment prognosis.

If the Frankfort-mandibular plan angle is between 16 and 28, the growth vector has been downward and forward to a degree which is normal. These patients usually benefit from a normal occlusion and a skeletal growth pattern with a negligible deviation from normal. A permanent treatment with a perfect esthetic could be expected in these patients.

If the Frankfort-mandibular plan angle is between 28 and 35, the growth vector is not so favorable. The prognosis is moderate, and it will be worse with FMA increase.

Rarely an orthodontic treatment can be useful and beneficial to whom the Frankfort mandibular plan angle is more than 35[6].

Regarding that, treatment effects of twin block appliance can be camouflaged by an increase in lower anterior face height (due to treatment effects or normal growth), it seems that patients with different growth patterns respond differently to this kind of treatment. So, this study is designed to compare the treatment responses to twin block appliance in patients with normal and vertical growth pattern.

MATERIALS AND METHODS

Participants and Inclusion criteria

Every patient with skeletal class II div I malocclusion who need functional treatment were entered to the study with an informed consent.

Inclusion criteria

- Skeletal class II div I malocclusion due to mandibular deficiency
- ANB angle>4
- Overjet> 6mm
- *Between 9-13 years of age*

Exclusion criteria

- Patients with any systemic disease
- Patients who use any systemic drug, effective on growth and skeletal metabolism
- Patients who need any choice of tooth movement except palatal expansion

Both groups treated by one orthodontist and received the same modification of Clark twin block appliance with Adams on first premolars and a labial bow in mandible, and Adams on first molars, labial bow and expansion screw in maxilla. During the treatment 20 patients received palatal expansion of necessity. All patients received pretreatment lateral cephalogram with the same machine (CranexD, Soredex, Tusuula, Finland). The sample then was divided into two groups according to the means of FMA angle, calculated from three separate measurements by one investigator with an interval of one week. Patients with 16<FMA≤28 were selected as the normal group and patients with 28<FMA≤35 as the vertical growth pattern group. At the end of functional therapy second radiograph were taken from any patients remaining in the study with the same terms as the beginning of treatment.

Requirements to finish the functional therapy and taking the second radiograph were as follows:

- At least 6 months after the start of functional therapy
- Patient in permanent dentition
- Overjet≤ 3mm
- Class l molar and canine relationship

At the end of the study pre and post lateral cephalograms were digitized and analyzed with Dolphin imaging software, version11.0.01.38

premium. Finally, all of the measurements were subjected to SPSS software tests.

Sample size calculation and statistical analysis

All the patients referred to dental school and met the inclusion criteria were chosen and entered to the research with an informed consent. At the end of recruiting phase, a sample of 36 patients with Class II div I malocclusion due to mandibular deficiency were collected.

In order to reduce the error of the method pre and post lateral cephalograms were digitized and analyzed 3 times with an interval of one week by one investigator. These measurements then were used to calculate the means for each variable and finally the means of all measurements were recorded in a check list and subjected to SPSS software tests.

In order to evaluate the changes resulting from treatment, paired sample t test was done for each variable, separately for each group. To compare the effect of treatment groups (normal and vertical growth pattern) on studied cephalometric variables, ANKOVA analysis was used.

RESULTS

At the end of recruitment phase, a sample of 36 patients, matching all of the inclusion criteria, were chosen and entered to the research with an informed consent. At the end of the study, 4 patients were excluded from the study due to poor cooperation, 1patient due to an open occlusion in second radiograph, 1 because of using headgear and 3 patients because of using a different version of x-ray machine to take second radiograph. So, the sample size reduced to 27 cases, including 11patients in normal and 16 in vertical growth pattern group.

