Original Article

Effects of a Magnetic Appliance in Functional Class III Patients

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Abstract: The aim of this study was to determine the effects of a magnetic appliance in functional Class III patients. Standardized lateral head cephalograms and hand-wrist films of 10 subjects (mean age nine years seven months) were taken. These records were repeated after a period of one year, and the serial films were compared to determine the direction of facial growth as the control group. After this observation period, the magnetic appliance was placed in the 10 patients for approximately 9.4 months. The significant findings showed a posterior rotation of the mandible ($x = 2.1 \pm 0.7°$), increased overjet ($x = 4.8 \pm 0.3$ mm), decreased overbite ($x = -3.7 \pm 0.7$ mm), protrusion of the upper incisors ($x = 6.2 \pm 1.2°$), retrusion in the lower incisors ($x = -0.6 \pm 0.3°$), reduced SNB angle ($x = -1.8 \pm 0.8°$), increased ANB angle ($x = 1.9 \pm 0.3°$), and an increased mandibular plane angle ($x = 2.1 \pm 0.7°$). The results of this study indicate that the primary effect of magnetic appliance was the increase in the posterior rotation of the mandible. (*Angle Orthod* 2005;75:768–777.)

Key Words: Functional Class III; Magnets

INTRODUCTION

The most commonly reported treatment protocols for Class III malocclusions have included Frankel III appliances,[1] face mask therapy,[2,3] orthopedic chincups, and magnetic appliances. The Fr-III appliance was recommended by Frankel for patients with skeletal maxillary retrusion. Face mask therapy produces protrusive forces to the maxilla and maxillary dentition. It has been stated that circummaxillary sutures are affected by this therapy.[2,3] The protraction forces on the maxilla by face mask therapy can be supported by orthopedic expansion because expansion is believed to facilitate the orthopedic effect of the mask. It has been reported that maxillary expansion produces a slight forward movement of the maxilla.[4]

The orthopedic chincup is also used in the treatment of Class III malocclusion. This therapy is useful in patients who have a protrusive mandible rather than a small and retrusive maxilla. It has been pointed that the primary effect of chincup therapy is a reduction in mandibular growth.[5]

Pseudo Class III is defined as the functional forward displacement of the mandible as a result of retroclined maxillary incisors.[6] Early treatment of Class III individuals, especially pseudo Class III individuals, has been suggested in several studies. The optimum treatment timing and the treatment modalities influence the effects of the therapies. Various appliances such as removable plates, fixed or removable inclined planes, functional appliances, fixed appliances, and chincups have been designed for early treatment of pseudo Class III subjects.[7]

Medical and dental applications are favorable fields for the use of magnets. Magnetic forces offer some advantages in orthodontics by their biologic effects, but there is some controversy about the effects on periodontal tissues. The clinical application of magnetic forces has been presented in several studies.[8–11] Darendeliler et al[9] developed a magnetic activator device for Class II division 1 malocclusions and stated the advantages of the less-bulky design of the appliance. Successful use of a magnetic appliance in skeletal Class III subjects has been achieved. Because of their high costs and the debate about the effects on human tissues, magnets have not yet been routinely used.[12]

