



A cephalometric comparison of treatment with the Twin-block and stainless steel crown Herbst appliances followed by fixed appliance therapy

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This study compared the effects of 2 treatment protocols for correcting Class II disharmony. The first phase of treatment consisted of functional jaw orthopedics with either the Twin-block or the stainless-steel crown Herbst appliance; the second phase consisted of comprehensive fixed-appliance therapy in both protocols. Each of the 2 samples comprised 28 consecutively treated Class II patients. The mean age at the start of treatment was approximately 12 years, and the mean age at the end of the treatment was approximately 14.5 years in both groups. The duration of the treatment phase with the functional appliance was approximately 13 months, and the duration of fixed-appliance therapy was approximately 15 months in both groups. The sex distribution was identical in the 2 groups. Lateral cephalograms were analyzed at the start of treatment (T1) and at the end of the overall treatment protocol (T2). Nonparametric statistics were used for comparisons of starting forms and of the T1-T2 changes between the 2 treatment groups. The stainless-steel crown Herbst appliance and the Twin-block appliance produced very similar therapeutic modifications in Class II patients, although the Twin-block group exhibited almost 2 mm greater correction of the maxillomandibular differential than did the crown Herbst group. The treatment effects of both protocols led to a normalization of the dentoskeletal parameters at the end of the overall treatment period. Twin-block therapy also induced a greater increase in the height of the mandibular ramus (posterior facial height). Overall, only minor differences were detected in the treatment and posttreatment effects of a compliance-free (crown Herbst) and a noncompliance-free (Twin-block) appliance for correcting Class II disharmony. (*Am J Orthod Dentofacial Orthop* 2004;126:7-15)

Two of the most commonly used functional appliances for correcting Class II dentoskeletal disharmony are the Herbst appliance, developed by Emil Herbst¹ in the early 1900s and reintroduced by Hans Pancherz² in the late 1970s, and the Twin-block appliance, developed by William Clark^{3,4} in the late 1970s. Perhaps more than any other type of functional

appliance, whether fixed or removable, the treatment effects produced by the banded Herbst appliance have been well documented, especially by Pancherz and coworkers.^{2,5-18} Other investigators have evaluated alternative designs, including the cast Herbst appliance by Wieslander^{19,20} and the acrylic splint Herbst appliance by McNamara and coworkers.²¹⁻²³ Although the long-term effects of the Herbst appliance used alone have been investigated,²⁴⁻²⁷ only 2 published studies have evaluated the treatment effects of the Herbst appliance (acrylic splint²³ and stainless-steel crown²⁸) followed by a phase of fixed appliances.

In contrast to the Herbst appliance, limited research has focused on the Twin-block appliance beyond the initial treatment phase with the functional appliance itself. Most of the Twin-block literature is based on short-term studies.²⁹⁻³⁶ A posttreatment evaluation of the craniofacial adaptations to Twin-block therapy is available only through the studies of Mills and McCullogh³⁵ and O'Brien.³⁶ In both investigations, a highly variable regimen of retention and postretention phases

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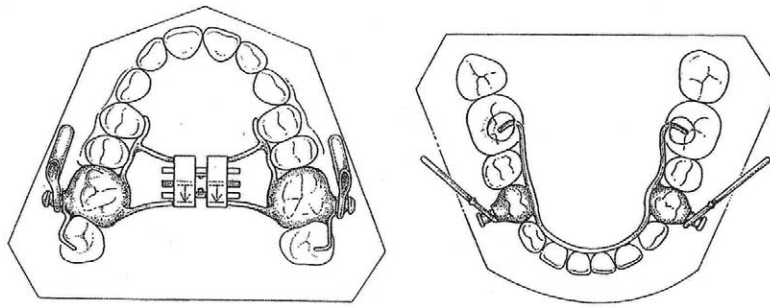


Fig 1. Stainless-steel crown Herbst appliance (modified from McNamara and Brudon³⁷). **A**, Maxillary view with expansion screw incorporated into appliance. **B**, Mandibular view with stainless steel crowns on mandibular first premolar and occlusal rests bonded to mandibular first molars.

