The effects of Twin Blocks: A prospective controlled study

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This prospective controlled study investigated the net effects of the Twin Block functional appliance taking into account the effects of normal growth in an untreated control group. The treatment group consisted of 36 subjects, mean age of 12.4 years, consecutively treated with Twin Block appliances for an average period of 0.9 years. Each subject had immediate pre- and posttreatment lateral cephalograms. The control group consisted of 27 subjects with a mean age of 12.1 years. These patients were observed for a mean time of 1.2 years and had radiographic investigation at the initial consultation and immediately before the start of Twin Block therapy. The data were then annualized and subjected to multiple regression analysis. In the treatment group, a reduction in ANB of 2.0° ($p < 0.001$) was observed largely because of an increase in SNB of 1.9° ($p < 0.001$). No statistically significant restraint in the maxillary growth was observed. Treatment resulted in an increase in Ar-Pog of 5.1 mm ($p < 0.001$) compared with the control group increase in Ar-Pog of 2.7 mm, resulting in a net gain of 2.4 mm. The overjet was reduced by combination of a net maxillary incisor retroclination of 10.8° ($p < 0.001$), net mandibular incisor proclination of 7.9° ($p < 0.001$) and forward movement of the mandible. Buccal segment relationships were corrected by means of lower molar eruption, restraint in the eruption of the upper molars and forward growth or repositioning of the mandible. Any possible fossa adaption was not assessed. (Am J Orthod Dentofacial Orthop 1998;113:104-10.)

Functional appliances have been used for over a century in the treatment of Class II Division 1 malocclusions. Although few clinicians deny their clinical efficacy, proof of their growth modifying effect remains elusive.

Many authors feel there is little evidence to support the claim that functional appliances significantly affected mandibular growth. Björk[1] and Pancherz[2] demonstrated only small changes in mandibular growth and concluded that it was not affected by treatment with functional appliances. By contrast Harris,[3] DeVincenzo,[4] and Windmiller[5] suggested that there may be significant influences on mandibular growth after timely intervention.

Robertson[6] suggested that the principal changes that occurred with functional appliance therapy were dentoalveolar, including distalization of the upper buccal teeth and retroclination of the upper labial segments, along with mesial movement of the lower buccal segments and proclination of the lower labial segments. Vertical changes included delay of eruption of the upper maxillary molars and enhanced eruption of the mandibular molars.[7,8]

Little scientific evidence exists as to the effect of functional appliances appliance on growth of the jaws. Tulloch et al.[9] systematically reviewed studies over a 7-year period in four major orthodontic journals that report on the treatment of Class II malocclusions. Failure to test for pretreatment equivalence, poor sample sizes, poor research designs, inappropriate selection of subjects and ambiguous and incomplete reporting made interpretation of the results difficult and their scientific validity questionable.

OBJECTIVES

This study was designed to investigate the maxillomandibular skeletal and dentoalveolar changes produced by the Twin Block appliance compared with those changes experienced by an untreated control group. It was also designed to address many of the criticisms put forward by Tulloch et al.[9]

MATERIAL AND METHODS

The treatment group consisted of 36 subjects (19 male and 17 female); the control group consisted of 27 subjects (13 male and 14 female) who had been referred for orthodontic treatment but then placed on the waiting list for functional appliance treatment. The reason for this approach is that the department sees about 750 new patients per year and despite restricting treatment to Index of Orthodontic Treatment Need groups 4 (great need) and 5 (very great need) still has about 300 to 400