There are only a few studies concerning functional

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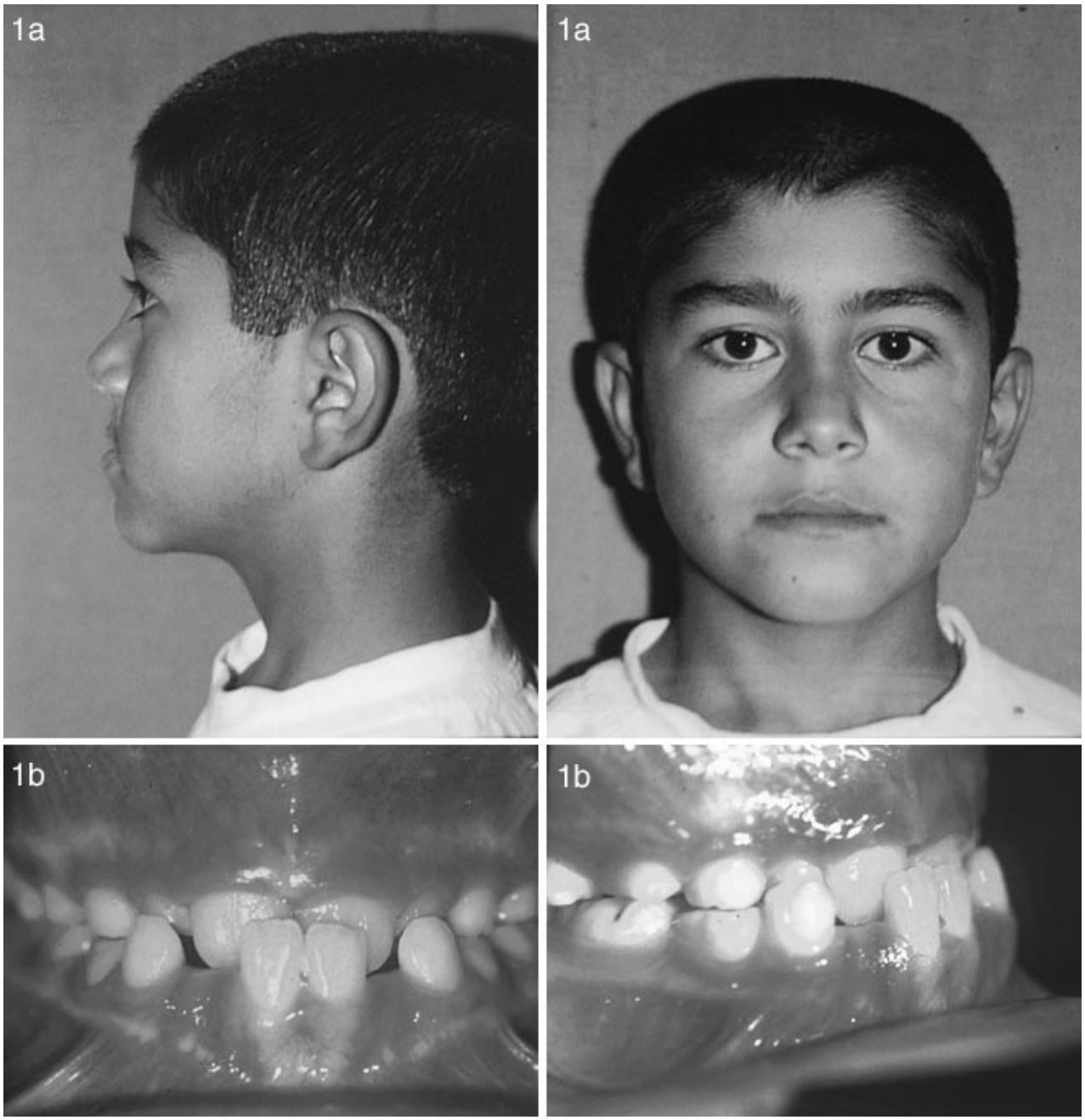

FIGURE 1. (a) Frontal and profile views before treatment. (b) Intraoral views before treatment.

Class III subjects. The aim of this study was to determine the craniofacial and dentoalveolar changes of a magnetic device in functional Class III malocclusions.

MATERIALS AND METHODS

A group of 10 children with pseudo Class III malocclusion (six boys, four girls), mean skeletal age of nine years six months ± 1.02, mean chronological age nine years seven months ± 1.04, were observed for one year without any orthodontic treatment. Mean skeletal age at the second observation was 10 years five months ± 1.02 and mean chronological age 10 years seven months ± 1.04. Serial lateral cephalograms and hand-wrist films were obtained both before and after the observation period and also just after the treatment period. The intraoral and extraoral photographs are shown in Figures 1a,b and 2a,b.

The patients were treated with a magnetic device consisting of upper and lower removable appliances carrying magnets in both segments. Heated wax with five mm of vertical activation was prepared for a bite and the patient's mandible was manipulated to the