At the end of the study, the sample consisted of 27 patients, including 11 cases in normal and 16 cases in vertical group. There were 13 boys and 14 girls. Distribution of sex frequency in two groups displayed in (Table 1), showed statistically no significant difference between the frequency of sex distribution in two groups (p=0.6). Age distribution comparative test also showed no significant difference between the means of age in two groups (p=0.06). The mean age was 11.1±0.3 in normal & 10.53±0.3 in vertical growth pattern group. Also the average of treatment time was calculated 12.8±3.9 months in normal & 13.7±3.9 months in vertical group, which revealed statistically no significant difference between two groups (p=0.5).

Table 1: The frequency of variable sex in each normal and vertical growth pattern group

			Group		Total
			Horizontal	Vertical	
Sex	Male	Count	5	8	13
		% within group	45.5	50.0	48.1
	female	Count	6	8	14
		% within group	54.5	50.0	51.9
Total		Count	11	16	27
		% within group	100.0	100.0	100.0

Numbers analyzed for each outcome

To evaluate the changes from treatment protocol, paired sample t test was done for all variables separately in two groups. Results are displayed in (Tables 2, 3).

According to these tables there was a statistically significant reduction in means of Overjet (P<0.001), U1-NA (P=0.006) and ANB (P<0.001) and increase in means of L1-NB (P=0.002), AFH (P=0.049) and the angle IMPA (P=0.007) in patients with normal growth pattern. In this group, no significant change happened in measurements related to mandible. Even though there was an increase in a few variables like Co-Go, Go-Me and LAFH.

As a result of treatment in patients with vertical growth pattern, a statistically significant reduction in overjet (P<0.001), ANB (P<0.001), U1-NA (P=0.013), U1-SN (P=0.005)& a statistically significant increase in SNB (P<0.001), L1-NB (P<0.001), Co-Go (P<0.001) , Co-Gn (P<0.001), AFH (P=0.001), PFH (P<0.001), PFH/AFH (P=0.043), LAFH (P<0.001), & ANS-PNS (P=0.005) can be mentioned.

The size of variables before treatment were assessed by independent sample t test and significant differences were seen in size of some variables including IMPA, Co-G, Co-Gn, Go-Me, Ar-Go-Me, PFH and ANS-PNS between two groups.

To evaluate the relationship between different growth patterns and the size of variables after treatment ANKOVA analysis was done.

The results of ANKOVA analysis are shown in (Table 4, 5)

The evaluation of results showed that in significance level of 0.05, after modulation of "variable size before treatment" the effect of group was not significant in none of the variables.

Table 2: The mean of linear variables before and after of applying treatment for normal and vertical growth pattern groups

Variable		Before±(SD)	After±(SD)	Difference±(SD)	P-value
Overjet	normal	8/76±(1/98)	2/49±(1/58)	6/27±(2/5)	*<0/001
	vertical	8/86±(1/88)	2/64±(1/10)	6/22±(2/3)	*<0/001
L1-NB	normal	5/18±(1/8)	6/71±0(1/7)	1/53±(1/0)	*0/002
	vertical	5/20±(1/9)	7/11±(1/8)	1/90±(1/2)	*<0/001
U1-NA	normal	4/75±(2/3)	2/68±(1/5)	-2/07±(1/8)	*0/006
	vertical	5/04±(1/8)	3/82±(2/5)	-1/22±(1/6)	*0/013
Co-Go	normal	49/73±(3/64)	52/06±(4/4)	2/33±(3/2)	0/52
	vertical	43/97±(2/4)	46/76±(4/2)	2/76±(2/4)	*0/001
Co-Gn	normal	106/04±(8/8)	109/22±(7/8)	3/18±(7/3)	0/205
	vertical	97/38±(4/4)	103/11±(4/7)	5/73±(3/3)	*<0/001
Go-Me	normal	69/25±(7/2)	70/73±(5/7)	1/48±(4/1)	0/291
	vertical	59/77±(5/4)	62/38±(5/7)	2/60±(6/2)	0/12
AFH	normal	108/51±(7/5)	112/09±(7/4)	3/58±(4/9)	*0/049
	vertical	103/03±(5/3)	107/48±(5/7)	4/44±(2/4)	*0/001
PFH	normal	72/93±(5/8)	74/06±(5/3)	1/13±3/95	0/782
	vertical	62/46±(4/1)	66/88±(5/2)	4/42±(2/5)	*<0/001
PFH/AFH(%)	normal	0/67±(0/11)	0/64±(0/03)	-0/03±(0/1)	0/386
	vertical	0/60±(0/03)	0/62±(0/03)	0/02±(0/02)	*0/043
LAFH	normal	61/83±(5/4)	63/81±(5/1)	1/98±(4/0)	0/154
	vertical	59/30±(3/8)	62/01±(3/7)	2/71±(2/3)	*0/001
LAFH/AFH (%)	normal	0/57±(0/01)	0/57±(0/01)	-<0/001	0/942
	vertical	0/57±(0/01)	0/57±(0/01)	0/001	0/384
ANS-PNS	normal	48/55±(2/7)	49/07±(2/9)	0/52±(2/3)	0/50
	vertical	44/26±(2/5)	45/79±(3/0)	1/52±(1/4)	*0/001

