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Clinical Effectiveness of the Twin Block Appliance in the Treatment of Class II Division 1 Malocclusion

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SUMMARY

The aim of the present study was to assess clinical effectiveness of Class II Division 1 malocclusion treatment with Twin block appliance.

Material and methods: analysis of cepahlometric radiographs of 34 Class II Divison 1 patients treated with Twin block appliance was performed before and after treatment. A control group was generated from the normative growth data published by Bhatia and Leighton. The treatment effect was calculated by subtracting the natural growth change from the treatment change. This was then compared to twice the method error to see if the treatment change was clinically significant.

Results: Mean mandibular length as measured from point Art to point Pog increased by 6.4 mm in the Twin–block group compare with 4.1 mm in the control group. The overjet during treatment was reduced by 4.9 mm. Relative to the maxilla upper incisor tipped backward by 6.7° and in the control group natural growth proclined them by 2.4°. Lower incisor after the treatment tipped forward and the angle between long axis of lower incisor and mandibular plane increased by 3.3°, whereas in the control group they stay almost in the same position, proclination only 0.7°.

Conclusions: Twin block appliance clinically significantly increases mandibular length (net effect 2.3 mm) and reduce overjet (net effect 4.9 mm). Modification of the Twin block appliance by acrylic extension to cover the edges of lower incisors reduce dentoalveolar tipping and maximize skeletal changes

Key words: malocclusion, treatment of malocclusion with functional appliances, Twin block.

INTRODUCTION

Functional appliances have been used for the treatment of Class II Division 1 malocclusion more than a hundred years. Despite the long history there continues to be much controversy related to their mode of action and clinical effectiveness. Majority of clinical studies (1) recognized useful effect of functional appliances for sagittal discrepancies correction, but it remained questionable whether the results could be attributed to skeletal changes rather than to dentoalveolar compensation. Histological studies on laboratory animals demonstrated a significant increase in cellular activity when mandible is protruded (2) and it is believed that similar effect can be produced in humans (3). Some cephalometric studies showed small amounts of statistically significant increased growth of mandible, when functional appliance was used. But do these small amounts may, however, be clinically significant in the total malocclusion correction? According to Baumrind and Frantz (4) the observed difference consider to be the result of therapy should at least be twice the method error (ME). They claim that in any single clinical case, one can not be sure that an observed difference, for example in the angle ANB, is biologic rather than a measurement error, unless it exceeds 2 × ME or 1.2°.

The other problem with the studies on functional appliances is a control group. To assess the factors that influence facial growth other than appliance therapy it is necessary to have an appropriate control group. The possibility to use untreated persons with Class II Division 1 as a control is limited by ethical considerations. The normative longitudinal growth records are suitable alternative. There are published four normative growth atlases: the Ann Arbor, Cleveland (Bolton), London (UK) and Philadelphia. It is recommended to match control group for age, gender, treatment time and geographic region (5). The research publications on the Twin block appliance despite its gained popularity in clinical practice are quite limited (6). The aim of the present study was to compare the cephalometric changes in Class II Division 1 malocclusion patients treated with Twin block appliance to natural growth change in the matched control group and assess if the treatment change was clinically significant.

MATERIAL AND METHODS

Sample selection. The treatment group consisted of 34 cases treated in the Clinic of Orthodontics, Kaunas university of medicine. The study included 15 boys and 19 girls ranging in age from 9 years 3 months to 10 years 8 months at the start of treatment (T_1). The mean age at the start of treatment was 10 years 2 months .

The criteria for inclusion of a given patient into this study were the existence of :

- the Class II Division 1 dental type : distal molar and canine occlusion of at least ½ premolar width;
- overjet ≥ 5,0 mm, protrusion of the maxillary incisors;
- Class II skeletal type, ANB angle ≥ 4^0;
- Occlusal development – late mixed or early permanent dentition.

Treatment protocol. The basic design of the Twin Block appliance used in this study is illustrated in Picture 1. Design differs somewhat from the conventional Clark's Twin Block appliance in that the acrylic was extended to cover the incisal edges of lower incisors. This helps to avoid tip-

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ping of the lower incisors and improve in retention. Torquing springs were used to control position of the upper incisors.