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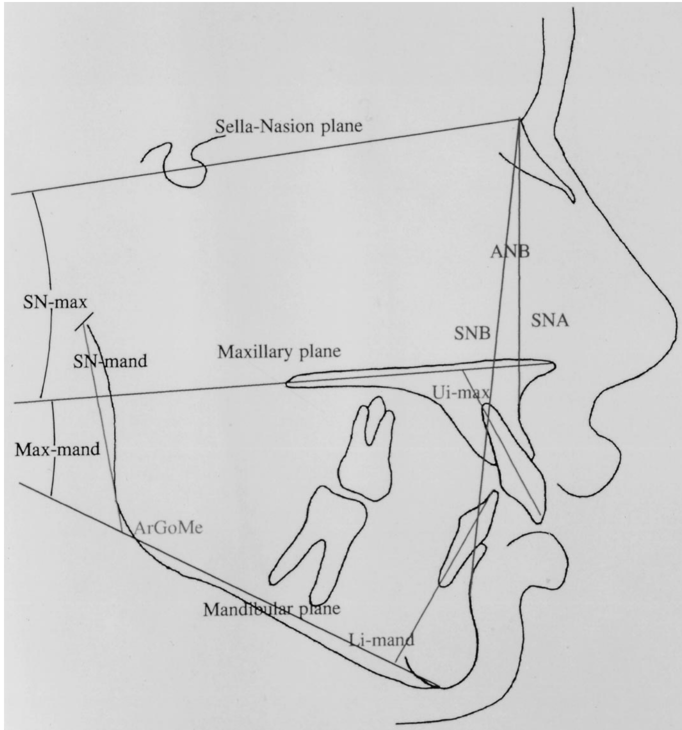

Fig. 1. Angular measurements.

patients on the waiting list at any one time. This results in a quite substantial delay between initial diagnosis and provision of definitive treatment.

To qualify for inclusion in either group of the study the patients satisfied the following criteria :

- 10 to 14 years of age
- White
- Class II skeletal pattern with ANB > 5°
- Class II division 1 incisor relationship
- An overjet of greater than 6 mm

All patients in the treatment group received pre- and posttreatment lateral cephalograms. In the control group, patients underwent radiographic investigation at the initial consultation and up to date records were taken immediately before the initiation of treatment. The radiographs were all taken on a Siemens "Orthoceph 10" machine.

THE APPLIANCE

A modification of the Twin Block appliance described by Clark[10] was used with Adams clasps on the maxillary and mandibular first premolars and first molars and ball clasps to the lower labial segment to maximize retention. A labial bow was also used that was soldered to the Adams clasp on the maxillary premolars. The jaw registration was taken with approximately 7 to 8 mm protrusion and the blocks 6 to 7 mm apart in the buccal segments. The steep inclined planes interlocked at about 70° to the occlusal plane. Compensatory lateral expansion of the upper arch was achieved by means of an upper midline expansion screw that was turned once a week. Reactivation of the blocks was carried out when necessary after 4 or 5 months therapy.

TECHNIQUE

After completion of functional appliance treatment (i.e., when the overjet was less than or equal to 2 mm or at the end of the observation period), changes were evaluated by means of cephalometric analysis. The control group and treatment group radiographs were digitized in a randomized manner. The pre- and posttreatment cephalograms were analyzed with a GTCO Digi-pad linked to a Viglen Dossier 486SD and Gela 1.7 software digitizing package. Each radiograph in the study was secured to a light box in a darkened room and digitized on two separate occasions by a single operator. The analysis was composed of linear and angular measurements illustrated in Figs. 1, 2, and 3.

After a period of approximately 2 weeks the radiographs were redigitized. When the difference

