Original Article

Adult Class III Treatment Using a J-Hook Headgear to the Mandibular Arch

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ABSTRACT

Objective: To evaluate the treatment effects of high-pull J-hook headgear on the lower dental arch in nongrowing Class III patients.

Materials and Methods: Fourteen nongrowing Class III patients having an Angle Class III malocclusion and ANB angle of less than 1.0 degree, were treated with high-pull J-hook headgear to the lower arch. Using lateral cephalograms and plaster models obtained before treatment (T1), after active treatment (T2), and after the retention period (T3), the treatment outcome was analyzed.

Results: The incisal edge of the lower central incisor moved a mean of 1.2 mm to the lingual and 1.7 mm to the occlusal between T1 and T2. The axis of the lower incisor inclined 4.0° to the lingual. The lower first molar cusp moved 1.5 mm to the distal and the root apex moved 2.0 mm to the mesial. Molar angulations were tipped 9.8° to the distal. The occlusal plane showed 4.5° counterclockwise rotation. The mean intermolar width increased 1.5 mm on average. Comparison of the records between T2 and T3 showed minimal changes.

Conclusions: Distal movement of the lower dental arch using J-hook headgear was clearly demonstrated, confirming that the application of high-pull J-hook headgear to the lower arch was effective for improvement of the Class III occlusion. (*Angle Orthod* 2010;80:336–343.)

KEY WORDS: Class III; Treatment; J-hook headgear

INTRODUCTION

Class III malocclusion with mandibular prognathism is of great concern to orthodontists because it is difficult to predict the nature of craniofacial growth for each individual.[1–4] In adult patients without growing ability, orthognathic surgery is indicated for severe skeletal Class III malocclusion, but moderate Class III cases, so-called borderline cases, can be treated orthodontically if the patient declines surgery.[5–7] Several methods have been reported to treat such moderate Class III cases.[8–13] Extraction of lower teeth combined with Class III elastics can improve the dental occlusion for Class III patients, although its results are often compromised.[8–10] Færøvig and Zachrisson[10] assessed the treatment outcome of the mandibular incisor position after extraction of a single incisor in adult Class III cases and demonstrated that this might be a good treatment alternative in selected adult cases. However, they suggested that improper transverse relationship of the buccal teeth or improper lower incisor inclination may remain.

The multiloop edgewise archwire (MEAW) is also often used in skeletal Class III treatment without orthognathic surgery or extraction of intermediate teeth.[11–13] In these cases, the entire lower dentition is moved to the distal and uprighted using a MEAW combined with intermaxillary elastics after extraction of third molars. However, this treatment often results in flaring and extrusion of the upper incisors to achieve proper interincisal relationships.

Merrifield[14] has previously described the value of the J-hook headgear applied to the lower arch for distal tooth movement. In his system, a J-hook headgear to the lower arch was used for producing sequential forces on the terminal molars, second premolars, and canines. As a result, the terminal molars were

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uprighted, second premolars leveled, and canines retracted. In the denture correction stage, the J-hook headgear contributes to maintaining the distally tipped terminal molars, prepares mandibular anchorage (distal tipping of first molars and second premolars), and eliminates intrusive forces on the incisors. Therefore, a J-hook headgear to the lower arch might be an alternative for treating Class III patients.

There are a few case reports presenting lower molar uprighting with J-hook headgear in Class III patients.[15,16] Little information is available, however, to quantify the changes of the lower dentition before and after use of the high-pull J-hook headgear in the lower arch in moderate skeletal Class III cases. The purpose of this study was to evaluate the treatment effect of a high-pull J-hook headgear on the lower dental arch in nongrowing Class III patients.

MATERIALS AND METHODS

The records of 14 nongrowing patients with Class III malocclusion (4 males and 10 females; mean age 21.1 years; SD 4.4 years) in a private practice were the subjects of this retrospective study. Inclusion criteria were as follows: (1) ANB angle $\leq 1.0^\circ$ (range -2.0° to 1.0°), (2) Angle Class III molar relationship, and (3) no congenital deformity in the craniofacial area.

