Cephalometric changes in Class II, Division 1 cases after orthopedic treatment with the bioactivator

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The bioactivator is an orthopedic appliance that has been used for 20 years in the treatment of Class II, Division 1 cases. The evaluation of its therapeutic effects was performed in this study of 76 9- to 10-year-old patients (at the beginning of treatment). The treated subjects were separated into two groups: group A (bioactivator only) and group B (bioactivator plus headgear). Group C comprised 14 untreated subjects selected as controls. Various statistical assessments were made to separate growth phenomena from treatment effects. It appears that the bioactivator has an effect not only on the dentition but also on the skeletal structures. In both treated groups, the maxillary changes were related to an increased anterior vertical growth and a posterior sagittal growth. The addition of extraoral force helped to achieve a posterior rotation of the upper jaw. When only the bioactivator was worn, the mandibular changes were more vertical than sagittal. The lower jaw appeared more forward, however. When the bioactivator and the headgear force were used simultaneously, the therapeutic effects seemed to be more sagittal than vertical, as if the occipitally directed force vector inhibits or at least exerts a control on the downward growth tendency. Without being significantly different statistically from one to the other, the treated groups showed a marked improvement of the sagittal jaw discrepancy. (Am J Orthod Dentofac Orthop 1989;95:127-37.)

The bioactivator is a bimaxillary appliance that was introduced in 1967 in Switzerland. Its name and basic principles are related to the activator and the Bionator. It also shares some other concepts with the Fränkel regulator.[1] It has a reduced acrylic base and a jackscrew, which replaces the coffin spring of the Bionator. A special multianchorage system in which the labial arch wire and/or a face-bow are fitted is placed between the premolars (Figs. 1 and 2).

After 20 years of clinical use,[2] the bioactivator needs a critical evaluation of its therapeutic action on the growing structures in Class II, Division 1 cases.[3]

MATERIAL AND METHODS

The sample (Table I)

Two main groups were selected from more than 200 patients who had previously completed nonextraction orthopedic treatment for a Class II, Division 1 malocclusion. The randomization was performed by alternating odd and even numbers of the patient files. These two samples were made more homogeneous with regard to the use (group A) or nonuse (group B) of extraoral force; thus 38 subjects could be selected for each group. A control group of 14 untreated Class II, Division 1 cases of the same age was chosen for comparison.

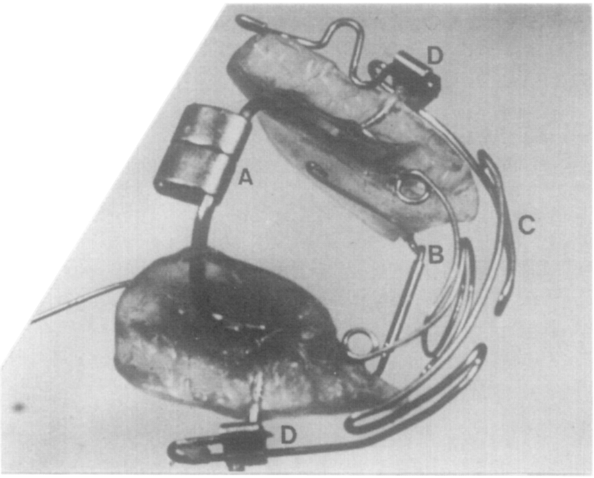

Fig. 1. The basic bioactivator appliance, which may be used with or without extraoral force. *A*, Jackscrew; *B*, tongue grid; *C*, labial arch wire or functional arch wire for specific therapy (FAST) III; *D*, multianchorage system. Increased expansion is obtained through activation of the jackscrew *(A)*. The buccal tubes *(D)* will receive the extraoral face-bow.

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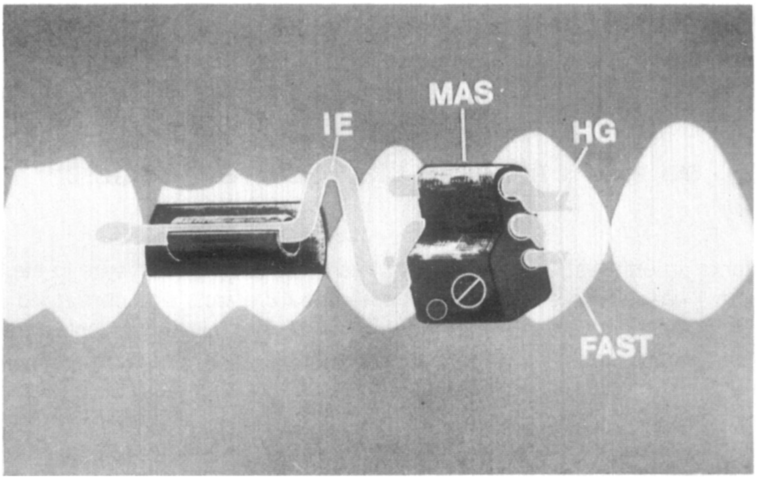

Fig. 2. Diagram showing the workings of the multianchorage system unit, together with first molar bands and horizontal buccal tubes. The multianchorage system *(MAS)* has an intermediate element *(IE)*, which inserts into the first molar buccal tube. The headgear inner face-bow fits into the top MAS buccal tube. The intermediate unit projects trough the middle tube; the labial arch, if needed, inserts into the bottom tube *(FAST)*. This labial arch element is a functional archwire for specific therapy.