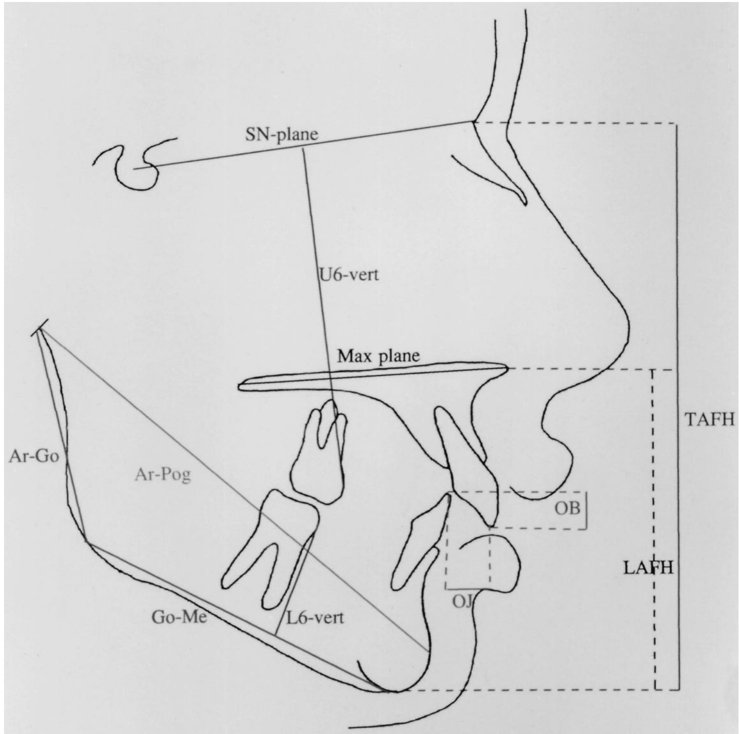

Fig. 2. Linear measurements.

of the two readings exceeded 1° or 1 mm, the radiographs were digitized a third time to detect any outlying points. The two readings with the least difference were then averaged for each group for the data.

STATISTICS

All statistical analysis was undertaken on the Statistical Package for the Social Sciences for Windows (SPSS). The error study involved analysis of 25 radiographs that were picked at random from the study and control groups. Systematic error was assessed with the paired *t* test, and random error was assessed with the coefficient of reliability.

The data were then checked for pretreatment equivalence between the two groups with the independent sample *t* test. Definitive data analysis was carried out with stepwise multiple regression analysis (Pin = 0.05, Pout = 0.10). The changes in dental occlusion and maxillofacial growth were the dependant variables. The independent variables were: treatment/study group, age, and gender.

RESULTS

Error of the method

From the data in Table I, it can be seen that the confidence interval includes zero in all cases and the *p* values are all acceptable. This confirms that there was no statistically significant difference between the two sets of replicates.

On examination of the values for the coefficient of reliability in Table I, there was no statistically significant random error in the study. This was also confirmed by the fact that the means and standard deviations of the differences were small.

Pretreatment equivalence

No statistically significant difference was found between the genders in either the treatment or control group at the start of the study except for the total anterior facial height (TAFH) in the treatment group and SNA in the control group. In the treatment group the mean TAFH value at the start of the study for the males was 110.2 mm and for the females was 104.4 mm suggesting that the males had longer faces than the females. In the control group, the angle SNA was greater in the female control group when compared with the male control group; this was bordering on statistical significance. Bearing these in mind, the gender groups were amalgamated into combined treatment and control groups.

Table II shows the equivalence of the combined

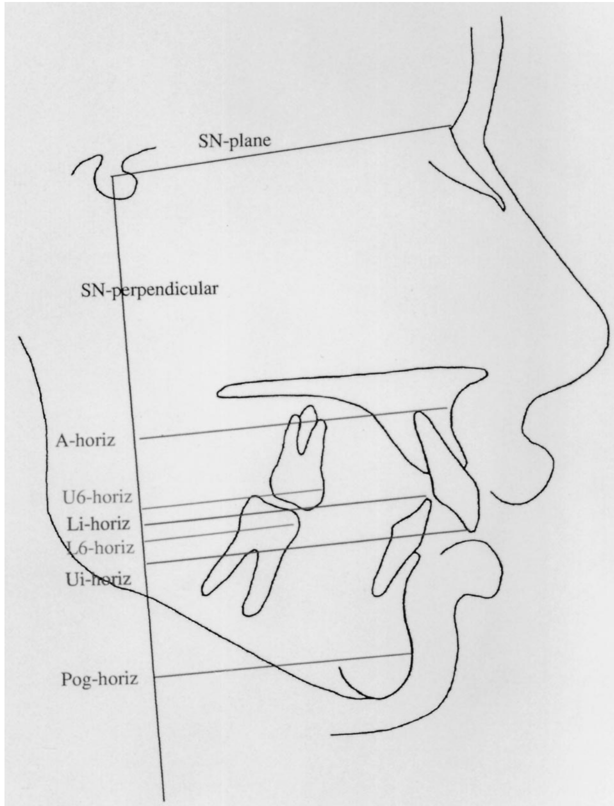

Fig. 3. Linear measurements recorded from cephalometric landmark to Sella-Nasion perpendicular.

