ORIGINAL ARTICLE

Early orthodontic treatment of skeletal open-bite malocclusion with the open-bite bionator: A cephalometric study

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Introduction: This study was designed to evaluate the effectiveness of the open-bite bionator in growing subjects with increased vertical dimensions. **Methods:** The records of 20 subjects with high-angle skeletal relationships (MPA ≥25°) were examined. Cephalometric measurements were compared with those obtained from 23 sets of records of an untreated group matched according to age, sex, vertical skeletal relationships, and time intervals between records. Lateral cephalograms were analyzed before the start of treatment (mean age; 8.3 years) and after therapy and retention, with a mean period of observation of 2.5 years. **Results:** The treated group had a significantly smaller palatal plane-mandibular plane angle (−1.9°) and a greater overbite (+1.5 mm) associated with a significantly smaller overjet when compared with the control group. **Conclusions:** Based on the analysis of this sample, early treatment of skeletal open bite with the open-bite bionator appears to produce a modest effect that mainly consists of significant improvement in intermaxillary divergence. No favorable effects on the extrusion of posterior teeth were found. (Am J Orthod Dentofacial Orthop 2007;132:595-8)

The management of malocclusions characterized by skeletal open bite is always difficult, especially in adults.[1,2] Early treatment in the mixed dentition was proposed by several authors to reduce the time of therapy needed in the permanent dentition.[3-11] Cozza et al,[12] in a systematic review of the literature, found only 7 scientific studies on this issue, and their quality level was insufficient to draw any evidence-based conclusions. One proposed treatment protocol is the open-bite bionator.[8] This appliance is a particular kind of bionator with posterior bite blocks to inhibit the extrusion of the posterior teeth. In the anterior region, the acrylic portion extends from the lower lingual part into the upper region as a lingual shield. The labial bow is placed at the height of correct lip closure, thus stimulating a competent seal relationship.[13] Weinbach and Smith[8] studied the effects of the open-bite bionator and reported good control of the vertical dimension with significant mandibular growth. However, in that study, the design of the appliances was variable (some patients wore high-pull headgear during the night), the tested sample was not composed of all hyperdivergent patients, and there was no control group.

Our aim in this study was to analyze the dentoskeletal changes after orthodontic treatment of skeletal open-bite malocclusion with the open-bite bionator in a group of 20 subjects in the mixed dentition compared with a control group (CG) of untreated subjects at the same stage of development to test the efficacy of this early functional therapy.

MATERIAL AND METHODS

The treated group (TG) was obtained from a group of patients treated in the Department of Orthodontics at the University of Florence in Italy. These patients were treated with an open-bite bionator for about 18 months; then the appliance was worn at night as a retention appliance.

Lateral cephalograms of the TG were analyzed regardless of treatment results. The patients had the following features: (1) initial mandibular plane angle relative to the Frankfort horizontal (MPA) 25° or greater[14]; (2) 2 consecutive lateral cephalograms of good quality with adequate landmark visualization and

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minimal or no rotation of the head, taken before treatment (T1) and after therapy and retention (T2); and (3) no permanent teeth extracted before or during treatment.

The TG included 20 subjects, 9 girls and 11 boys. The average ages were 8.3 years ± 10 months at T1 and 10.8 ± 1.5 years at T2. The mean duration of observation was 2.5 ± 1.2 years. The sample included 6 subjects with Class I occlusion and 14 subjects with Class II malocclusion.

The open-bite bionator has posterior acrylic bite blocks to prevent extrusion of the posterior teeth.[13] The construction bite is as low as possible, but a slight opening allows the interposition of posterior acrylic bite blocks for the posterior teeth to prevent their extrusion. The acrylic portion of the lower lingual part extends into the maxillary incisor region as a lingual shield, closing off the anterior space without touching the maxillary teeth. This portion of the appliance is intended to inhibit tongue movements.

The palatal bar has the same configuration as the standard bionator, to move the tongue into a more posterior or caudal position. The labial bow is placed at the height of correct lip closure, thus stimulating the lips to achieve a competent seal.

All patients in this study were asked to wear the appliance 24 hours a day (except during eating and playing certain sports) until the end of treatment. Their compliance with these instructions, however, varied.

A CG of 23 subjects was selected from the archives of the University of Michigan Elementary and Secondary School Growth Study. These subjects had T1 and T2 cephalograms available. The sample consisted of 13 girls and 10 boys. The average ages were 9.1 ± 1.6 years at T1 and 11.8 ± 1.3 years at T2. The mean duration of observation was 2.8 ± 1.1 years. The CG matched the TG as to hyperdivergent facial pattern (MPA ≥25°), mean ages at T1 and T2, and mean observation period.