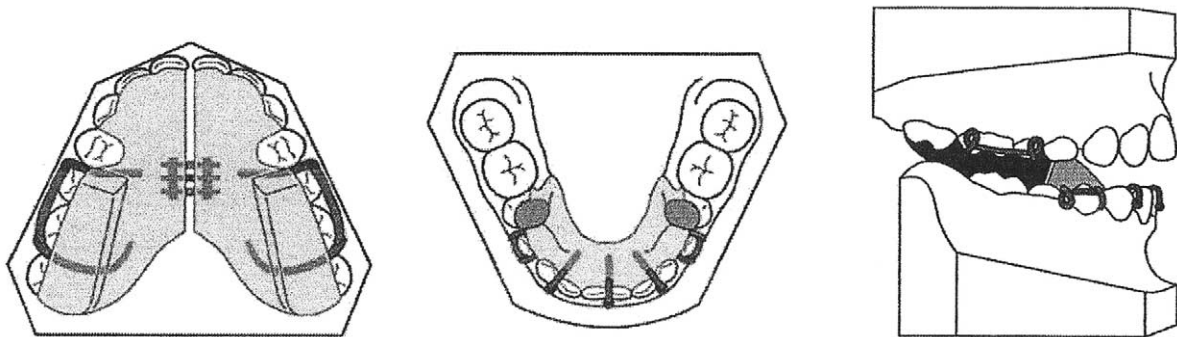


Fig 2. Twin-block appliance design (modified from McNamara and Brudon³⁷).

was performed. In the study by O'Brien,³⁶ the author also carried out a comparison between treatments involving the Twin-block and the Herbst appliance; the Twin-block design incorporated a maxillary labial bow.

The literature shows that both the Herbst and the Twin-block appliances can induce significant favorable modifications in growing subjects with Class II malocclusions. The objective of the present study was to compare the skeletal and dentoalveolar changes produced by 2 standardized treatment protocols for Class II disharmony, which consisted of a first phase with a functional appliance (Twin-block or stainless-steel crown Herbst), followed by a second phase of comprehensive edgewise orthodontic therapy.

MATERIAL AND METHODS

This cephalometric study was designed to evaluate the skeletal, dentoalveolar, and soft tissue effects of Class II correction with 2 treatment modalities. The first group consisted of 28 patients consecutively treated with the stainless-steel crown Herbst appliance, which included crowned maxillary first molars and mandibular first premolars (Fig 1). The second group included 28 patients consecutively treated with the

Twin-block appliance (Fig 2). Comprehensive fixed-appliance therapy followed phase I treatment in both groups. The specific treatment protocols for the crown Herbst appliance and the Twin-block appliance are described in detail elsewhere.³⁷

The treated subjects in both groups had the following features: (1) pretreatment Class II Division 1 malocclusion defined by at least an end-to-end molar relationship, (2) standardized treatment protocol that consisted of either Herbst or Twin-block therapy followed by preadjusted edgewise appliance treatment, (3) no permanent teeth extracted before or during treatment, and (4) good-quality radiographs with adequate landmark visualization taken before treatment (T1) and immediately after removal of preadjusted edgewise appliances (T2).

The sample treated with the crown Herbst consisted of 21 girls and 7 boys. The average age at the start of treatment (T1) was 11 years 9 months \pm 1 year. The average age at the end of treatment (T2) was 14 years 4 months \pm 1 year. The sample treated with the Twin-block also included 21 girls and 7 boys. The average age at T1 was 12 years 5 months \pm 1 year. The average age at T2 was 14 years 8 months \pm 1 year. The

duration of the treatment phase with the functional appliance was approximately 13 months in both groups. Fixed appliance therapy immediately followed functional jaw orthopedics, with a mean duration of approximately 15 months in both groups.

Cephalometric analysis

Lateral cephalograms of a given series were hand-traced at a single sitting in the same manner. Cephalograms were traced by 1 investigator (A.T.S.); landmark location was verified by a second (J.Mc.). Any disagreements were resolved by retracing the landmark or structure to the satisfaction of both observers.

A customized digitization regimen (Dentofacial Planner 2.5; Dentofacial Software, Toronto, Ontario, Canada) that included 78 landmarks and 4 fiducial markers was devised and instituted to assist in the cephalometric evaluation. This protocol was tested and analyzed for accuracy. This program allowed analysis of cephalometric data and superimposition among serial cephalograms, according to the specific needs of this study.

Lateral cephalograms for each patient at T1 and T2 in both treatment groups were standardized as to magnification factor (8%) and digitized. A cephalometric analysis containing measures chosen from the analyses of McNamara,^{38,39} Ricketts,⁴⁰ and Steiner⁴¹ was performed on each cephalogram.