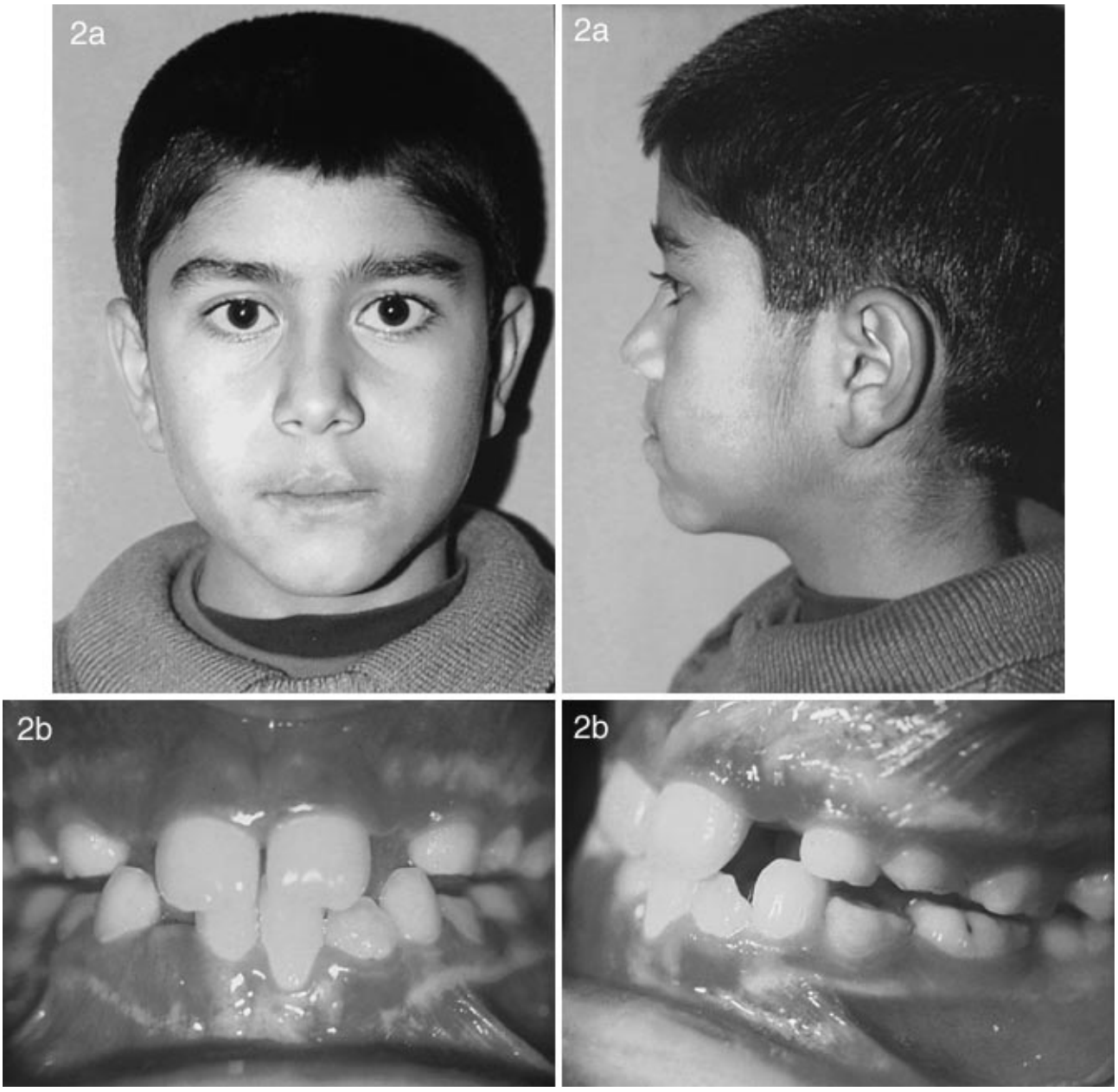

FIGURE 2. (a) Frontal and profile views after treatment. (b) Intraoral views after treatment.

most posterior position. Each appliance had Adams clasps on the first molars, a labial bow, and three neodymium (Nd2Fe17B) magnets. Two of the magnets were placed in the molar region and one in the anterior region (Figure 3a).

The upper-arch magnets were placed three mm distal to the lower-arch magnets (Figure 3b). This way, the upper and lower magnets try to locate at the same level by attractive forces, and a backward force toward the mandible was maintained. Magnets were placed to produce an attracting force of 300 g on each side, producing a total magnetic force of 900 g. The magnets had 2.5 mm height and nine mm radius (Figure 3c). The subjects were instructed to wear the two appliances approximately 18 hours per day and were seen every four weeks.

After obtaining the desired amount of overjet and correction of the anterior crossbite, a full set of records was obtained. The overall treatment period ranged from 5.5 to 12 months. The dentofacial changes were evaluated by linear and angular parameters on the lateral cephalometric films and the landmarks were digitized.

Evaluations were made by the RMO JOE Jiffy 5.0 orthodontic program (Rocky Mountain, Denver, Colo). Statistical evaluation was performed using a *t*-test.