The T1 and T2 cephalograms were hand traced by 1 investigator (G.B.), and another investigator (E.D.) verified the landmark locations. Any disagreements were resolved by retracing the landmark or the structure to the satisfaction of both observers.

Computer-assisted analysis of the serial lateral cephalograms of the 2 groups was performed by a digitizing tablet (2210; Numonics, Londsdale, Pa) and digitizing software (Viewbox, version 3.0; dHAL Software, Athens, Greece). The magnification factor of the cephalograms was standardized at 10%.

A cephalometric analysis consisting of 36 variables was generated.[15] Maxillary and mandibular superimpositions allowed the measurement of the movements of the maxillary and mandibular molars and incisors.

To superimpose the maxilla along the palatal plane, the superior and inferior surfaces of the hard palate and the internal structures of the maxilla superior to the incisors were used as landmarks. From this superimposition, the movement of the maxillary incisors and molars in the maxilla could be assessed. The mandibular superimposition was performed by using the mandibular canal and the tooth germs posteriorly and the internal structures of the symphysis and the anterior contour of the chin anteriorly. This superimposition allowed the measurement of the movement of the mandibular teeth in the mandible.

Statistical analysis

The data from the cephalometric analyses of the 2 groups were analyzed with the Shapiro-Wilk test; it indicated lack of normality for sample distribution. Therefore, the data were compared with a nonparametric test (Mann-Whitney U test) for independent samples ($P < .05$).

The homogeneity between 2 samples for ages at T1 and T2, and observation period allowed comparison of dentoskeletal changes (T2-T1) between the groups (Mann-Whitney U test). All statistical computations were performed with software (version 12.0; SPSS, Chicago, Ill).

The error of the method was evaluated on 20 cephalograms that were retraced and remeasured 1 month later. No systematic errors were found with the paired *t* test.[16] Random errors were estimated with Dahlberg's formula.[16] The errors for linear measurements ranged from 0.1 mm for pogonion to nasion perpendicular to 1.2 mm for condylion-gonion. The errors for angular measurements ranged from 0.4° for ANB angle to 1.4° for the interincisal angle.

RESULTS

Descriptive data and statistical comparisons for the increments from T1 to T2 of the skeletal and dental measurements for the 2 groups are given in the Table.

In the skeletal measurements on the sagittal plane, a significant difference between the 2 groups was found for pogonion to nasion perpendicular that was greater in the TG. In the vertical plane, the TG had a significant reduction in the palatal plane-mandibular plane angle (−1.9°) when compared with the CG.

The TG showed a significantly greater increase in overbite (1.5 mm more than the CG) that was associated with a significantly greater reduction of the overjet.

In the TG, the maxillary incisor exhibited a significant increase in the sagittal position (U1 horizontal, >1.2 mm),

Table. Comparison of changes from T1 to T2

	TG (n = 20)		CG (n = 23)			
Cephalometric measures	*Mean*	*SD*	*Mean*	*SD*	*Difference*	*Significance*
Maxillary skeletal						
SNA angle (°)	−0.6	1.6	−0.4	1.4	−0.2	NS
Point A to nasion perp (mm)	0.8	2.6	−0.4	1.2	1.2	NS
Co-Pt A (mm)	3.2	2.8	3.3	1.9	−0.1	NS
Mandibular skeletal						
SNB angle (°)	0.1	1.3	0.2	1.2	−0.1	NS
Pg to nasion perp (mm)	2.6	5.5	0.2	1.8	2.4	*
Co-Gn (mm)	6.1	3.9	5.4	2.5	0.7	NS
Maxillary/mandibular						
ANB angle (°)	−0.7	1.5	−0.5	0.9	−0.2	NS
Wits (mm)	1.3	2.7	0.0	1.6	1.3	NS
Maxillary/mandibular difference (mm)	2.9	2.1	2.1	1.7	0.8	NS
Vertical skeletal						
FH to palatal plane (°)	0.2	2.7	−1.0	1.7	1.2	NS
MPA (°)	−1.1	3.2	−0.3	1.4	−0.8	NS
Palatal plane to mandibular plane (°)	−1.2	1.8	0.7	2.7	−1.9	*
N-ANS (mm)	3.9	2.3	3.5	1.7	0.4	NS
ANS to Me (mm)	2.3	2.4	2.2	1.7	0.1	NS
N-Me (mm)	6.4	4.0	5.8	3.0	0.6	NS
Co-Go (mm)	2.7	2.2	2.4	2.3	0.3	NS
Gonial angle (°)	−0.4	2.2	−1.6	2.1	1.2	NS
Interdental						
Overjet (mm)	−0.7	1.5	−0.1	1.0	−0.6	*
Overbite (mm)	2.7	2.6	1.2	2.0	1.5	*
Interincisal angle (°)	4.4	5.4	1.4	6.1	3.0	NS
Molar relationship (mm)	0.5	1.3	0.5	1.0	0.0	NS
Maxillary dentoalveolar						
U1 to Pt A vert (mm)	0.5	1.4	0.6	1.0	−0.1	NS
U1 to FH	−2.0	4.1	−1.4	3.9	−0.6	NS
U1 horizontal (mm)	1.7	1.4	0.5	1.3	1.2	†
U1 vertical (mm)	2.1	1.4	1.8	1.6	0.3	NS
U6 horizontal (mm)	1.5	1.9	0.7	1.1	0.8	*
U6 vertical (mm)	1.4	1.1	0.6	1.3	0.8	*
Mandibular dentoalveolar						
L1 to Pt A Pg (mm)	0.2	1.3	0.5	1.1	−0.3	NS
L1 to MPA (°)	−1.4	3.3	0.3	3.4	−1.7	*
L1 horizontal (mm)	0.3	1.4	0.6	1.1	−0.3	NS
L1 vertical (mm)	2.8	1.3	1.9	1.1	0.9	†
L6 horizontal (mm)	0.9	1.6	1.5	1.1	−0.6	NS
L6 vertical (mm)	2.6	2.1	1.6	1.3	1.0	NS
Soft tissue						
UL to E plane (mm)	1.5	2.9	−1.7	1.3	3.2	‡
LL to E plane (mm)	1.0	6.1	−0.3	1.4	1.3	NS
Nasolabial angle (°)	1.7	9.1	3.8	6.7	−2.1	NS