**: significance level of 0.05; **: standard deviation*

Table 3: The mean of angular variables before and after of applying treatment for normal and vertical growth pattern

Variable		Before±(SD)	After±(SD)	Difference±(SD)	P-value
FMA	normal	25/49±(2/7)	26/11±(2/7)	0/62±(0/8)	0/53
	vertical	33/50±(2/5)	34/27±(3/0)	0/77±(1/5)	0/07
SNA	normal	80/78±(3/4)	79/93±(4/1)	-0/85±(2/1)	0/243
	vertical	80/11±(4/2)	80/52±(4/8)	0/41±(1/8)	0/415
SNB	normal	74/07±(3/.)	74/92±(3/1)	0/84±(2/3)	0/279
	vertical	73/04±(3/7)	75/37±(4/0)	2/32±(2/0)	*0/001
ANB	normal	6/72±(1/1)	5/01±(1/6)	-1/71±.(./9)	*<./001
	vertical	7/07±(1/8)	5/13±(2/7)	-1/93±(1/3)	*<./001
IMPA	normal	103/34±(5/9)	107/13±(5/3)	3/78±(3/4)	*0/007
	vertical	96/12±(5/4)	98/69±(4/4)	2/56±(4/8)	0/59
U1-SN	normal	108/39±(6/1)	102/55±(5/0)	-5/83±(6/0)	*0/014
	vertical	111/08±(6/2)	107/23±(6/9)	-3/84±(4/4)	*0/005
Interincisal angle	normal	114/12±(8/8)	116/05±(5/5)	1/92±(7/7)	0/452
	vertical	111/62±(8/3)	113/72±(7/5)	2/09±(7/0)	0/266
Ar-Go-Me	normal	126/02±(5/1)	126/92±(5/3)	0/89±(2/2)	0/23
	vertical	134/76±(5/0)	135/89±(4/2)	1/13±(1/9)	*0/04
Y-Axis	normal	69/16±(2/5)	69/10±(2/7)	-0/06±(1/2)	0/87
	vertical	71/11±(2/6)	70/03±(3/0)	-1/07±(2/0)	0/06