(male and female) group for treatment before fitting the appliance and the control group at the start of the observation period. There was no significant difference between the two combined gender groups at the start of the study.

The treatment effects of the Twin Block appliance are shown in Table III. Details of the multiple regression are presented in Table IV.

DISCUSSION

Is mandibular growth increased?

Growth effects were detected as a result of Twin Block therapy. There was a statistically significant increase in mandibular length measured from Articulare-Pogonion, with some forward movement of Pogonion, both of which are desirable outcomes of treatment.

It was not possible to determine whether the increase in Ar-Pog was due to an increase in mandibular length or a repositioning of the mandible. Baumrind and Korn[11] and Haynes[12] found similar changes in Ar-Pog. However, the Twin Block appliance produced a greater change over a shorter treatment period, which is of benefit to patients. No actual measurement of fossa adaptation or relocation was made in this study.[13]

An improvement in the mandibular retrognathia could also be demonstrated by the increase in SNB; it is hoped this would contribute to an improvement in the patients profile. Pogonion (Pog-horiz) showed forward movement, however, this did not prove to be statistically significant.

Probable lingual movement of the lower incisor roots could allow alveolar remodeling thus moving Point B lingually and reducing SNB. The incisors in the present study were proclined significantly during treatment, but there was still a statistically significant increase in the angle SNB. DeVinzenzo and Winn[14] found similar changes in their cephalometric study of functional appliance effects.

Do Twin Blocks restrain maxillary forward growth?

When forward growth of the maxilla was assessed by means of conventional angular measurement little change in SNA was observed thus indicating little maxillary restraint. These results do not

Table I. Error study for cephalometric analysis (n = 25)

Variable	*Diff. 1-2*	*SD*	*95% CI*	p	π
Linear					
A-horiz	−0.1	0.6	−0.33, 0.13	0.39	1.00
Ui-horiz	−0.2	0.6	−0.42, 0.11	0.24	1.00
Li-horiz	0.0	0.7	−0.27, 0.32	0.84	1.00
U6-horiz	−0.1	0.6	−0.43, 0.04	0.10	1.00
L6-horiz	0.0	0.8	−0.33, 0.31	0.96	1.00
Pog-horiz	0.0	0.7	−0.39, 0.21	0.53	1.00
Ar-Pog	−0.1	0.8	−0.40, 0.24	0.59	1.00
Ar-Go	0.0	0.3	−0.21, 0.04	0.16	1.00
Go-ME	0.0	0.5	−0.15, 0.23	0.69	1.00
U6-vert	0.1	0.4	−0.09, 0.27	0.31	0.98
L6-vert	0.0	0.4	−0.12, 0.25	0.48	0.99
OJ	−0.2	0.4	−0.28, 0.02	0.10	1.00
OB	0.1	0.1	−0.03, 0.08	0.37	1.00
TAFH	0.1	0.6	−0.10, 0.36	0.27	1.00
LFH/TAFH	0.01	0.005	−0.004, 0.001	0.18	0.99
Angular					
SNA	−0.1	0.4	−0.26, 0.07	0.26	1.00
SNB	−0.2	0.5	−0.34, 0.06	0.16	1.00
ANB	−0.1	0.5	−0.31, 0.09	0.27	0.99
Ui-Max	0.3	1.6	−0.36, 0.96	0.36	0.99
Li-Mand	−0.1	1.0	−0.45, 0.34	0.78	1.00
SN-MAX	0.1	0.7	−0.17, 0.47	0.34	0.98
SN-Mand	0.1	0.4	−0.12, 0.22	0.57	1.00
Max-Mand	−0.1	0.7	−0.41, 0.18	0.43	1.00
Ar-Go-Me	0.2	0.5	−0.08, 0.37	0.20	1.00

SD, Standard deviation.
CI, Confidence interval.