Perp, Perpendicular; *U1,* maxillary central incisor; *U6,* maxillary first molar; *L1,* mandibular central incisor; *L6,* mandibular first molar; *NS,* not significant.
*$P < .05$; †$P < .01$; ‡$P < .001$.

the maxillary first molar had significantly greater forward position and greater extrusion (0.8 mm for both measures), and the mandibular incisors exhibited significantly greater lingual inclination (L1 to MPA, −1.7°) and greater extrusion (L1 vertical, 0.9 mm) than the CG.

The upper lip showed a significant tendency toward protraction relative to the E plane in the TG with respect to the CG (3.2 mm).

DISCUSSION

Orthodontic literature about early treatment of vertical malocclusion is scarce. To our knowledge, this is

the first longitudinal investigation on the effects of the open-bite bionator in growing subjects with skeletal open bite compared with a CG of untreated subjects with similar vertical relationships. All subjects in our investigation had mandibular plane angles relative to the Frankfort horizontal (MPA) 25° or greater at T1. Weinbach and Smith[8] reported good control of the vertical dimension with significant mandibular growth in patients treated with the open-bite bionator. Unfortunately, the design of the appliances in that study was variable (some patients wore high-pull headgear during the night), the tested sample was not composed of all hyperdivergent patients, and there was no control group. They found that the use of high-pull headgear during bionator therapy had no significant effect compared with the bionator alone. Recently, Freeman et al[15] investigated a therapeutic protocol consisting of a first phase of bionator and high-pull facebow followed by a second phase of fixed appliances in a sample of growing subjects with increased vertical dimensions. They concluded that this therapeutic protocol worsens the hyperdivergent facial pattern at a clinically significant level, and it is not recommended for growing patients with hyperdivergent facial pattern.

The aim of our study was to investigate the effects of the open-bite bionator used alone compared with a matched CG of untreated subjects with excessive vertical dimension. Our results showed improvements of skeletal and dental components of the malocclusion from the bionator. In the TG, the overbite improved by 2.7 mm for a net gain of 1.5 mm with respect to the CG. Seventeen of 20 subjects (85%) had improvement of the overbite. Favorable skeletal changes were observed: the opposite directions of change in the inclination of the palatal plane and the mandibular plane with respect to Frankfort plane caused a significant reduction of the intermaxillary divergence of 1.9° with respect to the CG. The clinical relevance of these data, however, should be considered with caution because of the great variability associated with the assessed changes. In general, the outcomes of this study showed modest improvements in the overall vertical dimensions. There was no significant change in the MPA and Frankfort horizontal to palatal plane measurements after bionator treatment.

Extrusion of the mandibular first molar occurred in the TG when compared with the CG. This unfavorable effect of functional appliances was also found by Freeman et al,[15] and it occurred despite of the bite blocks for the posterior teeth.

CONCLUSIONS

These results demonstrate modest effectiveness of early treatment of skeletal open bite with the open-bite bionator. The main favorable outcome was improvement in the intermaxillary divergence in the TG with respect to the CG. No favorable effects on the extrusion of posterior teeth were found.

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