Table I. Sample distribution

Group	Sex (N = 90)		Age (start)		Duration of follow-up		ANB angle	
	Male	Female	$\bar{X}$ (Years, months)	SD (Years, months)	$\bar{X}$ (Years, months)	SD (Years, months)	$\bar{X}$ (°)	SD (°)
A, Bioactivator	18	20	9,0	1,9	2,6	1,6	5.3	2.1
B, Bioactivator + headgear	19	19	10,1	3,6	2,4	1,1	6.6	2.5
C, Control	7	7	9,1	2,0	2,3	1,7	5.9	2.5

The distribution according to treatment, sex, age, and degree of maxillomandibular discrepancies is reported in Table I.

The appliance

The treated patients wore the bioactivator day and night for the first year and then only during the night for the remaining period of observation.

Group A underwent the entire treatment without extraoral force. In group B, a high-pull headgear was adjusted to the buccal tube units of the multianchorage system as previously described.[4,5] The headgear was worn every night (8 to 10 hours) during the first year of treatment (Fig. 3).

The bite registration for all cases was 4 mm of vertical interocclusal clearance in the first molar region. Sagittally it was two thirds of the potential maximum protrusion from habitual occlusion.

All the appliances were checked for optimal fit at the beginning of the treatment and if necessary relined with cold-cure acrylic to ensure perfect adjustment to the upper dental arch. Relining and trimming of the acrylic parts, which should be in close relationship with the erupting teeth, were repeated every 2 months to achieve perfect adjustment. When the bioactivator was inserted, further forward and lateral mandibular movements were possible. Only the backward and upward displacements were restrained.

The subjects in the control group (C), like those in the treated groups, were followed by use of lateral cephalograms taken every year but without any type of orthodontic intervention. All the cephalograms taken before and after the completion of the follow-up period were performed in centric relation at a distance of 1524 mm with 85 kV and 1-second exposure time. In addition to the usual methods of obtaining the most retruded position, the subject was asked to feel and maintain a reciprocal contact of his last occluding molars during the exposure.

The measurements

The cephalograms were traced and evaluated four times by operators not involved in the treatment. Only the mean value of the four measurements for each vari-

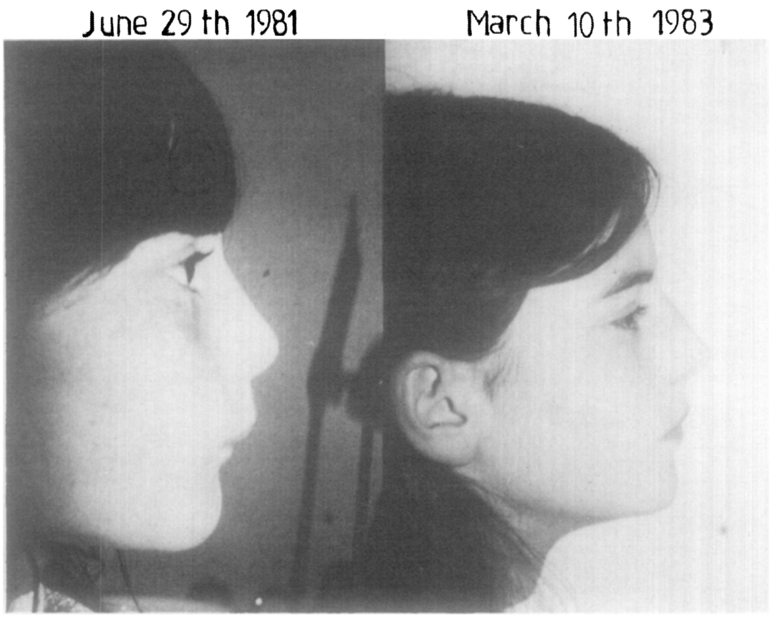

Fig. 3. A, Before *(left)* and after *(right)* profile photographs of a patient with a combination bioactivator and headgear combination. The time interval is approximately 21 months. Note the elimination of the mandibular retrusion, maxillary incisor protrusion, and the anterior open bite. Normal muscle function has been restored. The high-pull headgear has effectively depressed the maxillary posterior segments.