Regional superimpositions were accomplished by hand, and then 78 landmarks and 4 fiducial markers were digitized with Dentofacial Planner. The cranial bases were superimposed along the basion-nasion line and registered at the most posterosuperior aspect of the pterygomaxillary fissure, with the contour of the skull immediately posterior to the foramen magnum used to check the accuracy of the cranial base superimposition. Movements of the maxilla and mandible relative to the cranial base were assessed. The maxillae were superimposed along the palatal plane by registering on internal structures of the maxilla superior to the incisors and the superior and inferior surfaces of the hard palate.^{38,40} The movement of the maxillary dentition in the maxilla was determined from this maxillary superimposition. The mandibles were superimposed posteriorly on the outline of the mandibular canal and tooth germs (before initial root formation) and anteriorly on the internal structures of the symphysis and the anterior contour of the chin.^{38,40}

Statistical analysis

Descriptive statistics were calculated for all cephalometric measures at T1 for the 2 treatment groups and for the changes between T1 and T2 in each group. The

comparisons between craniofacial starting forms and on the T1–T2 changes were performed by means of nonparametric statistics (Mann-Whitney *U* test) with a social science statistical package (SPSS 10.0, SPSS, Chicago, Ill). Statistical significance was tested at $P < .05$ and $P < .01$. The error of the method has been described previously by McNamara et al.⁴²

RESULTS

The crown Herbst group and the Twin-block group were very similar at the start of treatment; they did not show any significant difference as to molar relationship, mandibular length, mandibular position, maxillary position, and vertical skeletal relationships, with the exception of posterior facial height, which was significantly larger in the Twin-block group. This latter group also had a greater overjet of almost 3 mm, associated with greater maxillary incisor proclination and mandibular incisor retroclination (Table I).

Descriptive and inferential statistics for changes during overall treatment interval, $\Delta(T2-T1)$, are summarized in Table II.

Over the entire treatment period (T1 to T2), the Twin-block group exhibited significantly smaller increments (1.4 mm) in midfacial length (condylion-point A) than did the Herbst group (2.3 mm). There was no significant difference in the increase in mandibular length between the 2 treatment groups during the orthopedic phase of treatment (7.0 mm in the Twin-block group, 6.1 mm in the Herbst group). The Twin-block group, however, underwent greater mandibular advancement as measured by the SNB angle and the projection of the chin (pogonion) relative to the nasion perpendicular. In addition, at the end of the comprehensive fixed-appliance phase, a significant reduction in the ANB angle associated with a significant favorable change in the maxillomandibular differential with respect to the Herbst treatment group was observed in the Twin-block sample.

From T1 to T2, neither group exhibited any change in the inclination of the palatal and mandibular planes to the cranial base (the increments were within 1° of change). The Twin-block group showed a significantly larger increase in the height of the mandibular ramus.

The Twin-block group showed a significantly greater reduction in overjet (2.7 mm more than the Herbst group), associated with a significantly greater correction in molar relationship (1 mm more than the Herbst group).

The amount of labial inclination of the maxillary incisors (U1 to vertical point A and U1 horizontal) was reduced significantly (1–1.5 mm) in the Twin-block group compared with the Herbst group. No significant