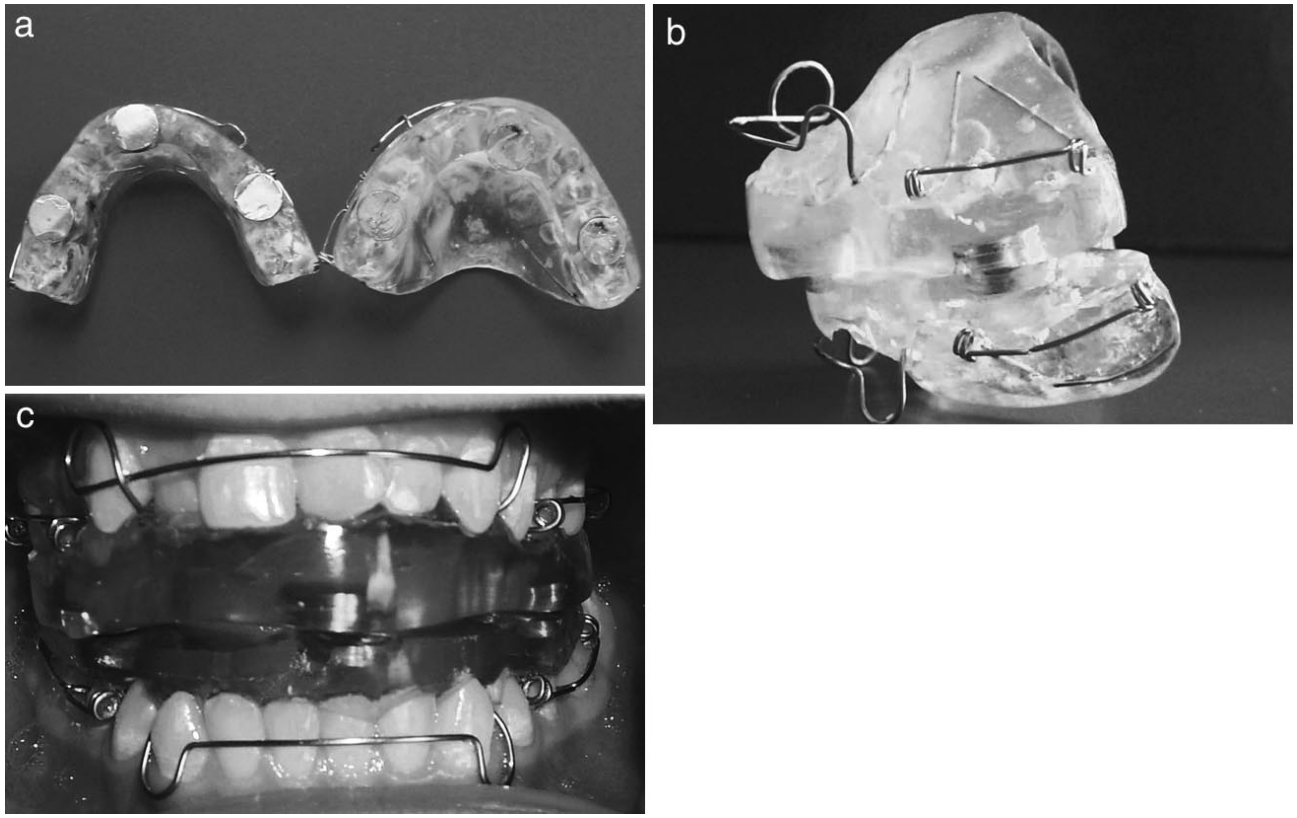

FIGURE 3. (a) The view of upper and lower parts of the magnetic appliance. (b) The view of the magnetic appliance extraorally. (c) Intraoral view of the magnetic appliance.

RESULTS

Descriptive statistics for the cephalometric variables before and after the observation and also posttreatment periods are shown in Table 1. Table 2 shows the results of the statistical comparisons during the observation period. The statistical comparisons of the treatment period are represented in Table 3. The statistical comparisons of changes determined in the observation and treatment periods are shown in Table 4.

Maxillomandibular relationship

The ANB angle decreased during the observation period ($P < .01$) but increased significantly after the treatment ($P < .001$). The difference between the two periods is significant ($P < .001$). The lower facial height angle (ANS-Xi/Xi-Pg) increased during the treatment period ($P < .05$). No significant difference was determined between periods ($P > .05$). The palatomandibular plane angle (ANS-PNS/Go-Me) increased during the treatment period ($P < .05$). A statistical difference was noted between periods ($P < .05$).

Mandibular measurements

The decrease in SNB angle during the treatment period was statistically significant ($P < .05$). A statistical difference was present between periods ($P < .05$).

The Facial axis angle (N-Ba/CC-Gn) decreased during both periods ($P < .05$). The difference between the two periods was significant ($P < .05$).

The y-axis (S-N/S-Gn) ($P < .05$) and the mandibular plane (S-N/Go-Gn) ($P < .01$) increased as a treatment effect. Statistical differences were present between periods ($P < .05$).

The lower gonial angle increased during the treatment period ($P < .01$), and the difference between the periods was significant ($P < .01$). The mandibular length, as indicated by Co-Gn, increased during the observation period ($P < .01$), and no significant differences were found during treatment and between periods ($P > .05$). The mandibular plane-Frankfurt horizontal plane angle showed statistically significant results between periods ($P < .05$).