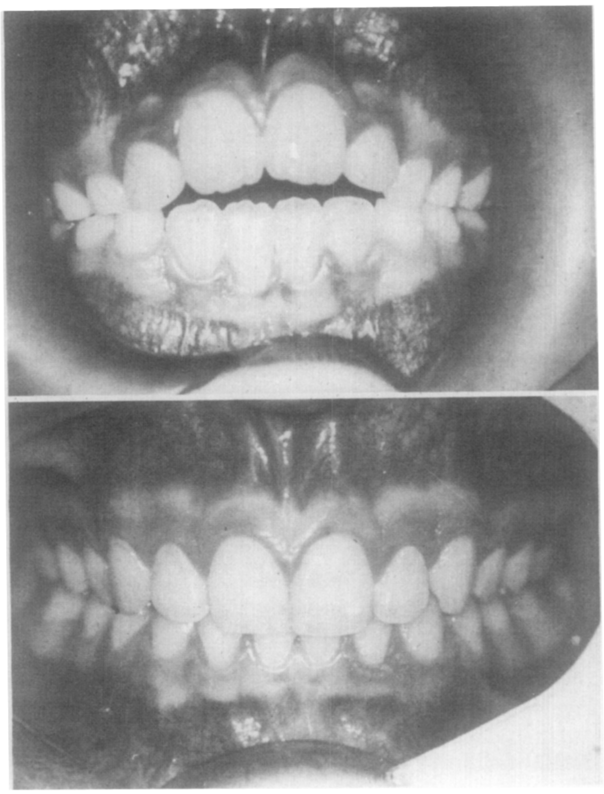

Fig. 3 (Cont'd). B, Before *(upper)* and after *(lower)* interior intraoral views of patient in **Fig. 3, A,** with a bioactivator and headgear combination. The time interval is approximately 21 months. Note the elimination of the mandibular retrusion, maxillary incisor protrusion, and the anterior open bite. Normal muscle function has been restored.

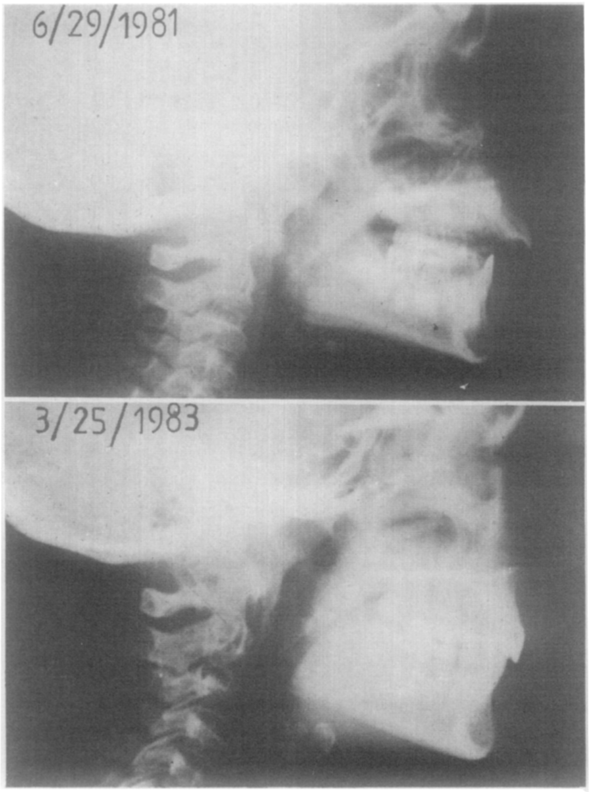

Fig. 3 (Cont'd). C, Before *(upper)* and after *(lower)* lateral cephalograms of patient in **Fig. 3, A,** with bioactivator and headgear combination. The time interval is approximately 21 months. Note elimination of the mandibular retrusion, maxillary incisor protrusion, and anterior open bite. The high-pull headgear has effectively depressed maxillary posterior segments.