Table I. Comparison on starting forms

Cephalometric measures	Twin-block (n = 28)					Crown Herbst (n = 28)					Mann-Whitney U test	
	Mean	Median	SD	Min	Max	Mean	Median	SD	Min	Max	Z	Significance
Maxillary skeletal												
Co-Pt A (mm)	88.5	88.8	3.7	79.2	95.5	86.7	87.0	4.1	78.3	95.8	-1.729	NS
SNA (°)	82.0	82.2	3.3	75.4	86.5	81.7	81.5	2.8	76.9	86.5	-0.443	NS
Pt A to nasion perp (mm)	-0.1	-0.1	2.5	-3.8	4.1	0.8	0.5	2.7	-5.0	5.3	-1.172	NS
Mandibular skeletal												
Co-Gn (mm)	105.7	105.6	4.1	97.5	112.7	104.8	104.3	4.6	95.9	112.4	-0.721	NS
Ar-Gn (mm)	98.0	97.7	4.0	90.6	106.2	97.2	96.8	4.2	89.2	104.4	-0.565	NS
SNB (°)	75.8	75.9	2.7	69.6	80.5	76.2	76.3	2.4	72.4	79.9	-0.385	NS
Pg to nasion perp (mm)	-8.1	-7.6	5.0	-16.7	0.6	-6.3	-7.3	3.9	-14.6	5.0	-1.246	NS
Maxillary/mandibular												
Max/mand difference (mm)	17.2	16.7	3.5	10.7	26.2	18.2	17.7	3.5	13.4	29.4	-1.057	NS
ANB (°)	6.2	6.0	1.7	3.6	9.7	5.5	5.6	1.8	1.4	9.1	-1.254	NS
Vertical skeletal												
N-Me (mm)	105.9	106.7	5.5	96.0	115.7	105.4	105.2	5.2	97.6	116.7	-0.524	NS
N-ANS (mm)	49.4	49.0	2.9	43.6	54.5	48.2	47.8	2.9	42.5	54.9	-1.623	NS
ANS-Me (mm)	59.8	60.0	4.7	50.1	69.3	60.1	59.3	4.2	52.7	68.5	-0.049	NS
S-Go (mm)	68.6	67.9	4.7	56.3	76.0	66.1	64.7	4.9	59.6	79.7	-2.188	*
Co-Go (mm)	50.1	50.4	3.6	42.4	56.6	48.9	48.4	4.3	41.9	61.1	-1.311	NS
SN to palatal plane (°)	7.6	7.5	2.7	1.6	11.7	7.1	7.7	2.9	0.4	11.4	-0.549	NS
SN to mandibular plane (°)	30.0	29.8	4.8	19.6	38.5	31.9	32.1	4.3	21.1	41.5	-1.508	NS
Interdental												
Overbite (mm)	6.3	6.4	2.4	1.4	11.9	5.2	5.9	2.0	-0.9	8.0	-1.574	NS
Overjet (mm)	9.4	9.3	1.8	6.4	14.1	6.5	6.6	1.3	4.6	9.5	-5.238	**
Interincisal angle (°)	119.6	118.9	7.6	100.9	133.9	123.5	123.0	8.4	107.3	142.4	-1.672	NS
Molar relationship (mm)	-1.7	-1.6	1.4	-4.8	0.9	-1.4	-1.4	1.4	-5.5	0.5	-0.910	NS
Maxillary dentoalveolar												
U1 to SN (°)	111.5	111.3	7.9	99.4	124.0	104.9	106.5	7.1	87.6	115.2	-2.614	**
U1 to palatal plane (mm)	25.9	25.7	2.4	20.8	30.4	26.8	26.8	2.7	18.8	32.7	-1.639	NS
U6 to palatal plane (mm)	20.0	20.0	1.7	17.0	23.8	19.6	18.6	2.4	16.5	23.9	-1.106	NS
U1 to vert Pt A (mm)	6.0	6.4	1.9	0.9	9.0	4.9	4.7	1.9	0.9	8.3	-2.238	*
Mandibular dentoalveolar												
L1 to mandibular plane (°)	99.4	99.7	5.7	89.5	109.5	100.0	100.0	5.5	84.8	111.2	-0.254	NS
L1 to A-Pg (mm)	-1.6	-1.5	1.7	-5.6	2.2	0.3	-0.1	2.0	-3.7	5.0	-3.353	**
L1 to mandibular plane (mm)	37.6	37.4	2.6	32.4	43.3	36.8	36.7	2.2	34.1	41.3	-1.492	NS
L6 to mandibular plane (mm)	27.7	27.3	1.9	23.3	31.4	28.1	28.1	2.0	24.1	31.8	-0.844	NS
Soft tissue												
UL to E plane (mm)	-1.3	-1.3	2.0	-5.3	2.9	-1.0	-0.6	1.9	-5.8	1.8	-0.754	NS
LL to E plane (mm)	-0.9	-0.9	2.1	-5.3	2.9	0.2	0.1	2.7	-6.1	4.8	-1.778	NS
Nasolabial angle (°)	111.2	112.5	13.7	77.6	133.8	116.1	117.7	9.1	100.5	132.3	-1.221	NS
Cant of upper lip (°)	8.4	7.9	11.2	-8.5	31.2	5.6	7.3	7.0	-12.4	19.6	-0.418	NS

SD, Standard deviation; *Min*, minimum; *Max*, maximum; *Co*, condyilion; *Pt A*, point A; *NS*, not significant; *Gn*, gnathion; *Ar*, articulare; *N*, nasion; *Me*, menton; *S*, sella; *Go*, gonion; *UL*, upper lip; *LL*, lower lip.