**: significance level of 0.05; **: standard deviation*

Table 4: Linear regression models for linear variables

Variable		P-value
L1-NB	Intercept (B_0)	*<0/001
	Group(B_1)	0/415
	size of variable before tx (B_2)	*<0/001
U1-NA	Intercept (B_0)	0/724
	Group(B_1)	0/192
	size of variable before tx (B_2)	*<0/001
Co-Go	Intercept (B_0)	0/780
	Group(B_1)	0/510
	size of variable before tx (B_2)	*<0/001
Co-Gn	Intercept (B_0)	*0/009
	Group(B_1)	0/726
	size of variable before tx (B_2)	*<0/001
Go-Me	Intercept (B_0)	*0/006
	Group(B_1)	0/201
	size of variable before tx (B_2)	*0/003
AFH	Intercept (B_0)	0/080
	Group(B_1)	0/842
	size of variable before tx (B_2)	*<0/001
PFH	Intercept (B_0)	*<0/001
	Group(B_1)	0/303
	size of variable before tx (B_2)	*0/002
PFH/AFH	Intercept (B_0)	*<0/001
	Group(B_1)	0/449
	size of variable before tx (B_2)	*0/010
LAFH	Intercept (B_0)	*0/028
	Group(B_1)	0/984
	size of variable before tx (B_2)	*<0/001
LAFH/AFH	Intercept (B_0)	0/116
	Group(B_1)	0/458
	size of variable before tx (B_2)	*<0/001
ANS-PNS	Intercept (B_0)	0/453
	Group(B_1)	0/557
	size of variable before tx (B_2)	*<0/001

**: Significance level of 0.05.*

Table 5: Linear regression models for angular variables

Variable		P-value
SNA	Intercept (B_0)	0/593
	Group(B_1)	0/133
	size of variable before tx (B_2)	*<0/001
SNB	Intercept (B_0)	0/276
	Group(B_1)	0/141
	size of variable before tx (B_2)	*<0/001
ANB	Intercept (B_0)	0/101
	Group(B_1)	0/653
	size of variable before tx (B_2)	*<0/001
IMPA	Intercept (B_0)	0/003
	Group(B_1)	0/343
	size of variable before tx (B_2)	*<0/001
U1-SN	Intercept (B_0)	0/085
	Group(B_1)	0/165
	size of variable before tx (B_2)	*<0/001
Interincisal angle	Intercept (B_0)	*0/001
	Group(B_1)	0/617
	size of variable before tx (B_2)	*0/004
Ar-Go-Me	Intercept (B_0)	0/054
	Group(B_1)	0/146
	size of variable before tx (B_2)	*<0/001
Y-Axis	Intercept (B_0)	0/427
	Group(B_1)	0/323
	size of variable before tx (B_2)	*<0/001

Significance level of 0.05

DISCUSSION

Main findings

The results from this research revealed that twin block appliance is effective in correcting skeletal class II malocclusion both in normal and vertical growth pattern groups. This conclusion was achieved regarding a significant reduction in overjet and ANB at the end of treatment in both groups. Using twin block functional appliance separately in both groups induced a number of dentoskeletal changes in relation to mandible and maxilla. Most of these changes including all of the changes in relation to mandibular skeleton and dental changes were in the same direction in both groups, however, there were differences in significance in some of those variables. It should be noted that after data analysis no significant difference was found in size of variables after treatment between two groups (with modulation the size of variables before treatment).

Skeletal changes in mandible

In this study findings revealed a forward movement and/or an increase in mandibular length and ramus height in both groups. However, in vertical group these findings showed a significant and more increase in total mandibular length, ramus height and forward movement of mandible. The means of results indicate that in normal growth pattern group, mandibular skeletal changes happened less, that is also not statistically significant. The findings in relation with mandibular length increase were in consistent with other studies [5-13]. Burhan et al [14], Lau Ey et al [11] and Schaefer et al [13] also found ramus height increase as a result of treatment with twin block. It should be noticed that till now no research has studied the patients separately in different growth patterns.

Maxillary skeletal changes

These findings show slight and different changes in size and direction of maxillary growth regarding the points S, N & A in both groups; In a way that in normal group a slight reduction in SNA(-2.8 ± 0.85) was seen. Although, this reduction was not clinically noticeable and statistically significant, but in Lunda & Sandler's view, claiming that retroclination of maxillary incisors and labial tipping of the roots cause remodeling of point A to a forward position and hiding the headgear effect on maxilla, this slight reduction in SNA could show the headgear effect of the appliance and growth restriction of maxilla in normal group. But significantly, this growth restriction was not seen in any group, which is in agreement with Lunda and Sandler [12], Dauravu et al [15] and several other studies [8, 16]. However, some studies [7, 17, 18] suggest significant headgear effect in treatment with twin block appliance regarding SNA angle.