The patients were instructed to turn the maxillary expansion screw one turn per week to achieve co-ordination of the upper and lower arches in the transverse dimension. The active treatment time with the Twin Block appliance ranged from 9 to 14 months (average 12 months).

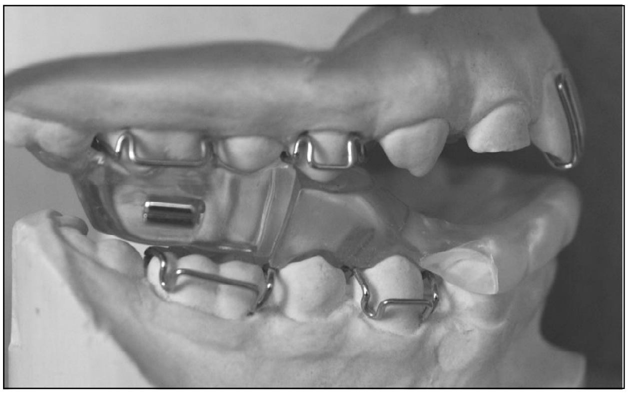
Cephalometric analysis was performed on the lateral cephalometric radiographs taken at the start of treatment (T_1) and after active treatment period (T_2). The cephalograms were taken in centric occlusion under standard conditions (constant film-focus distance of 1.50 m, object-film distance 0.15 m). The decisive structures of all cephalograms were traced by the author with the pencil on acetate foil and all necessary reference points were marked. The radiographs were traced in random odder to reduce bias. A sliding calliper was used to measure distances between reference points to a nearest half millimetre. Angular measurements were made to the nearest degree, using a protractor. When there were two images of a structure, the reference point was placed at the midpoint between the images. No correction was made for enlargement of the radiographs (approximately 8.2%) in the median plane. The points and planes used in the cephalometric analysis shown in the Picture 2. Cephalometric analysis comprised the 16 variables: SNA, SNB, ANB, overjet, overbite, maxillary base – distances (PTM–ANS) and (Art–A), mandibular base – distances (Art–Pog) and (Art–B), total anterior facial height TAFH (N–ANS + ANS–ME), lower anterior facial height LAFH (ANS–Me), facial proportion: the ratio of the LAFH to the TAFH (calculated as percentage), mandibular plane angle to cranial base (SN/Man), mandibular plane angle to maxillary plane (Max/Man), maxillary incisor angle to maxillary plane (is – as/Max), mandibular incisor angle to mandibular plane (ii – ai/Man).

Statistical analysis was performed using the Statistical Package for the Social Sciences for Windows (SPSS V8.0). The following values were calculated for every single variable: mean, standard deviation (SD), method error (ME). All mean values were compared before (T_1) and after treatment (T_2) with Twin block using a Mann-Whitney U–test for statistical significance. Significance was determined at the 0.05, 0.01 and 0.001 levels of confidence. The treatment effect (net effect) was calculated by subtracting the natural growth from the treatment change. This was then compared to twice the method error to evaluate if the treatment change was clinically significant.

Method error. Intra-observer method error was analyzed using a method suggested by Bland and Altman (8). The reliability of the method was tested by tracing and measuring 20 randomly selected lateral cephalograms twice. The estimated error between the measurements was calculated using the formula:

$$ME = \sqrt{\sum (d_1 - d_2)^2 / 2(n-1)}$$

Where d1 = first measurement, d2 = second measurement; N=number of patients.



Picture 1. Twin block appliance construction

Table 1. Cephalometric measurement in Class II Division 1 malocclusion before and after treatment with Twin block.