* $P < .05$.

** $P < .01$.

differences in molar movement (U6 horizontal) existed between the 2 groups from T1 to T2. At T2, the maxillary molars were near their original sagittal position in both groups. The Twin-block group exhibited a significantly larger extrusion (1.5 mm) of the maxillary incisors (U1 to palatal plane) compared with subjects treated with the crown Herbst appliance.

From T1 to T2, the mandibular incisors tipped labially (L1 to mandibular plane, L1 horizontal) in both

groups. The mandibular first molars moved mesially (L6 horizontal) in both groups, although the mesial movement in the Twin-block group was significantly greater (1.2 mm) than that in the Herbst groups. The greater increase in the eruption of the mandibular molars (L6 to mandibular plane) in the Twin-block group compared with the crown Herbst group, though statistically significant, was not clinically significant (0.8 mm; Table II).

Table II. Comparison of T2–T1 changes

Cephalometric measures	Twin-block (n = 28)					Crown Herbst (n = 28)					Mann-Whitney U test	
	Mean	Median	SD	Min	Max	Mean	Median	SD	Min	Max	Z	Significant
Maxillary skeletal												
Co-Pt A (mm)	1.4	1.2	1.8	-1.5	6.9	2.3	2.6	1.5	-0.2	4.5	-2.304	*
SNA (°)	-1.0	-0.7	1.2	-3.7	1.4	-1.1	-0.7	1.5	-4.2	1.4	-0.074	NS
Pt A to Nasion perp (mm)	-1.0	-1.0	1.3	-4.3	2.1	-0.7	-0.4	1.5	-3.8	2.0	-1.132	NS
Mandibular skeletal												
Co-Gn (mm)	7.0	6.5	2.8	2.1	13.3	6.1	6.1	2.2	1.3	10.4	-0.992	NS
Ar-Gn (mm)	6.5	5.3	3.1	1.6	12.7	5.6	5.7	2.4	0.4	10.3	-0.746	NS
SNB (°)	1.5	1.7	1.1	-0.8	3.8	0.2	0.0	1.0	-1.5	2.1	-4.142	**
Pg to nasion perp (mm)	1.8	1.6	1.9	-2.2	5.9	0.8	0.7	1.6	-2.1	3.8	-2.000	*
Maxillary/Mandibular												
Max/mand difference (mm)	5.6	5.4	1.6	3.0	9.7	3.8	3.9	1.8	0.8	8.0	-3.395	**
ANB (°)	-2.5	-2.3	1.2	-5.5	-0.8	-1.3	-1.4	1.3	-4.1	0.5	-3.042	**
Vertical skeletal												
N-Me (mm)	7.0	7.1	3.3	3.0	14.5	6.1	6.1	2.2	1.4	9.9	-0.886	NS
N-ANS (mm)	2.1	2.2	1.6	-0.5	5.0	2.5	2.3	1.4	0.1	5.9	-1.041	NS
ANS-Me (mm)	4.1	3.8	2.1	1.1	8.8	3.2	3.3	1.4	0.8	6.0	-1.451	NS
S-Go (mm)	5.5	5.4	2.7	-0.1	11.4	4.0	3.9	2.5	0.2	9.0	-1.836	NS
Co-Go (mm)	4.9	4.9	2.4	-1.0	10.3	3.6	4.2	2.2	-0.9	8.4	-1.890	*
SN to palatal plane (°)	0.6	0.6	1.4	-2.4	3.9	1.0	1.0	1.5	-1.7	4.3	-0.984	NS
SN to mandibular plane (°)	0.3	-0.1	1.7	-2.3	3.5	0.6	0.6	1.7	-2.5	3.9	-0.648	NS
Interdental												
Overbite (mm)	-4.1	-3.6	2.7	-11.1	1.4	-3.0	-3.4	1.9	-7.2	2.3	-1.410	NS
Overjet (mm)	-6.4	-6.5	1.8	-11.5	-3.4	-3.7	-3.8	1.4	-7.0	-1.5	-5.042	**
Interincisal angle (°)	0.9	0.9	9.1	-15.7	15.8	-2.1	-3.0	10.1	-26.5	19.6	-1.139	NS
Molar relationship (mm)	4.3	4.3	1.4	0.7	7.5	3.2	3.3	1.5	1.2	8.1	-2.853	**
Maxillary dentoalveolar												
U1 to SN (°)	-6.0	-6.8	7.5	-20.0	7.2	-2.1	-2.9	7.0	-17.9	13.7	-1.680	NS
U1 to Vert Pt A (mm)	-2.5	-2.8	1.8	-5.2	1.0	-1.3	-1.5	1.6	-4.1	3.0	-2.426	*
U1 horizontal (mm)	-2.7	-2.8	1.9	-5.8	0.6	-1.2	-1.2	1.5	-5.3	1.5	-2.934	**
U6 horizontal (mm)	0.3	0.1	1.2	-1.9	2.8	0.7	0.5	1.1	-0.7	2.7	-1.189	NS
U1 to palatal plane (mm)	1.3	1.9	1.7	-2.0	3.9	0.2	0.3	1.6	-2.7	4.4	-2.607	**
U6 to palatal plane (mm)	1.5	1.4	1.1	-1.1	3.6	1.7	1.5	0.9	-0.5	3.1	-0.705	NS
Mandibular dentoalveolar												
L1 to mandibular plane (°)	4.5	4.0	6.0	-5.3	18.5	3.8	2.5	6.8	-9.9	19.4	-0.385	NS
L1 horizontal (mm)	0.9	0.9	1.6	-2.4	3.2	1.2	1.4	1.4	-2.3	4.1	-0.582	NS
L6 horizontal (mm)	1.2	1.3	1.2	-1.2	3.7	2.4	2.1	1.0	1.0	5.2	-3.420	**
L1 to A-Pg (mm)	3.5	3.6	1.5	1.5	7.5	2.2	2.2	1.6	-0.6	5.8	-2.927	**
L1 to mandibular plane (mm)	0.2	0.3	1.6	-3.2	3.1	1.0	1.1	1.1	-1.6	3.6	-1.730	NS
L6 to mandibular plane (mm)	3.4	3.2	1.6	1.0	7.6	2.6	2.6	1.0	0.0	4.5	-1.961	*
Soft Tissue												
UL to E plane (mm)	-2.8	-2.5	1.4	-5.4	-0.2	-2.4	-2.5	1.6	-5.9	1.0	-0.673	NS
LL to E plane (mm)	-0.5	-0.2	1.6	-3.5	2.4	-1.1	-1.2	1.7	-6.4	1.9	-1.304	NS
Nasolabial angle (°)	4.8	4.7	8.6	-14.0	25.3	-0.1	0.0	5.8	-17.2	11.4	-2.343	*
Cant of upper lip (°)	-8.0	-8.1	8.7	-28.3	9.4	-4.2	-3.0	6.0	-18.5	8.0	-1.762	NS