Among the linear measurements for the assessment of facial height, posterior face height (S-Go) exhibited a significant increase during both periods ($P < .01$), but no difference was determined among periods (P

TABLE 1. Descriptive Statistics for all Variables[a]

Measurements	Preobservation		Postobservation		Posttreatment	
	X1	SX1	X2	SX2	X3	SX3
Cranial						
ArSN	123.1	1.9	123.1	1.9	123.5	1.8
SN	67.9	0.8	68.7	1.0	69.4	1.0
Maxillary						
SNA	79.2	0.9	79.4	0.8	79.9	0.9
Maxillary depth	86.5	0.9	86.5	1.0	87.7	1.1
Maxillary height	62.3	1.4	61.3	1.1	61.6	1.0
Condylion-A	80.6	1.1	82.0	1.1	83.7	1.8
Palatal/Franfurt horizontal	−2.1	0.9	−1.6	0.7	−0.5	0.6
Maxilla and mandible						
ANB	−1.1	0.7	−2.0	0.7	−0.1	0.7
Angle of lower facial height	43.2	0.8	43.2	1.0	44.3	0.9
Palatal/mandibular	25.8	1.5	25.2	1.4	27.3	1.4
Mandibular						
SNB	80.3	1.3	81.4	1.0	79.6	1.3
Facial axis	87.9	1.2	89.8	1.1	88.2	1.2
y-axis	65.4	1.2	64.4	0.8	66.6	1.2
SN/GoGn	35.3	1.9	33.9	1.5	35.9	1.8
SArGo angle	22.7	1.8	22.6	1.7	21.6	1.6
ArGoN (upper gonial angle)	53.7	1.6	54.2	1.1	52.6	1.7
NGoMe (lower gonial angle)	76.5	1.3	75.9	1.3	76.9	1.4
CoGn	110.4	2.2	113.9	2.2	115.3	2.8
Mandibular/Frankfurt horizontal	27.9	1.6	26.8	1.3	27.8	1.4
Facial height						
Sgo	70.7	1.5	72.7	1.8	74.2	2.4
NMe	111.7	2.0	113.0	1.7	117.4	2.3
SGo/NMe × 100	63.4	1.4	64.3	1.2	63.1	1.3
ANSMe	61.3	1.3	62.1	1.5	65.1	1.7
Dental and dentoalveolar						
Overjet	−2.3	0.3	−2.2	0.2	2.6	0.2
Overbite	3.3	0.8	4.2	0.7	0.5	0.4
Interincisal angle	147.1	1.1	145.8	1.5	139.9	1.5
1-NA distance	2.83	0.5	3.6	0.6	5.07	0.6
1-NA angle	17.3	1.8	19.7	1.8	25.9	1.6
1-NB distance	3.2	0.3	3.2	0.3	2.7	0.3
1-NB angle	16.7	1.6	16.4	1.5	14.1	1.3
6-PTV	9.2	1.1	10.5	1.5	13.8	1.4
FMIA	70.8	2.2	72.1	2.4	73.7	2.2
Occlusal plane/cella-Nasion	19.9	1.9	18.4	1.5	17.6	1.0
Occlusal plane/Frankfurt plane	12.4	1.8	11.3	1.6	9.5	1.3
Mandibular incisor extrusion	2.6	0.8	2.5	0.6	0.7	0.4
Lower incisor/mandibular plane	81.1	1.6	81.0	1.6	78.5	1.3
Upper incisor/palatal plane	106.6	1.8	108.3	1.7	114.7	2.0
1⊥ANS-PNS	26.5	0.5	26.8	0.6	27.1	0.5
1⊥GoGn	34.0	0.6	34.3	0.7	34.6	0.8
$\underline{6}$⊥ANS-PNS	19.1	0.3	19.3	0.4	20.6	0.4
$\underline{6}$⊥GoGn	25.3	0.8	25.5	0.8	25.7	1.0
Esthetic						
Lower lip-esthetic plane	−1.7	0.7	−1.7	0.8	−1.8	0.6
Nasolabial angle	104.8	5.0	103.2	4.6	98.7	5.1
Age						
Chronological age	114.6	5.2	126.6	5.2	136.0	5.6
Skeletal age	113.7	4.4	125.2	4.3	134.9	4.9

[a] X1 indicates mean of preobservation period; SX1, standard error of mean of preobservation period; X2, mean of postobservation period; SX2, standard error of mean of postobservation period; X3, mean of posttreatment period; SX3, standard error of mean of posttreatment period.