Table II. Pre-treatment equivalence: combined treatment and control groups

Variable	*Mean Start*	*(SD)*	*Mean Start*	*(SD)*	*95% CI*	p
	Treatment		Control			
Linear (mm)						
A-horiz	58.7	4.4	59.7	5.4	−3.48, 1.49	0.43
Ui-horiz	60.1	5.4	61.8	6.2	−4.67, 1.25	0.25
Li-horiz	52.4	5.5	53.4	7.0	−4.12, 2.19	0.54
U6-horiz	31.7	4.4	32.7	5.3	−3.49, 1.38	0.39
L6-horiz	28.6	5.2	29.6	5.8	−3.70, 1.88	0.52
Pog-horiz	42.8	7.8	44.6	8.0	−5.87, 2.12	0.35
Ar-Pog	93.3	4.6	93.5	5.0	−2.64, 2.23	0.86
Ar-Go	40.4	3.7	40.0	4.1	−1.56, 2.40	0.67
Go-Me	62.4	4.0	62.8	4.0	−2.46, 1.58	0.67
U6-vert	17.9	2.0	18.0	1.8	−1.05, 0.90	0.88
L6-vert	24.6	2.3	24.1	2.5	−0.70, 1.75	0.39
OJ	8.2	1.9	8.9	2.8	−1.95, 0.41	0.20
OB	4.5	2.3	4.0	2.1	−0.61, 1.65	0.36
TAFH	107.4	6.9	105.5	5.4	−1.20, 5.19	0.22
LFH/TAFH%	55.0	2.0	55.0	2.0	−0.02, 0.01	0.35
Angular (°)						
SNA	82.0	3.8	82.7	4.0	−2.69, 1.25	0.47
SNB	75.3	3.6	76.2	4.0	−2.82, 1.00	0.35
ANB	6.7	2.0	6.5	2.3	−0.90, 1.28	0.73
Ui-Max	112.6	6.7	113.6	5.3	−4.11, 2.13	0.53
Li-Mand	94.6	7.1	95.3	7.9	−4.50, 3.11	0.72
Sn-Max	5.6	2.4	5.1	2.9	−0.85, 1.80	0.47
Sn-Mand	35.2	6.6	33.4	5.8	−1.45, 4.93	0.28
Max-Mand	29.6	6.7	28.4	5.6	−1.98, 4.39	0.45
Ar-Go-Me	128.6	6.1	128.1	6.5	−2.75, 3.67	0.78

SD, Standard deviation.
CI, Confidence interval.

suggest any significant headgear effect associated with the Twin Block therapy and are in agreement with DeVinzenzo et al.[7]

If the upper incisors are tipped significantly in a palatal direction then the root apices may move anteriorly, Point A may be advanced as a result of reshaping of the alveolus. If SNA is not increased under these circumstances, it could be postulated that some degree of maxillary restraint might have occurred but was not detected because of dentoalveolar remodeling disguising the skeletal effects of the treatment.

Is there a beneficial sagittal change?

Despite the fact a restraining effect on the maxilla could not be demonstrated, the forward growth/repositioning of the mandible does result in a significant change in ANB thus the severity of the Class II skeletal pattern is reduced.

Does tooth tipping contribute greatly to correction?

There was a significant amount of tipping of the labial segment teeth in both arches. The maxillary incisors were retroclined, and the mandibular incisors were proclined as a result of treatment, which greatly contributed to correction of the overjet. Excessive tipping of incisors, however, should be limited as it reduces the potential for orthopedic change. There was a high degree of variability with these tipping movements that in conjunction with the forward growth/repositioning of the mandible were responsible for a statistically significant reduction in the overjet.

The slight reduction of overjet in the control group may be accounted for either by slight retraction of the upper labial segment as a result of improved lip posture or alternatively a change in the position of the lower labial segment as a result of dentoalveolar compensation for the skeletal pattern as the facial complex continues to grow.

Does anteroposterior molar movement aid correction of the malocclusion?