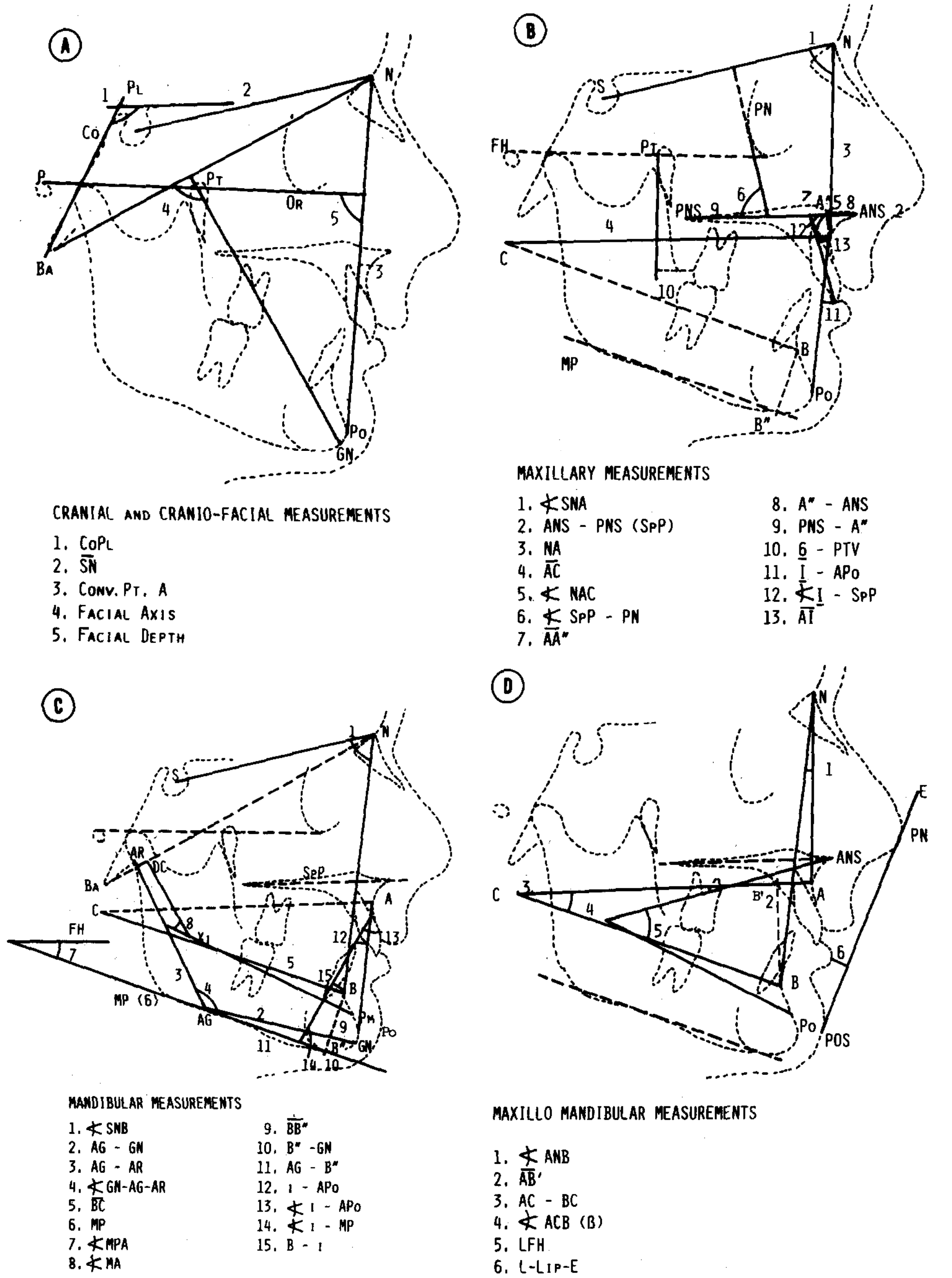

Fig. 4. Lateral cephalometric tracings to illustrate the cephalometric criteria used in this study. **A,** Set of specific cranial and craniofacial measurements; **B,** maxillary measurements; **C,** specific mandibular criteria; **D,** maxillomandibular measurements.

able was reported. All the tracings were performed with an accuracy of 0.5 mm and 0.5°.

The cephalometric evaluation

Skeletal landmarks were defined and variables were selected so that sufficient information could be reported on cranial, maxillary, and mandibular growth and on any dentoalveolar change occurring during the observation time. The variables are reported in Table II, Fig. 4.

Statistical analysis

Analysis of variance. An incomplete four-way analysis of variance was performed to define the different sources of variation and to identify which variable was able to give enough information on the altered landmark