**P* < .05.

***P* < .01.

The overall changes in soft tissue profile from T1 to T2 were similar between the 2 groups. Both upper and lower lips showed a tendency toward retraction relative to the E plane in both groups. A significantly larger increase in the nasolabial angle was detected in the Twin-block group (4.9°) compared with the crown Herbst group.

DISCUSSION

This study compared the treatment effects of 2 standardized Class II treatment modalities, 1 protocol incorporating the Twin-block appliance and the other the stainless steel crown Herbst appliance for the first phase of treatment. Both protocols included a second phase of treatment with comprehensive fixed-appliance

therapy that started immediately after the functional jaw orthopedics. The results showed that the differences between the 2 treatment approaches were modest, with the exception of a few significant ones.

No major differences between groups in measures of maxillary, mandibular, or vertical skeletal relationships existed before treatment (Table I). The homogeneity of the 2 samples analyzed as to initial parameters of both maxillary and mandibular size and position reduces significantly the impact of susceptibility bias^{43,44} that occurs when treatment assignment is based on diagnostic criteria (ie, not randomized) and causes patients treated 1 way to be different at the start of treatment from patients treated another way.⁴⁴ Moreover, the analysis of patients treated consecutively in the 2 groups without differences in mean age at T1 and T2 and mean duration of overall observation period corroborated further the validity of the study design. Nonparametric statistics were applied to between-group comparisons to avoid type II statistical errors due to limited sample size.