TABLE 2. Statistical Comparison on the Differences Between Preobservation and Postobservation

Measurements	Mean	SD	P^a
Cranial			
ArSN	0.1	1.1	NS
SN	0.8	0.4	NS
Maxillary			
SNA	0.3	0.8	NS
Maxillary depth	0.1	0.6	NS
Maxillary height	−1.0	0.8	NS
Condylion-A	1.4	0.9	NS
Palatal/Franfurt horizontal plane	0.5	0.8	NS
Maxilla and mandible			
ANB	−0.9	0.2	**
Lower facial height	−0.1	0.7	NS
Palatal/mandibular plane	−0.6	0.8	NS
Mandibular			
SNB	1.2	0.8	NS
Facial axis	1.9	0.8	NS
y-axis	−1.0	0.7	NS
SN/GoGn	−1.5	0.8	NS
SArGo	−0.1	0.6	NS
ArGoN (upper gonial angle)	0.5	0.8	NS
NGoMe (lower gonial angle)	−0.7	0.4	NS
CoGn	3.6	0.9	**
Mandibular/Frankfurt horizontal plane	−1.1	0.6	NS
Facial height			
Sgo	1.9	0.6	**
Nme	1.3	0.9	NS
Sgo/NMe × 100	0.9	0.6	NS
ANS-Me	0.8	0.5	NS
Dental and dentoalveolar			
Overjet	0.1	0.2	NS
Overbite	0.8	0.4	NS
Interincisal angle	−1.3	1.5	NS
$\underline{1}$-NA distance	0.7	0.3	*
$\underline{\overline{1}}$-NA angle	2.5	1.2	NS
$\underline{\overline{1}}$-NB distance	0.1	0.2	NS
1-NB angle	−0.3	0.9	NS
6-PTV	1.4	0.9	NS
FMIA	1.3	1.1	NS
Occlusal plane/cella-Nasion	−1.6	1.7	NS
Occlusal plane/Frankfurt plane	−1.1	1.8	NS
Mandibular incisor extrusion	−0.1	0.6	NS
Lower incisor/mandibular plane	−0.1	0.9	NS
Upper incisor/palatal plane	1.8	1.3	NS
$\underline{1}\perp$ANS-PNS	0.4	0.2	NS
$\underline{\overline{1}}\perp$GoGn	0.3	0.2	NS
$\underline{6}\perp$ANS-PNS	0.2	0.2	NS
$\underline{\overline{6}}\perp$GoGn	0.3	0.2	NS
Esthetic			
Lower lip-esthetic plane	−0.1	0.3	NS
Nasolabial angle	−1.5	3.4	NS
Age			
Chronological age	12.0	0.2	***
Skeletal age	11.5	0.5	***

[a] NS indicates not significant; * $P < .05$; ** $P < .01$; *** $P < .001$.

TABLE 3. Statistical Comparison on the Differences Between Pretreatment and Posttreatment Periods

Measurements	Mean	SD	P^a
Cranial			
ArSN	0.4	1.2	NS
SN	0.7	0.3	NS
Maxillary			
SNA	0.5	0.7	NS
Maxillary depth	1.2	0.7	NS
Maxillary height	0.3	0.7	NS
Condylion-A	1.7	1.1	NS
Palatal/Franfurt horizontal plane	1.1	0.7	NS
Maxilla and mandible			
ANB	1.9	0.3	**
Lower facial height	1.1	0.5	*
Palatal/mandibular plane	2.1	0.7	*
Mandibular			
SNB	−1.8	0.8	*
Facial axis	−1.6	0.8	*
y-axis	2.1	0.7	*
SN/GoGn	2.1	0.7	**
SArGo	−1.0	1.1	NS
ArGoN (upper gonial angle)	−1.6	1.0	NS
NGoMe (lower gonial angle)	1.1	0.4	**
CoGn	1.4	1.0	NS
Mandibular/Frankfurt horizontal plane	1.0	0.5	NS
Facial height			
SGo	1.5	0.8	**
NMe	4.5	0.8	***
SGo/NMe × 100	−1.2	0.5	NS
ANS-Me	3.0	0.7	***
Dental and dentoalveolar			
Overjet	4.8	0.3	***
Overbite	−3.7	0.7	***
Interincisal angle	−5.9	1.4	**
$\underline{1}$-NA distance	1.5	0.3	***
$\overline{1}$-NA angle	6.2	1.2	***
$\overline{1}$-NB distance	−0.6	0.3	NS
1-NB angle	−2.3	0.7	**
6-PTV	3.3	0.9	**
FMIA	1.6	1.2	NS
Occlusal plane/cella-Nasion	−0.7	1.3	NS
Occlusal plane/Frankfurt plane	−1.8	1.1	NS
Mandibular incisor extrusion	−1.9	0.4	***
Lower incisor/mandibular plane	−2.6	0.8	*
Upper incisor/palatal plane	6.4	1.3	***
$\underline{1}\perp$ANS-PNS	0.3	0.3	NS
$\overline{1}\perp$GoGn	0.4	0.3	NS
$\underline{6}\perp$ANS-PNS	1.3	0.3	**
$\overline{6}\perp$GoGn	0.2	0.8	NS
Esthetic			
Lower lip-esthetic plane	−0.1	0.5	NS
Nasolabial angle	−4.5	3.8	NS
Age			
Chronological age	9.4	1.2	***
Skeletal age	9.2	1.0	***