Table II. Description of cephalometric criteria illustrated in Fig. 4

Landmarks and measurements	*Definition*
Variable	
Cranial	
CoPl	Sphenooccipital angle that relates jugum sphenoidale (Pl) to clivus occipitale (Co); it informs on endochondral growth pattern
Craniofacial	
SN	Anterior cranial fossa
Conv. Pt. A	Convexity point A according to Ricketts
∢ FA	Facial axis according to Ricketts
∢ FD	Facial depth according to Ricketts
PN	Perpendicular to SN (Schwarz)
Maxillary	
∢ SNA	Maxillary angle (Downs and Riedel)
ANS	Anterior nasal spine; the most anterior point of the triangular reproduction of the nasal spine
PNS	Posterior nasal spine; intersection of the anterior pterygoid border with the reproduction of the hard palate
ANS-PNS (SpP)	Palatal plane and interspinal distance
NA	Upper facial height
AC	A parallel to the palatal plane through the point A (maxillary chelegnathometric branch)
C	Intersection point of this parallel with another line that is parallel to the mandibular plane (to be defined afterward)
$\overline{AC}$	The distance between both points that varies according to the maxillomandibular vertical and sagittal relationships
∢ NAC	Informs on sagittal and vertical relationships of the upper jaw
∢ SpP-Pn	Informs on maxillary rotation (Schwarz)
A″	Projection of A on the palatal plane SpP
$\overline{AA''}$	Measurement of the distance between A and its projected point A″; it informs on premaxillary and alveolar vertical growth
A″-ANS	Measurement between the anterior nasal spine and the projected point A″; it informs on premaxillary sagittal growth
PNS-A″	Measurement of the posterior max. growth-segment; it informs on maxillopalatal growth
Dentomaxillary	
$\underline{6}$-PTV	Measurement of the position of the upper molar according to Ricketts
$\underline{I}$-APo	Measurement of the upper incisor according to Ricketts
∢ $\underline{I}$-SpP	Axis inclination of the upper incisor to the palatal line
$\overline{AI}$	Measurement of the distance between A and upper incisor axis through a perpendicular from A on this axis
Variable	
Mandibular	
∢ SNB	Mandibular angle according to Downs and Riedel
AG	Antegonion; the most posterior superior point on the mandibular notch
AR	Articular point according to Björk
ME	Menton
GN	Gnathion; the most anterior inferior point of the chin between menton and pogonion
AG-GN	Corpus length
AG-AR	Ramus length
∢ GN-AG-AR	Gonial angle
BC	A parallel to the mandibular plane through point B that joins the parallel to the palatal plane at the intersection point C (mandibular chelegnathometric branch)
$\overline{BC}$	The distance between both points
MP	Mandibular plane through menton (ME) and antegonion (AG)
∢ MPA	Mandibular plane angle
∢ MA	Mandibular arc angle according to Ricketts between corpus and condyle axes
B″	Projection of B on the mandibular plane
$\overline{BB''}$	Distance between B and its projected point B″
B″-GN	Distance between projected B″ and GN
AG-B″	Distance between projected B and antegonion
Dentomandibular	
I-APo	Distance of the lower incisor tip to the APo line (Ricketts)
∢ I-APo	Axial inclination of the lower incisors to APo line (Ricketts)
∢ I-MP	Axial inclination of the lower incisors to mandibular plane measured forward
B-I	Distance between B point and lower incisor axis through a perpendicular from B on this axis
Maxillomandibular	
∢ ANB	Angular maxillomandibular relationship according to Downs and Riedel
$\overline{AB''}$	Chelegnathometric maxillomandibular relationship (Dahan) distance between A and the projected point B on the AC line; $AB' = (AC - BC) \times \cos \beta$
AC-BC	Difference between AC and BC
∢ ACB (β)	Maxillomandibular vertical relationship; it is the homothetic report of the angle (β) between palatal plane and mandibular plane (Schwarz)
LFH	Lower facial height (ANS-Xi-Po) according to Ricketts
L-Lip-E	Lower lip-esthetic line according to Ricketts

Table III. Analysis of variance for selected criteria of growth and treatment

	Variable	Group	Session	Duration	Group × session	Group × duration	Session × duration
C	CoPl	NS	NS	NS	NS	NS	NS
CF	SN	NS	39.45***	3.64*	NS	NS	6.23**
	Conv. Pt. A	3.59*	28.10***	NS	NS	NS	NS
	∢FA	NS	4.88*	NS	NS	NS	NS
	∢FD	NS	NS	NS	NS	NS	NS
Mx	∢SNA	NS	NS	NS	NS	NS	NS
	ANS-PNS	3.56*	13.17***	NS	NS	NS	4.69*
	NA	NS	NS	NS	NS	NS	NS
	AC	NS	24.65***	NS	3.41*	NS	NS
	∢NAC	NS	NS	4.70*	NS	NS	4.56*
	∢SpP-PN	NS	9.90**	NS	NS	NS	NS
	AA″	NS	NS	NS	NS	NS	NS
	A″-PNS	3.22*	NS	3.51*	NS	NS	NS
	PNS-A″	5.80**	19.48***	NS	NS	NS	NS
DMx	6-PTC	NS	19.21***	NS	NS	NS	3.72*
	I-APo	NS	30.27***	NS	14.98***	NS	NS
	∢I-SpP	NS	34.34***	3.94*	6.82*	NS	NS
	AI	NS	15.30***	NS	NS	NS	NS
Ma	∢SNB	NS	9.39**	NS	NS	NS	NS
	AG-GN	5.35**	31.58***	NS	NS	NS	9.70***
	AG-AR	NS	123.22***	NS	5.67**	NS	17.72***
	∢GN-AG-AR	NS	4.13*	NS	NS	NS	NS
	BC	3.19*	36.93***	NS	4.93*	NS	3.63*
	∢MPA	NS	4.61*	NS	NS	NS	NS
	∢MA	NS	NS	NS	NS	NS	NS
	BB″	NS	8.06**	NS	NS	NS	9.27***
	B″-GN	5.40**	NS	NS	NS	NS	NS
	AG-B″	3.26*	28.72***	NS	NS	NS	10.93***
DMa	I-APo	NC	24.95***	NS	NS	NS	NS
	∢I-APo	NS	31.14***	NS	NS	NS	NS
	∢I-MP	3.32*	NS	NS	NS	NS	NS
	B-i	NS	NS	NS	NS	NS	NS
MxMa	∢ANB	NS	32.61***	NS	3.48*	NS	NS
	AB′	7.71*	19.61***	NS	8.36***	NS	3.41*
	AC − BC	NS	44.28**	NS	3.49*	NS	NS
	∢ACB	4.03*	NS	4.40*	NS	NS	9.91***
	LFH	NS	NS	NS	NS	NS	NS
	L-Lip, E	NS	13.45***	NS	3.33*	NS	NS