The significant differences between patients treated with the Twin-block and those treated with the crown Herbst as the first phase of therapy followed by fixed appliances were represented mainly by a more favorable change in the sagittal intermaxillary relationships. The Twin-block group showed almost 2 mm greater correction of the maxillomandibular differential than did the crown Herbst group. This difference was due mainly to better control of sagittal midfacial growth (condylion-point A). The Twin-block group also showed a significantly greater enhancement in the forward repositioning of the mandible compared with the Herbst group, resulting in a greater reduction in the ANB angle.

The Twin-block appliance also induced larger increases in the height of the mandibular ramus; these contributed to slightly greater increases in total mandibular length in the overall observation period. This increase in posterior facial height probably can be attributed to the Twin-block appliance design, which has a greater vertical activation (bite blocks must be at least 5-7 mm thick vertically)³⁷ compared with the stainless-steel crown Herbst appliance. In addition, trimming the inferior border of the posterior bite blocks allows the clinician to facilitate the eruption of the posterior dentition in patients with a short lower anterior facial height and an accentuated curve of Spee.

Most of the other significant differences in the response to the therapeutic protocols incorporating either Twin-block or Herbst treatments in this study are related to the initial differences in dentoalveolar parameters between the 2 groups. Before the start of treat-

ment, the Twin-block group showed larger overjet with a higher degree of maxillary incisor proclination and mandibular incisor retroclination. These dentoalveolar differences also were associated with a more acute nasolabial angle. Twin-block therapy was able to correct for these initial discrepancies. Moreover, the same type of treatment protocol was more efficient in improving the molar relationship (1.1 mm more with the Twin-block protocol than with the Herbst protocol).

Another observation of significant clinical interest was the timing of the mandibular response with the 2 protocols. The increases in mandibular length observed in the Twin-block group occurred almost entirely during active Class II correction (condylion-gnathion, 6.6 mm), rather than during the fixed-appliance phase (Fig 3). (Cephalometric data on each phase of treatment are available upon request from the authors.) These findings are similar to those of Baccetti et al,³⁴ who described a mean increase in total mandibular length of 7.3 mm in subjects treated for a similar amount of time at the pubertal peak in mandibular growth. All skeletal parameters in general exhibited significant changes during active treatment with the Twin-block, whereas craniofacial modifications during the fixed-appliance phase were modest at best, limited to 1 mm or 1° of change. In contrast, a similar analysis of the crown Herbst group showed that skeletal changes are distributed almost equally between the 2 phases of treatment (Fig 4). The increases in mandibular length, for example, occurred at an extent of 3.8 mm during active Herbst treatment and of 3.1 mm during fixed-appliance therapy. These results differ from those of other investigators,^{22,23} who found an accelerated mandibular growth rate during the first phase of treatment with the acrylic splint Herbst appliance, followed by a diminished growth rate in the second phase (compared with untreated Class II controls). The molar relationships in both treatment groups analyzed here were overcorrected during the phase of functional jaw orthopedics (7.1 mm and 5.3 mm for the Twin-block and crown Herbst groups, respectively), with some relapse during the fixed-appliance therapy.

The final outcomes of the 2 treatment protocols can be compared with cephalometric composite norms³⁷ at the end of the overall treatment period (T2) to test the effectiveness of the 2 therapeutic procedures in correcting the initial Class II disharmony. The skeletal positions of the maxilla (point A to nasion perpendicular) were -1.1 mm and 0.1 mm at T2 in the Twin-block and Herbst groups, respectively, whereas the norm is 1 mm \pm 2 mm.³⁷ The skeletal positions of the mandible (pogonion to nasion perpendicular) were -6.4 mm and -5.5 mm at T2 in the Twin-block and Herbst groups,

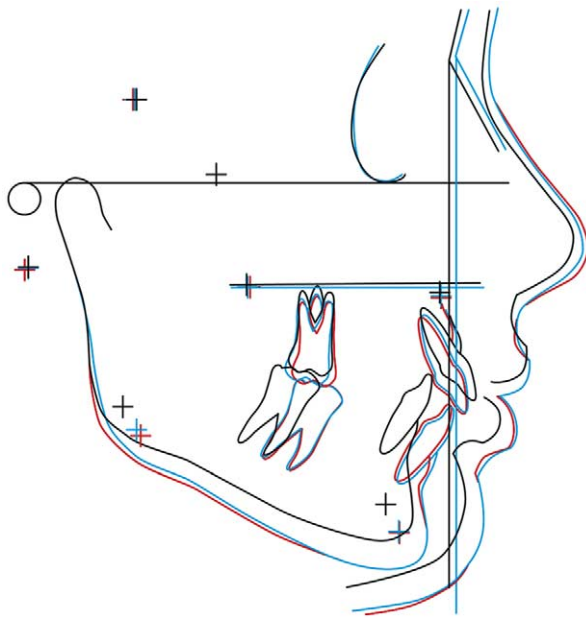


Fig 3. Average craniofacial forms for Twin-block group before treatment and after phase I and phase II treatments. *Black line*, pretreatment; *blue line*, end of phase I treatment; *red line*, end of phase II treatment.