A restraining effect on the upper molars was demonstrated to the extent that there was slight distalization along with a statistically significant for-

Table III. Mean changes at the end of the study period: treatment group and control group

Variable	Mean Difference	(SD)	Mean Difference	(SD)	Net effects
	Treatment		Control		
Linear (mm)					
A-horiz	0.6ns	1.9	0.9	1.0	−0.3
Ui-horiz	−2.9***	3.1	1.0	1.6	−3.9
Li-horiz	4.4***	3.4	0.9	1.5	3.5
U6-horiz	−0.7*	2.7	0.9	1.4	−1.6
L6-horiz	4.7**	4.4	1.0	2.3	3.7
Pog-horiz	2.3ns	3.9	0.9	1.5	1.4
Ar-Pog	5.1***	2.3	2.7	1.5	2.4
Ar-Go	4.0***	2.9	1.8	1.5	2.2
Go-Me	1.9ns	2.2	1.2	1.6	0.7
U6-vert	0.2ns	1.7	0.7	0.8	−0.5
L6-vert	1.6*	1.8	0.7	1.0	0.9
OJ	−7.8***	3.8	−0.3	1.3	−7.5
OB	−5.0***	2.8	−0.5	1.2	−4.5
TAFH	4.9***	2.6	2.3	1.8	2.6
LFH/TAFH%	1.5***	1.0	0.0	1.0	1.5
Angular (°)					
SNA	−0.1ns	1.6	0.3	0.8	−0.4
SNB	1.9***	2.0	0.4	1.0	1.5
ANB	−2.0***	1.9	−0.1	0.8	−1.9
Ui-Max	−11.0***	7.6	−0.2	2.4	−10.8
Li-Mand	8.2***	7.1	0.3	2.6	7.9
Sn-Max	0.0ns	1.7	−0.2	1.1	0.2
Sn-Mand	0.1ns	2.7	−0.5	1.2	0.6
Max-Mand	0.2ns	3.3	−0.3	1.4	0.5
A-Go-Me	1.4*	2.8	−0.3	2.0	1.7

Significance using Multiple regression analysis: >0.05 = ns, 0.05 − 0.01 = *, 0.01 − 0.001 = **, <0.001 = ***
SD, Standard deviation.
CI, Confidence interval.

Table IV. Results of the regression analysis and their significance

Dependent variable	Variables in the equation	β	SE β	R^2	t	p
Ui-horiz	Constant	1.00	0.50	0.37		
	Treatment group	−3.92	0.66		−5.94	0.000
Li-horiz	Constant	0.95	0.53	0.28		
	Treatment group	3.42	0.70		4.87	0.000
U6-horiz	Constant	0.87	0.44	0.09		
	Treatment group	−1.54	0.58		−2.66	0.010
L6-horiz	Constant	0.96	0.71	0.21		
	Treatment group	3.70	0.93		3.97	0.002
Ar-Pog	Constant	2.72	0.39	0.26		
	Treatment group	2.37	0.52		4.60	0.000
Ar-Go	Constant	1.79	0.47	0.17		
	Treatment group	2.19	0.62		3.55	0.0007
L6-vert	Constant	0.70	0.29	0.08		
	Treatment group	0.90	0.38		2.34	0.020
OJ	Constant	−2.77	0.57	0.62		
	Treatment group	−7.52	0.76		−9.88	0.0000
OB	Constant	−0.45	0.58	0.50		
	Treatment group	−4.51	0.58		−7.84	0.0000
TAFH	Constant	2.28	0.45	0.24		
	Treatment group	2.60	0.59		4.41	0.0000
LFH/TAFH	Constant	−1.85	0.002	0.28		
	Treatment group	0.012	0.003		4.93	0.0000
SNB	Constant	0.38	0.32	0.18		
	Treatment group	1.56	0.43		3.63	0.0006
ANB	Constant	−0.06	0.29	0.29		
	Treatment group	−1.90	0.38		−5.00	0.0000
Ui-max	Constant	−0.22	1.15	0.45		
	Treatment group	−10.81	1.52		−7.11	0.0000
Li-mand	Constant	0.29	1.09	0.33		
	Treatment group	7.91	1.44		5.49	0.0000
Ar-Go-Me	Constant	−0.25	0.48			
	Treatment group	1.64	0.64	0.10	2.56	0.013

β, Partial regression coefficient.
SEβ, Standard deviation of regression coefficient.
R2, Coefficient of probability.
t, + Statistic.
p, Probability.

ward movement of the lower molars. This change in molar position aids the correction of the disto-occlusion.

Do Twin Blocks control the vertical position of the teeth?