C, Cranial; *MA*, mandibular; *CF*, cranofacial; *DMA*, dentomandibular; *MX*, maxillary; *MxMa*, maxillomandibular; *DMx*, dentomaxillary.
$*p \leq 0.05$; $**p \leq 0.01$; $***p \leq 0.001$.

positions. The following three factors were considered **fixed**.

1. **Group** with three levels: bioactivator (A), bioactivator with headgear (B), and control (C). Analysis was performed to determine which source of variation was related to the selection procedure or differences among the samples with regard to the number of the subject's morphologic tendencies or typological particularities.
2. **Session** with two levels: before and after the observation time. Analysis was performed to determine which source of variation was related to growth changes during the follow-up period.
3. **Duration** of observation with three levels: less than 19 months; greater than 19, less than 33; greater than 33. Analysis was performed to determine which source of variation was related to the type of incremental changes (linear or not).

One factor was considered random—the "individuals"—with 90 levels (that is, 90 subjects).

Using the mean squares of the individual variations and those of their different interactions with the other factors as an "error term," it was possible to define different components of variance, which are reported in Table III.

Table IV. Significant morphologic or typological differences among the groups before and after observation (t test) for dentomaxillary (DMx), mandibular (Ma), and maxillomandibular (MxMa)

Variables		Probability (t test)			Comparison of the means		
		A ≠ B	B ≠ C	A ≠ C	$\bar{X}A$	$\bar{X}B$	$\bar{X}C$
Before							
DMx	I-APo		**		7.61	8.18	6.35
Ma	∢MA		*		29.89	29.23	33.78
	B"-GN	**			3.84	2.05	3.28
MxMa	AB'	***			10.13	12.94	11.17
	∢ACB	*			29.26	32.58	33.35
After							
CF	Conv. pt. A	*			3.35	4.97	5.25
Mx	ANS-PNS			*	43.57	42.68	40.28
	PNS-A"			**	49.36	47.23	45.87
Ma	AG-AR			*	56.89	55.00	53.00
	BC			**	83.50	79.26	70.57
MxMa	AB'	**		**	8.50	11.00	11.85
	AC − BC			*	−1.44	0.21	1.57

A, Bioactivator; *B*, bioactivator + headgear; *C*, control group.
$*p \leq 0.01$; $**p \leq 0.005$; $***p \leq 0.001$.

Table V. Significant effect of treatment—the increase or decrease of the measurements made for each criterion using the t test (total and average monthly changes after the survey for the selected cephalometric criteria are reported separately—See Table IV

Variables		Probability (t test)					
		$\bar{\Delta}A \neq \bar{\Delta}B$	$\bar{\Delta}B \neq \bar{\Delta}C$	$\bar{\Delta}A \neq \bar{\Delta}C$	$\bar{\Delta}A$	$\bar{\Delta}B$	$\bar{\Delta}C$
Totals							
DMx	I-APO		***	**	−1.71	−2.27	1.10
	∢I-SpP		**	*	5.05	6.60	−1.85
Ma	AG-AR	*		*	4.44	2.57	2.21
	BC		*		7.57	10.26	2.14
MxMa	AB'		**	**	−1.63	−1.94	0.67
	AC − BC			**	−2.39	−1.57	−0.50
Monthly							
Mx	AC		*		0.18	0.370	0.027
	PNS-A"			*	0.065	0.037	−0.036
DMx	I-APO		*	*	−0.065	−0.089	0.038
	∢I-SpP		*		0.150	0.310	−0.130
Ma	BC				0.270	0.430	0.060
			*				

A, Bioactivator; *B*, bioactivator + headgear; *C*, control group.
$*p \leq 0.01$; $**p \leq 0.005$; $***p \leq 0.001$.

Different t tests. These were performed afterward to compare pre- and postobservation values in each group and among the groups (Table IV). Differences between the data before and after the survey were also computed and compared among the groups either directly or after having been averaged by the duration of the survey in months (Table V).