[a] NS indicates not significant; * $P < .05$; ** $P < .01$; *** $P < .001$.

TABLE 4. Statistical Comparison on the Differences Between Observation and Treatment Periods

Measurements	Prepost observation		Prepost treatment		
	Mean	SD	Mean 1	SD 1	P[a]
Cranial					
ArSN	0.1	1.1	0.4	1.2	NS
SN	0.8	0.4	0.7	0.3	NS
Maxillary					
SNA	0.3	0.8	0.5	0.7	NS
Maxillary depth	0.1	0.6	1.2	0.7	NS
Maxillary height	−1.0	0.8	0.3	0.7	NS
Condylion-A	1.4	0.9	1.7	1.1	NS
Palatal/Franfurt horizontal plane	0.5	0.8	1.1	0.7	NS
Maxilla and mandible					NS
ANB	−0.9	0.2	1.9	0.3	***
Lower facial height	−0.1	0.7	1.1	0.5	NS
Palatal/mandibular plane	−0.6	0.8	2.1	0.7	*
Mandibular					
SNB	1.2	0.8	−1.8	0.8	*
Facial axis	1.9	0.8	−1.6	0.8	*
y-axis	−1.0	0.7	2.1	0.7	*
SN/GoGn	−1.5	0.8	2.1	0.7	*
SArGo	−0.1	0.6	−1.0	1.1	NS
ArGoN (upper gonial angle)	0.5	0.8	−1.6	0.7	NS
NGoMe (lower gonial angle)	−0.7	0.4	1.1	0.4	**
CoGn	3.6	0.9	1.4	1.0	NS
Mandibular/Frankfurt horizontal plane	−1.1	0.6	1.0	0.5	*
Facial height					
SGo	1.9	0.6	1.5	0.8	NS
NMe	1.3	0.9	4.5	0.8	*
SGo/NMe × 100	0.9	0.6	−1.2	0.5	*
ANS-Me	0.8	0.5	3.0	0.7	*
Dental and dentoalveolar					
Overjet	0.1	0.2	4.8	0.3	***
Overbite	0.8	0.4	−3.7	0.7	***
Interincisal angle	−1.3	1.5	−5.9	1.4	NS
$\underline{1}$-NA distance	0.7	0.3	1.5	0.3	NS
$\underline{1}$-NA angle	2.5	1.2	6.2	1.2	NS
$\underline{1}$-NB distance	0.1	0.2	−0.6	0.3	NS
1-NB angle	−0.3	0.9	−2.3	0.7	NS
6-PTV	1.4	0.9	3.3	0.9	NS
FMIA	1.3	1.1	1.6	1.2	NS
Occlusal plane/cella-Nasion	−1.6	1.7	−0.7	1.3	NS
Occlusal plane/Frankfurt plane	−1.1	1.8	−1.8	1.1	NS
Lower incisor extrusion	−0.1	0.6	−1.9	0.4	*
Lower incisor/mandibular plane	−0.1	0.9	−2.6	0.8	NS
Upper incisor/palatal plane	1.8	1.3	6.4	1.3	NS
$\underline{1}$⊥ANS-PNS	0.4	0.2	0.3	0.3	NS
$\underline{\overline{1}}$⊥GoGn	0.3	0.2	0.4	0.3	NS
$\underline{6}$⊥ANS-PNS	0.2	0.2	1.3	0.3	*
$\underline{\overline{6}}$⊥GoGn	0.3	0.2	0.2	0.8	NS
Esthetic					
Lower lip-esthetic plane	−0.1	0.3	−0.1	0.5	NS
Nasolabial angle	−1.5	3.4	−4.5	3.8	NS
Age					
Chronological age	12.0	0.2	9.4	1.2	NS
Skeletal age	11.5	0.5	9.2	1.0	NS

[a] NS indicates not significant; * $P < .05$; ** $P < .01$; *** $P < .001$.