Variable	Twin block group				Control group			
	T1		T2		T1		T2	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Linear (mm)								
1. Maxillary base *PTM-ANS*	49.8	2.4	50.5	2.2	49.5	2.9	50.9	2.7
2. Maxillary base *Art-A*	80.4	3.9	82.2	4.4	76.9	4.1	79.3	4.3
3. Mandibular base *Art-Pog*	96.7	4.8	103.1	5.2	92.4	4.4	96.5	4.9
4. Mandibular base *Art-B*	88.6	4.5	94.7	4.6	84.5	3.9	87.7	4.4
5. Total anterior facial height *N-ANS + ANS-ME*	106.7	7.2	112.9	7.5	103.5	5.7	107.2	6.6
6. Lower anterior facial height *ANS-Me*	58.0	4.9	61.9	4.8	55.4	4.0	57.5	4.6
7. Lower anterior facial height / Total anterior facial height (%)	54.3	1.6	54.8	1.5	54.2	1.9	53.6	2.7
8. Overjet	6.2	1.9	1.4	1.0	3.9	1.7	4.0	1.6
9. Overbite	4.5	1.8	1.2	1.1	2.9	2.2	3.2	1.5
Angular (°)								
10. SNA	81.4	3.0	81.1	2.6	79.6	4.2	80.1	3.4
11. SNB	75.8	2.9	77.8	2.9	76.6	4.0	77.3	3.3
12. ANB	5.6	1.5	3.3	0.8	3.0	2.7	2.8	2.1
13. SN/Man	33.1	3.0	33.5	2.8	36.0	5.9	35.3	4.8
14. Max/Man	26.4	3.5	26.6	3.0	28.9	5.5	28.3	4.5
15. Maxillary incisor angle is – as/Max	112.9	6.9	106.2	5.7	109.5	7.7	111.9	5.8
16. Mandibular incisor angle ii – ai/Man	94.9	5.6	98.2	6.1	90.5	7.6	91.2	6.2

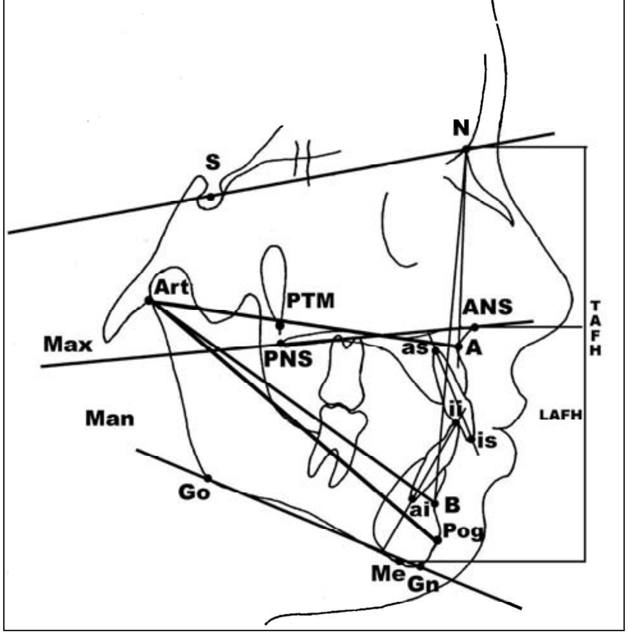
Table 2. Mean changes in cephalometric parameters during treatment (T2 minus T1).