All subjects were treated with a multibracket edgewise appliance (The Alexander Discipline)[17] and a high-pull J-hook headgear by one clinician. The mean treatment period was 26.1 months (SD 6.2 months). Application of the J-hook headgear on the lower arch was based on a directional force system described by Merrifield.[14] After placement of a 0.016 $\times$ 0.022-inch beta-titanium or stiffer archwire on the lower dentition, a high-pull J-hook headgear was applied directly to the lower archwire with 200 g of force on each side at night only (Figure 1). The mean duration of usage of the headgear was 8.9 months (SD 4.6 months). After uprighting of the lower molars and a Class I molar relationship were achieved by the headgear, short Class III elastics were used for 7.9 months (SD 3.5 months) to maintain the occlusion. The lower third molars were extracted in all subjects before treatment, but no other teeth were extracted. No patients had any symptoms of temporomandibular disorder after active treatment.

Lateral cephalograms and plaster models obtained before treatment (T1) and after active treatment (T2) from 14 subjects were analyzed. Records of the 10 subjects after at least 2 years' retention (postretention, T3) were also analyzed. The mean observation period after active treatment was 49.3 months (SD 28.7 months). One examiner randomly traced the cephalograms on acetate paper. Accuracy of tracing was

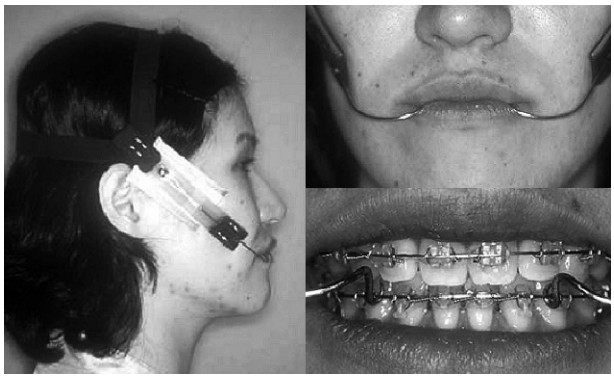

Figure 1. Application of J-hook high-pull headgear to the lower arch. J-hook was applied directly to the lower arch wire between the laterals and canines.

confirmed by an orthodontic professional joining this study as collaborator. Cephalometric measurements were calculated with a cephalometric analysis software (Win-Ceph, Rise Co, Sendai, Japan). To eliminate interobserver error and ensure standardization, one experienced observer made all the measurements. All registrations (tracing and measurements) were done twice by the same operator. Intraobserver reliability was calculated by remeasuring all variables 2 weeks apart. A paired *t*-test for the reproducibility of measurements showed no significant difference between the variables measured 2 weeks apart. The differences with a *P* value of less than .05 were considered significant, indicating that the variables were reproducible. For the final evaluation, the mean value of the double registrations was used. Nine angular and 15 linear measurements were taken to analyze the skeletal and dental change before and after orthodontic treatment (Figures 2 and 3). On the tracing, changes in the lower dentition were evaluated by a pterygoid vertical line (PTV) drawn perpendicular to the Frankfort horizontal plane.[18] Horizontal positions of the incisal edge (L1e to PTV) and apex of the lower incisors (L1a to PTV) and the vertical positions of the lower incisors (L1e to MP) were measured. The same measurements were calculated for the lower first molars (L6c to PTV, L6a to PTV, L6c to MP).

The dental casts were measured using calipers accurate to 0.1 mm. Arch depth was measured from the midpoint of the most labial aspect of the central incisors to the point bisecting the line connecting the mesial contacts of the first molars (Figure 4). Intercanine width (ICW) was measured between the cusp tips or estimated cusp tips when wear facets were present. Intermolar width (IMW) was measured between the buccal fissures on the occlusal surfaces of both lower first molars. One experienced observer made all measurements to eliminate interobserver error. Three measurements were taken for each