RESULTS

Selection of the variables (Table III)

This selection was based on the study of the main effects and interactions of the three factors—namely, group, session, and duration—that were obtained from the analysis of variance. The interaction between group and session indicates interfaced variations within groups and within sessions and could therefore separate therapeutically induced changes from natural growth. The following variables seemed to be more influenced through the type of group observation (that is, just control follow-up or therapy with or without headgear):

1. The position and inclination of the upper incisors
2. The ramus length (AG-AR)
3. The maxillomandibular sagittal relationships (∢ ANB, distance AB′, and the difference, AC − BC)

The interaction between session and duration, which provided supplementary information on the effect of time on the growth-related changes, emphasized some variables like maxillary length or mandibular corpus and ramus lengths.

Study of the morphologic or typological differences (Table IV)

The significant differences among the groups before the follow-up period (preobservation measurements). These differences were related to morphologic tendencies of the selected samples and may be summarized as follows:

1. The upper incisors (I-APo) were more forward in group B.
2. The mandibular arc angle (MA) was larger in the control group.
3. The anterior segment of the mandible (B″-GN) was longer in group A (bioactivator) than in group B (bioactivator and headgear).
4. The maxillomandibular sagittal distance (AB′) and vertical angle (ACB) were more important in group B than in group A.

The significant differences among the groups after the follow-up period. Of these, the following may be related to nonidentical incremental modifications during the observation time:

1. The convexity or the distance between point A and the facial plane NPo
2. The posterior maxillary growth segment (PNS-A″)
3. The ramus length (AG-AR)
4. The sagittal maxillomandibular distance (AB′)

Evaluation of the changes related to growth and/or treatment

The results of the t tests performed on the measurements before and after the observation time within each group and on their differences in order to match group variations (Table V) led to the following observations.

1. *Cranial changes* (C)
   No changes attributed to the sphenooccipital angle (Co. Pl).
2. *Craniofacial changes* (CF)
   There was an increase in the anterior cranial length in both treated groups (A and B). There was a reduction in the convexity of point A in the group treated with the bioactivator alone (4.36 mm before and 3.35 mm after). No differences were reported among the group.
3. *Maxillary changes* (Mx)
   a. The *maxillary length* or interspinal distance was increased after the treatment with the bioactivator and headgear (group B) in a significant way. The mean difference was 1.5 mm. There were no changes in the other two groups.
   b. The *maxillary rotation*. The upper jaw showed an increased posterior rotation in group B, with a significant reduction (−1.28°) of the angle SpP-PN.
   c. The *posterior maxillary segment* (PNS-A″) was increased in both groups A and B treated with the bioactivator. The monthly change in group A (+0.065) was different than that in the control group C (−0.036) (Table V).
   d. The *dentomaxillary* changes (DMx)
      (1) The distance between the upper molars and the PTV line showed a significant increase in the cases treated with the bioactivator (+1.81 mm).
      (2) The upper incisor position was modified in the two treated groups. Its distance to APo was reduced by 1.71 mm in group A and 2.28 mm in group B. A significant monthly reduction was also demonstrated as shown in Table V.
      (3) The upper incisor proclination (I-SpP) was reduced 5.05° in group A and 6.60° in group B. This was significantly different than that of the control group (Table V). A relative monthly decrease was also significant in the treated group B (Table V).
4. *Mandibular changes* (Ma)
   a. The sagittal position of the mandible, estimated through the SNB angle, seemed to be influenced only in the treated group A (+0.98°).
   b. The corpus length (AG-GN) in the treated group B (bioactivator and headgear) alone showed a significant increase—namely, 3.03 mm.
   c. The ramus length AG-AR varied in the three groups. The comparison of the differences before

and after observation time (Table V) shows a major increase of 4.44 mm in group A (treated with the bioactivator alone), an increase of 2.21 mm in the control group (C), and a similar increase of 2.57 mm in group B.

d. The mandibular element of the chelegnathometric analysis (BC) (Table II) increased only in the treated groups. The major increment seemed to be in group B (+10.26 mm), when compared with the control group (Table V). There was also a specific tendency in the monthly incremental measurements, with 0.43 mm in the treated group B and only 0.06 mm in group C.

e. There were no particular changes of the mandibular plane angle (MPA) or the mandibular arc angle (MA).

f. The posterior segment of the mandibular body (AG-B″) was significantly increased in the treated group B (+2.90 mm).

g. The dentomandibular changes (DMa) included:

(1) The increased inclination of the lower incisors in relation to the APo line in the three groups with no significant differences among them. Even without therapy, the lower incisors underwent proclination during the survey (+2,67° in group A, +2,24° in group B, and +2,86° in group C).

(2) The labial displacement of the lower incisors, in relation to the APo line, was approximately 1.32 mm in the subjects treated with the bioactivator alone.

5. *Maxillomandibular relationships* (MxMa)

The sagittal relationship between the upper and lower jaws was modified only in the two treated groups. The control group showed no significant difference before and after the follow-up.

— The ANB-angle was reduced 1.03° in the treated group A and 1.58° in group B. The differences between groups A and B or between treated groups and control group were not significant.

— The distance (AB′) in the chelegnathometric analysis was significantly reduced after treatment. This reduction was not specific for each treated group. However, it was relatively highly significant when compared with the control group (group A, −1.63 mm; group B, −1.94 mm; group C, +0.67 mm).