Variable	Twin block goup T2 - T1		Control group T2 - T1		p	Net effect	Method error	2 x ME	Clinical significance
	Mean	SD	Mean	SD					
Linear (mm)									
1. Maxillary base *PTM-ANS*	0.7	0.4	1.4	1.2	0.01	- 0.7	0.42	0.84	N.S.
2. Maxillary base *Art-A*	1.8	1.6	2.4	1.7	N.S.	- 0.6	0.43	0.86	N.S.
3. Mandibular base *Art-Pog*	6.4	4.3	4.1	3.2	0.001	2.3	0.67	1.34	+
4. Mandibular base *Art-B*	6.1	3.9	3.2	1.9	0.001	2.9	0.83	1.66	+
5. Total anterior facial height *N-ANS + ANS-ME*	6.2	1.5	3.7	1.8	0.001	2.5	0.51	1.02	+
6. Lower anterior facial height *ANS-Me*	3.9	1.2	2.1	0.9	0.001	1.8	0.55	1.10	+
7. Lower anterior facial height / Total anterior facial height (%)	0.5	0.9	- 0.6	0.7	0.001	1.1	0.63	1.26	N.S.
8. Overjet	- 4.8	1.4	0.1	0.1	0.001	- 4.9	0.62	1.24	+
9. Overbite	- 3.3	1.1	1.0	0.6	0.001	- 4.3	0.73	1.46	+
Angular (°)									
10. SNA	- 0.3	1.0	0.5	0.4	0.001	- 0.8	0.57	1.14	N.S.
11. SNB	2.0	1.5	0.7	0.5	0.001	1.3	0.52	1.04	+
12. ANB	- 2.3	1.5	- 0.2	0.1	0.001	- 2.1	0.51	1.02	+
13. SN/Man	0.4	0.9	- 0.7	0.6	0.001	1.1	0.62	1.24	N.S.
14. Max/Man	0.2	1.1	- 0.6	0.4	0.001	0.8	0.54	1.08	N.S.
15. Maxillary incisor angle is – as/Max	- 6.7	1.8	2.4	1.2	0.001	- 9.1	1.08	2.16	+
16. Mandibular incisor angle ii – ai/Man	3.3	2.2	0.7	0.5	0.001	2.6	1.14	2.28	+

RESULTS

Cephalometric measurements before and after Twin block appliance treatment as well as natural growth change in the matched control group are seen in Table1. The net effect and clinical significance presented in Table 2. Mean mandibular length as measured from point Art to point Pog increased by 6.4 mm in the Twin block group compare with 4.1 mm in the control group. The net treatment effect gained on the Art–Pog was 2.3 mm and it is clinically significant. The similar results received when mandibular base was assessed from point Art to point B: the net effect was clinically significant increase in length by 2.9 mm. Maxillary skeletal measures indicate little change in the length of the maxillary base. The net effect of maxillary base reduction as measured from point PTM to ANS was only 0.7 mm and from point Art to A only 0.6 mm.

Skeletal relationship between maxillary and mandibular bases improved significantly, as indicated by reduced angle ANB. This was mainly due to a statistically significant in-



Picture 2. Points and planes used in the cephalometric analysis

Points :

S	Sella : the midpoint of sella turcica
N	Nasion : the extreme anterior point of the frontonasal suture
A	Point A : the deepest point in the curvature of the maxillary alveolar process
B	Pont B : the deepest point in the curvature of the mandibular alveolar process
ANS	Anterior nasal spine : the apex of anterior nasal spine
PNS	Posterior nasal spine : the extreme posterior point of maxilla
PTM	Pterygomaxillare : the inferior point at the junction of the anterior and posterior borders of the pterygo-maxillary fissure
Art	Articulare : the point of intersection between the posterior border of the mandibular condyle and the lower border of the cranial base
Me	Menton : the extreme inferior point of the chin
Pog	Pogonion : the most anterior point on the mandibular symphysis
Go	Gonion : the midpoint of the mandibular angle between ramus and the mandibular corpus
Gn	Gnathion: the midpoint between Pogonion and Menton
as	Apex superior : the root apex of the most anterior maxillary central incisor
ai	Apex inferior : the root apex of the most anterior mandibular central incisor
is	Incision superius : the incisal tip of the most anterior maxillary central incisor
ii	Incision inferius : the incisal tip of the most anterior mandibular central incisor

Planes and lines :

SN	Sella-Nasion line
Max	Maxillary plane (ANS – PNS)
Man	Mandibular plane (Go-Gn)
LAFH	Lower anterior facial height (A – ANS)
TAFH	Total anterior facial height (A – Me)

crease in angle SNB. Because reduction in angle SNA was statistically significant, but the treatment change was less than 2ME.

The overjet during treatment was reduced almost by 5 mm and this treatment change was clinically significant. The Twin block treatment resulted in a posterior movement of upper incisor. Relative to the maxilla upper incisor tipped backward by 6.7° while in the control group natural growth proclined them by 2.4°. Lower incisor after the treatment tipped forward and the angle between long axis of lower incisor and mandibular plane increased by 3.3°, whereas without treatment (control group) they stay almost in the same position, proclination only 0.7°.