respectively; the norm is between -6 and -2 mm.³⁷ As for dentoalveolar parameters, the positions of the maxillary incisors to point A vertical were 3.5 and 3.6 mm at T2 in the Twin-block and Herbst groups, respectively; the norm is between 4 and 6 mm.³⁷ Finally, the positions of the mandibular incisors to the A-pogonion line were 1.9 and 2.4 mm at T2 in the Twin-block and Herbst groups, respectively; the norm is between 1 and 3 mm.³⁷ Therefore, both the Twin-block and the crown Herbst treatment modalities seem to be effective in producing a normalization of the maxillary and mandibular dentoskeletal relationships at the end of treatment.

The findings presented here confirm previous observations by O'Brien,³⁶ who compared Twin-block and Herbst appliances followed by a phase of fixed appliances in the early teenage years. Both treatments proved to be efficient in terms of outcome at the dentoskeletal level. However, the designs of both appliances in O'Brien's study were different from those analyzed in the present study: the Twin-block appliance in the O'Brien study incorporated an upper labial bow to aid anterior retention, and the O'Brien Herbst appliance had a cast cobalt-chromium design, in which the framework covered all posterior teeth.⁷

A final interesting aspect of the present study is the comparison of a fully compliance-free treatment proto-

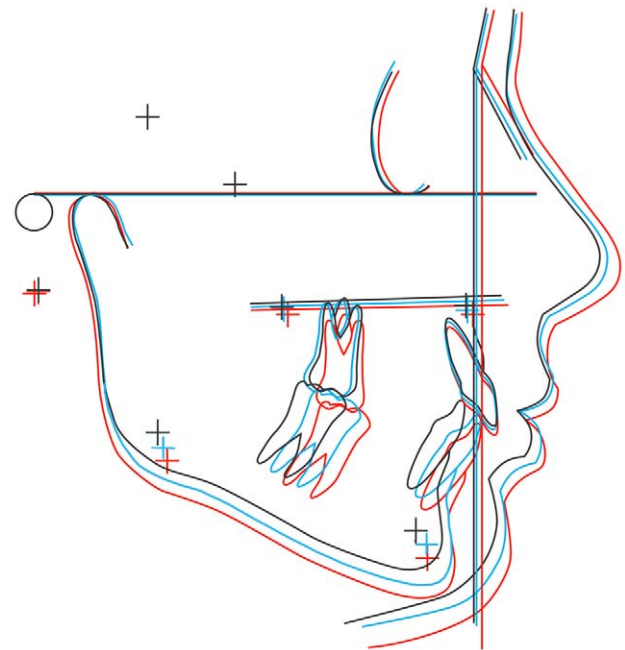


Fig 4. Average craniofacial forms for crown Herbst group before treatment and after phase I and phase II treatments. *Black line*, pretreatment; *blue line*, end of phase I treatment; *red line*, end of phase II treatment.

col (crown Herbst appliance) with a procedure for functional jaw orthopedics requiring substantial compliance on the patient's part (Twin-block appliance). Considering that success of treatment was not a prerequisite for case selection, it can be concluded that the need for patient collaboration was not a key factor in determining final treatment outcome, in that the Herbst appliance protocol produced an average result that was similar in most respects to the outcome with the Twin-block protocol.

CONCLUSIONS

This study compared the treatment effects of the stainless-steel crown Herbst appliance followed by fixed appliances with those of the Twin-block appliance followed by fixed appliances. The stainless-steel crown Herbst and the Twin-block produced similar therapeutic changes in Class II patients; these changes led to normalization of the dentoskeletal parameters at the end of overall treatment. The Twin-block appliance seemed to be slightly more efficient in correcting the molar relationship and the sagittal maxillomandibular skeletal differential. Patients treated with the Twin-block appliance also showed a greater elongation of the mandibular ramus.

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