As another difference between these two groups about maxillary skeletal changes, slight but significant increase in maxillary length in vertical group can be mentioned. These cephalometric findings which are exclusively seen in vertical growth pattern group, in addition to those related to SNA angle, can show the inability of this kind of functional therapy in modification of maxillary skeletal growth in this group.

Dentoalveolar changes

Dentoalveolar changes in this study, the same as in other past studies [5, 7, 8, 14, 16], showed significant mandibular incisor protrusion and maxillary incisor retrusion. When evaluating this factor separately in two groups, dentoalveolar changes of both arches were more noticeable in vertical group.

Skeletal class II correction

According to the changes mentioned in previous parts, the correction of maxillomandibular sagital relationship in both groups has happened with this functional appliance; although, when dividing groups, it seems that this amount of overjet correction in normal group was dominantly because of dentoalveolar changes (and a slight but not significant restriction of maxillary growth). These findings are consistent with those of Lunda & Sandler [14] and O'Brien et al., [19] about the dominant and significant effects of dentoalveolar changes on class II correction.

According to the results, displayed in Tables 2 & 3, the correction of maxillomandibular relationship in patients with vertical growth pattern has been achieved differently from normal group, by dominant effects of skeletal changes in mandibular length and height. Studies of Bacceti et al [20], Jenna et al [16] and Mills and Mc Culloach [17] were also in agreement with this study; however, Jenna had considered this amount of skeletal changes in his sample due to treatment time because they were all in their pubertal growth spurts. O'Brien [19] also argues that most of the studies that have reported significant skeletal improvements were retrospective and therefore exposed to selection bias, resulting in overestimated treatment effects. So, this study was designed prospectively with no significant difference in the average of age between two groups.

Vertical dimension

Regarding the results, the mandibular plan has not been affected significantly during treatment, just the same as what Lunda [14] and Mc Culloach [17] mentioned. However, a slight but significant increase in gonial angle occurred in patients with vertical growth pattern.

About the changes of vertical dimension, although we saw an increase in anterior facial height in both groups, but the same as Sidlauskas [18] study, we found that since the lower anterior facial height to total anterior facial height ratio did not change, the proportionality of upper and lower anterior face height was not affected. So, this finding can be indicative of normal growth and also the ability of twin block appliance in controlling vertical dimensions in both groups.

As the most prominent finding of changes in vertical dimension, a significant increase in posterior facial height and the ratio of posterior facial height to the anterior facial height in vertical group can be mentioned. Burhan et al [14] and Scheafer et al [13] noted the increase of posterior facial height as a significant finding in their studies, but none of them evaluate the ratio of posterior height changes to the anterior. So, this study suggests that, in addition to a vertical dimension control, treatment with twin block appliance can modulate the pattern of vertical growth significantly by stimulating ramus growth and increasing the posterior facial height in patients with vertical growth pattern.

The effects of different growth patterns on treatment results

According to the results from ANKOVA analysis displayed in Tables 4 & 5, after modulating the effects of variable size before treatment, "group" has no significant effect on any variable size after treatment.

CONCLUSIONS

Twin block appliance is effective on correcting skeletal class II in both normal and vertical growth patterns, and there is statistically no significant difference in size of variables after treatment between two groups. The correction of maxillomandibular Sagital relationship is achieved due to reduction in overjet an ANB angle. In patients with vertical growth pattern, there are significant skeletal changes in mandibular length and ramus height which cause an increase in posterior facial height and modulation of vertical pattern of growth consequently. Dentoalveolar changes including mandibular incisors protrusion and maxillary incisors retrusion are the most common findings of both groups that seem to have the most dominant effect on skeletal class II correction in patients with normal growth pattern.

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