The treatment tended to produce increase in vertical facial dimensions. The net increase of lower anterior facial height after the treatment is 1.8 mm. The mandibular plane (SN/Man) angle remained almost unchanged during treatment but decreased in the control group. The latter difference was statistically significant, but treatment change was less then 2ME. The TAFH and LAFH ratio changes also were not clinically significant.

DISCUSSION

The small differences in outcome between the treated patients and the normative growth data become statistically significant if standard deviations are low or numbers in the study are high. Clinically significant changes in this study were checked for the criterion suggested by Baumrind and Frantz (4), that the treatment effect should be at least twice the method error and exceed 1° or 1 mm.

The functional appliances are used in the hope of correcting Class II skeletal malocclusion by enhancing mandibular growth. There was a clinically significant increase in mandibular length measured from point Art to points Pog and B. This mandibular growth probably was responsible for the increase in angle SNB in the Twin block group by 2.0° as compare with an increase of only 0.7° in the control group. Similar changes in Art–Pog were found by other researches (9, 10). The lower incisors in this study were proclined by 3.3° and lingual movement of lower incisors roots could allow alveolar remodelling moving point B lingually and reducing SNB. So, increase of angle SNB by 2° in this circumstances demonstrates significant its improvement. The enhanced mandibular growth may be of no value to the patient if the growth is expressed in a vertical direction (11). This study demonstrated some vertical facial growth, but the most important is that the treatment change of the ratio LAFH /TAFH in the study group was less then 2 ME. This means that the proportionality in the vertical upper and lower anterior face growth was not affected by the treatment. The Twin block appliance used in the study mainly provided favourable horizontal direction of the mandibular growth and thus substantially contributed to the anteroposterior skeletal correction. The vertical position of the molars was controlled by Adams clasps added to the appliance at the beginning of the treatment and very careful trimming of the acrylic bases afterwards in the subsequent stages.

The impact of Twin block on maxillary forward growth was assessed by means of changes in maxillary base length and angle SNA size. Little change in angle SNA and maxillary base length indicate little maxillary growth restrain.

The study demonstrated that the Twin block appliance reduce the overjet by a combination of dentoaloveolar and skeletal changes. Frontal teeth tipped significantly in the upper dental arch and less in the lower. A desirable lingual tipping of upper incisors could be explained by the Twin block construction used in the study. The torquing springs on the upper incisors presumably resulted their palatally retroclined position. Excessive labial tipping of lower incisors should be limited as it reduces the potential for orthopedic change. This study used acrylic cover for lower incisors which provide rigid retention in the lower labial segment. Nevertheless the lower incisors have been proclined by 3.3° in the treatment group as compare to 0.7° in the control group. To avoid completely dentoalveolar tipping of lower incisor is ideal goal, but there are no study could it report. Many attempts have been done to minimize this side–effect by Twin block appliance modifications (12). The best results achieved by using Sounthend clasps (13) and acrylic cover for lower incisors as it was in this study.

The amount and interrelationship between sagittal skeletal and dental changes contributing to Class II Division 1 correction is decisive to justify the effectiveness of Twin block treatment (14). This study indicates that with the Twin block treatment major part of 4.9 mm net overjet correction was achieved by skeletal changes: 0.7 mm maxillary growth restriction at PTM–ANS, 2.3 mm increase in the mandibular base length at Art–Pog and the rest by dentolaveolar changes.

CONCLUSIONS

1. Twin block appliance clinically significantly increases mandibular length (net effect 2.3 mm) as compare to the normative growth.
2. Significant decrease in overjet (net effect 4.9 mm) was observed at the end of treatment with the Twin block mainly (~3.0 mm) due to the skeletal changes.
3. Modification of the Twin block appliance by acrylic extension to cover the edges of lower incisors reduce dentoalveolar tipping and maximize skeletal changes.

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