One might have expected that, as a result of the capping effect of the Twin Blocks, vertical eruption of the upper molars would have been restricted. This was not found to be the case, however, the apparent lack of vertical control of the upper molar may be due to distal tipping, extruding the mesial contact point that was the reference landmark on the tooth.

There was a significantly increased eruption of the lower molars during treatment after judicious trimming of the bite blocks. This differential lower molar eruption is an important feature in Twin Block therapy as it not only contributes to overbite reduction and closure of lateral open bites but also helps with Class II molar correction.

SUMMARY OF TREATMENT EFFECTS

Skeletal changes as a result of Twin Block therapy

1. A mean forward growth/repositioning of the mandible of 2.4 mm, measured at Ar-Pog, was demonstrated after Twin Block therapy.
2. The most noticeable skeletal change was an increase in the angle SNB.
3. No significant maxillary restraint could be demonstrated.
4. There was an increase in lower anterior facial height.

Dental changes as a result of Twin Block therapy

1. The mean overjet reduction of 7.5 mm involved a net 10.8° retroclination of the upper incisors and 7.9° proclination of the lower incisors.
2. Buccal segment correction occurred by distal

movement of the upper molars and lower molar eruption in an anterior and superior direction.

CONCLUSIONS

This study demonstrates that the Twin Block appliance is a very effective and efficient tool with which overjets can be reduced. Quantitatively the changes are impressive. However, qualitatively they leave something to be desired, which invariably necessitate finishing with fixed appliances.

Much of the overjet reduction is due to dentoalveolar tipping although a small and significant increase in SNB is very worthwhile. Correction of postnormal buccal segments is also efficiently obtained.

Further modifications to the Twin Block appliance might attempt to minimize the contribution from dentoalveolar tipping and to maximize skeletal changes by including the use of headgear to maximize maxillary restraint and torquing spurs to the upper labial segment. Further work is proceeding in this field. Further studies are indicated on what role, if any, the fossa adaptation and possible relocation plays in the sagittal correction.

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REFERENCES

1. Björk A. The principles of the Andresen method of orthodontic treatment: a discussion based on cephalometric x-ray analysis of treated cases. Am J Orthod 1951;37:437-58.
2. Pancherz H. A cephalometric analysis of skeletal and dental changes contributing to Class II correction in activator treatment. Am J Orthod 1984;85:125-34.
3. Harris JE. A cephalometric analysis of mandibular growth rate. Am J Orthod 1962;48:161-74.
4. DeVincenzo JP. Changes in mandibular length before, during and after successful orthopaedic correction of Class II malocclusions using a functional appliance. Am J Orthod Dentofac Orthop 1991;99:241-57.
5. Windmiller EC. Acrylic splint Herbst appliance: cephalometric evaluation. Am J Orthod Dentofac Orthop 1993;104:73-84.
6. Robertson NR. An examination of treatment changes in children treated with the functional regulator of Fränkel. Am J Orthod 1983;83:299-310.
7. DeVincenzo JP, Huffer RA, Winn MW. A study in human subjects using a device designed to mimic the protrusive functional appliances used previously in monkeys. Am J Orthod Dentofac Orthop 1987;91:213-24.
8. Nelson C, Harkness M, Herbison P. Mandibular changes during functional appliance treatment. Am J Orthod Dentofac Orthop 1993;104:153-61.
9. Tulloch JFC, Medland W, Tuncay OC. Methods used to evaluate growth modification in Class II malocclusion Am J Orthod Dentofac Orthop 1990;98:340-7.
10. Clark WJ. The Twin Block technique: a functional orthopaedic appliance system. Am J Orthod Dentofac Orthop 1988;93:1-18.
11. Baumrind S, Korn EL. Patterns of change in mandibular and facial shape associated with the use of forces to retract the maxilla. Am J Orthod 1981;80:31-47.
12. Haynes S. Profile changes in modified functional regulator therapy. Angle Orthod 1986;56:309-14.
13. DeVincenzo JP, Winn MW. Orthopaedic and orthodontic effects resulting from the use of a functional appliance with different amounts of protrusive activation. Am J Orthod Dentofac Orthop 1989;96:181-90.