— The difference (AB − BC) between the maxillary and the mandibular branches in the chelegnathometric analysis also showed a significant decrease after therapy. The average decrease in group A (−2.39 mm) was different from that of the control group C (−0.50 mm).

— The relation of the lower lip to the esthetic line E showed a significant change in the treated group B (−1.39 mm), but there was no trend among the groups.

DISCUSSION

Treatment changes in young subjects are always affected by incremental alterations caused by growth. Because the optimal age for functional treatment is from 9 to 13 years, study of treatment effects should include an assessment of what could be spontaneous development.

Growth phenomena, with their individual variations, are involved at the beginning and during the whole period of treatment. Two main methods have been suggested to separate natural from therapeutic changes:

1. Matching measurements of the same subject during two periods of survey: one without therapy and one with therapy.[6,7] However, the possibility exists, that because of nonlinear incremental growth, natural differences during the two follow-up periods might become significant and could influence this comparison.
2. Comparing investigations of treated and untreated subjects. It supposes that both groups are homogeneous regarding age and sex of the subjects, but does not reject the fact that this selection may not exclude specific group tendencies or typological variabilites.[8]

One way to reduce these biases is proposed by Remmer and associates.[9] They suggested comparing the pretreatment measurements for each variable. This comparison, however, does not estimate natural growth phenomena occurring during the survey, which could be related to group differences.

The evaluation of the different sources of variations resulting from the sampling, the technique of observation, and the type of growth in an analysis of variance lead to another way of selecting the variables. Besides dental measurements, the ramus length (AG-AR) and the maxillomandibular variables (AB′, AC − BC, and ∢ANB) are most likely to distinguish spontaneous growth from treatment changes (Table III).

Further t test comparisons among groups and between sessions helps to clarify what occurred during the survey. The results elicited the following observations.

1. *The maxillary changes* seemed to be more im-

portant in the treated groups than in the control group.

The modifications were in not only the dentition but also in the maxillary structures. Some of these are comparable to those obtained in other studies, like the dorsal displacements of point A.[6,10,11]

The increased posterior rotation of the maxilla in group B (bioactivator and headgear) could help confirm this statement. Already suspected by Teuscher,[5] this rotation is evaluated through the angle between the palatal plane and a perpendicular line to SN (SpP-PN).

A further interesting result was the paradoxical increase in the length of the upper jaw (ANS-PNS) in the same group B.

Orthopedic forces of the type used in this study do not seem to inhibit intramaxillary sagittal growth. The posterior maxillary growth segment (PNS-A″) was particularly influenced by the bioactivator therapy with a monthly increment in both treated groups that was significantly greater than that in the control group. Dentoalveolar changes related to therapy were in the molar and incisor regions. The mesial drift of the upper molars seemed to be increased in group A (bioactivator). In addition to changes in the dentition,[11] a possible functional explanation for this might be found in the mesial force transmitted to the upper teeth each time the mandible moved toward the protruding position during closure on the appliance. Wearing the headgear on the bioactivator could inhibit this mesial drift.

2. *The mandibular changes* were more significant in the treated groups than in the control group. The lower jaw showed vertical growth in the three groups. However, the ramus length was greater in the group treated with the bioactivator. This result has been suspected in other investigations using the activator.[8,12] The sagittal growth (increased body length) was evident in the group treated with the bioactivator and headgear. The dentition underwent changes that were not necessarily related to therapy, with the exception of the distance between the lower incisors and the APo line.

3. *The maxillomandibular relationships* were directly influenced by therapy. There were no obvious differences between the treated groups. Very important, however, was the good vertical control observed on the maxilla in relation to the mandible. The general concept of an increased lower facial height[13,14] when bimaxillary appliances are used seems to be contradicted by the resulting changes of the maxillomandibular angle ACB. Its value, which was higher in group B before the combined therapy with bioactivator and headgear, was no more significantly different from that of the other groups after the survey. This finding could be related to the previously described backward rotation of the palatal plane.

CONCLUSION

The combination of a bimaxillary appliance with extraoral forces leads to rapid changes in the correction of Class II, Division 1 skeletal conditions.[5,11,15,16] Although the cervical headgear initiates the most efficient orthopedic effect on the maxilla,[17] undesirable movements of the upper molars (extrusion) and rotation of the upper jaw (backward and downward) can lead to the opening of the bite. This tendency may be enhanced with a cumulative effect attributable to the activator.[5] It is important to reduce any exaggerated upward and forward rotation of the mandible during the treatment of skeletal Class II relationships.

This effect can be obtained by an increase of the ramus length and by a decrease of the anterior rotation of the upper jaw. In skeletal open bite conditions, an occipital headgear directly fitted to the bimaxillary appliance[4] is useful to stimulate growth tendencies in a more sagittal than vertical direction.

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