$> .05$). The anterior face height (N-Me) exhibited an increase during the treatment period ($P < .001$), and a difference was noted among periods ($P < .05$). No significant differences were found for posteroanterior face height ratios and, therefore, a difference existed between periods ($P < .05$). The lower anterior face height (ANS-Me) showed a significant increase during the treatment period ($P < .001$), and a significant difference was assessed between periods ($P < .05$).

Dentoalveolar measurements

The increase in overjet and decrease in overbite exhibited significant results during the treatment periods ($P < .001$). Differences were assessed between periods ($P < .001$). A decrease in interincisal angle was determined only during the treatment period ($P < .01$).

The distance of the upper incisor relative to the NA plane increased during both periods ($P < .05$, $P < .001$). The angle of the upper incisor relative to the NA plane exhibited a significant increase during the treatment ($P < .001$). A decrease in the angle of the lower incisor relative to NB plane was determined by the treatment ($P < .01$). No significant differences were noted among the periods ($P > .05$).

The distance of the upper first molar relative to PTV showed an increase during the treatment period ($P < .01$), but no difference among periods was noted ($P > .05$).

Extrusion of the mandibular incisors exhibited a significant decrease on treatment ($P < .001$), and a significant difference was assessed between periods ($P < .05$).

A slight decrease in the lower incisor-mandibular plane angle was determined as a treatment effect ($P < .05$). The angle between upper incisor and palatal plane increased on the treatment ($P < .001$). No significant difference was present among periods ($P > .05$).

The distance of the upper first molar to ANS-PNS plane increased with the treatment ($P < .01$). Difference among periods was noted ($P < .05$).

DISCUSSION

The early treatment need of nonskeletal and skeletal orthodontic anomalies is intended to prevent the development of major anomalies. There is a general consensus in the literature that early therapy is indicated in cases of both anterior and lateral crossbites, Class III malocclusion, mandibular retrognathism, and open bite.[13] Kidner et al[14] stated that Class III twin-blocks have been used successfully for early treatment of Class III malocclusion with proclination of the upper incisors, retroclination of lower incisors, reduction in the SNB angle, and increases in the maxillary/mandibular plane angles.

Treatments with reverse headgear have been investigated several times.[15,16] Skeletal Class III anomalies due to maxillary retrusion cases have also been treated by Frankel III appliances with no effect on maxillary development. In addition, chincup therapy has been shown to produce a change in the mandible associated with a downward and backward rotation.[5]

In this study, a decrease occurred in the ANB angle during the observation period. Therefore, the increase in ANB angle might depend on the decrease in SNB angle. The increase in the lower facial height and palatomandibular plane angle by treatment contributes to the backward rotation of the mandible. Baccetti et al[17] found that after the treatment with the removable mandibular retractor appliance, the palatomandibular plane angle increased. Darendeliler et al[9] found a significant increase in the ANB angle, and Vardimon et al[11] presented the same results using a functional orthopedic magnetic appliance.

The SNB angle showed significant decrease during the treatment period, and the difference between the control and treatment periods was significant. The Facial axis increased during the control period and decreased during treatment. The y-axis also increased during treatment.

Class III treatment has been shown to demonstrate a backward and downward direction of mandibular growth in studies. Our findings in facial axis, y-axis, and mandibular plane angle are due to the posterior mandibular displacement.

Studies concerning the effects of Frankel III appliance resulted in a decrease in the SNB angle and an increase in the y-axis, mandibular plane angle, and lower anterior facial height, indicating the posterior rotation of the mandible by the treatment.[18–23]

It has been stated that chincup treatment induces a backward rotation of the mandible and that the vertical control is extremely important for such subjects and no increase in lower anterior facial height occurred.[24] In the subjects of this study, a significant increase in lower facial height and total anterior facial height occurred relative to the control period. These are in accordance with such studies.[20,22,25–28]

In this study, the overjet increased and the overbite decreased during treatment. The protrusion of the upper incisors and retrusion of the lower incisors were assessed, and the magnetic appliance showed improvement of any anterior crossbite. The magnetic force may produce an extrusive force on the incisors and, therefore, the mandibular incisor extrusion was decreased by the treatment. The acrylic portion of the appliance overcomes the extrusive force.

The increase in the distance of upper first molar to

ANS-PNS plane demonstrated the effective forces of the two magnets placed posteriorly. This is in accordance with the results obtained in face mask therapies. A study with a larger sample size may add strength to such studies.

CONCLUSIONS

In the current study, a two-piece magnetic device was used for correction of functional Class III malocclusions. The Class III subjects were observed for one year as the control group and then treated with the magnetic appliance. The primary effects of the therapy were the backward and downward rotation in the mandible, protrusion of the upper incisors, and retrusion of the lower incisors. Lower anterior facial height was affected during treatment. No significant effect on maxilla was determined.

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