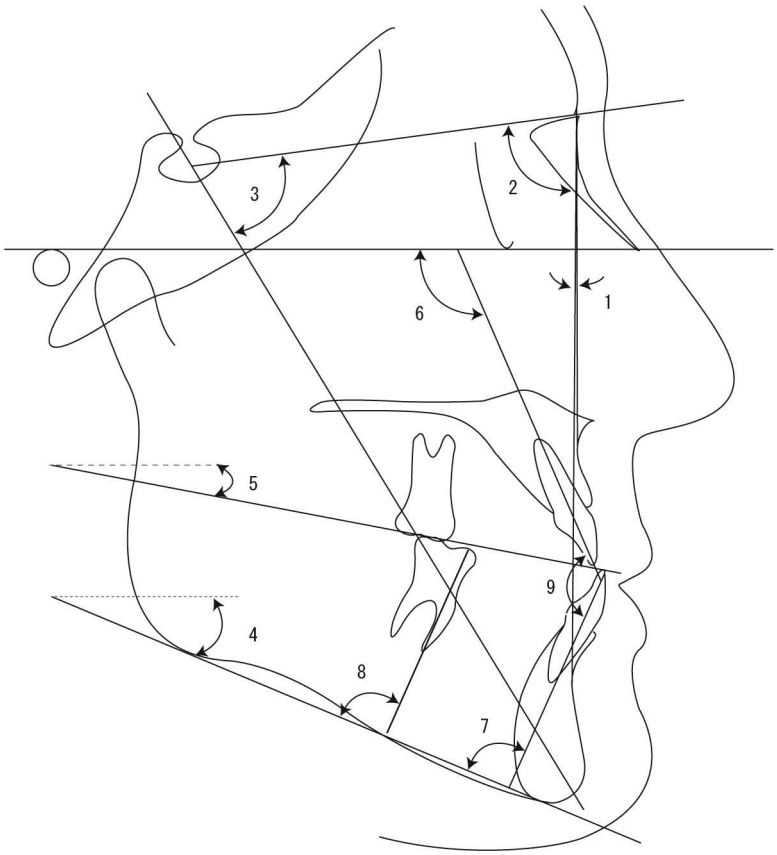

Figure 2. Cephalometric angular measurements: 1, ANB; 2, SNB; 3, Y-axis; 4,FMA (Frankfort horizontal [FH] plane to mandibular plane [MP]); 5, occlusal plane (Occ) to FH plane; 6, U1 to FH plane; 7, L1 to MP; 8, L6 to MP; 9, interincisal angle.

parameter and averaged. The average value was used in the study.

The Wilcoxon signed rank test was used to evaluate the changes of craniofacial morphology (cephalometric measurements and cast analysis) from stage T1 to T3. A probability of $P < .05$ was considered significant. Analyses were carried out with statistical analysis software (StatView, SAS Int, Chicago, Ill).

RESULTS

Clinical Findings

Figure 5 shows the facial and intraoral photographs of a representative case at three stages. In all the cases, posttreatment occlusion was satisfactory with bilateral Class I canine and molar relationships and sufficient interdigitation of posterior teeth.

Cephalometric Analysis

Table 1 and Figure 6 demonstrate the cephalometric changes induced by treatment with the J-hook headgear in 14 patients. At the T2 stage, overbite and overjet were significantly ($P < .001$) improved to 1.8 mm and 2.8 mm, respectively, and maintained well at the T3 stage (Table 1). At T2, the lower incisal edge had moved 1.2 mm lingually ($P < .05$) and extruded a mean of 1.7 mm ($P < .05$). Positional change of the lower incisor apex was 0.7 mm to the labial ($P < .05$), while its long axis had inclined 4.0° lingually ($P < .05$). The E line to lower lip was significantly ($P < .05$) decreased according to the lingual inclination of the lower incisors. Regarding the lower first molar, the cusp moved 1.5 mm distally ($P < .01$) and the apex moved 2.0 mm mesially ($P < .01$) at the T2 stage. No significant difference was seen in the vertical position of the lower first molar between T1 and T2. The molar was tipped to the distal a mean of 9.8° ($P < .01$) on average. As a result of molar uprighting, a molar Class I relationship was achieved in all cases. The occlusal plane showed a counterclockwise rotation of 4.5° ($P < .01$), and the Wits appraisal was improved from −6.0 mm to −2.8 mm after treatment ($P < .01$). No significant difference was observed in the FMA between T1 and T2.

Analysis of the records at T3 shows a minimal change compared with T2. However, the occlusal plane angle had increased 1.5° in a clockwise direction ($P < .05$), the upper incisor was inclined 1.5° to the lingual, and the lower incisor apex had moved 0.5 mm to the lingual ($P < .05$) (Table 1).

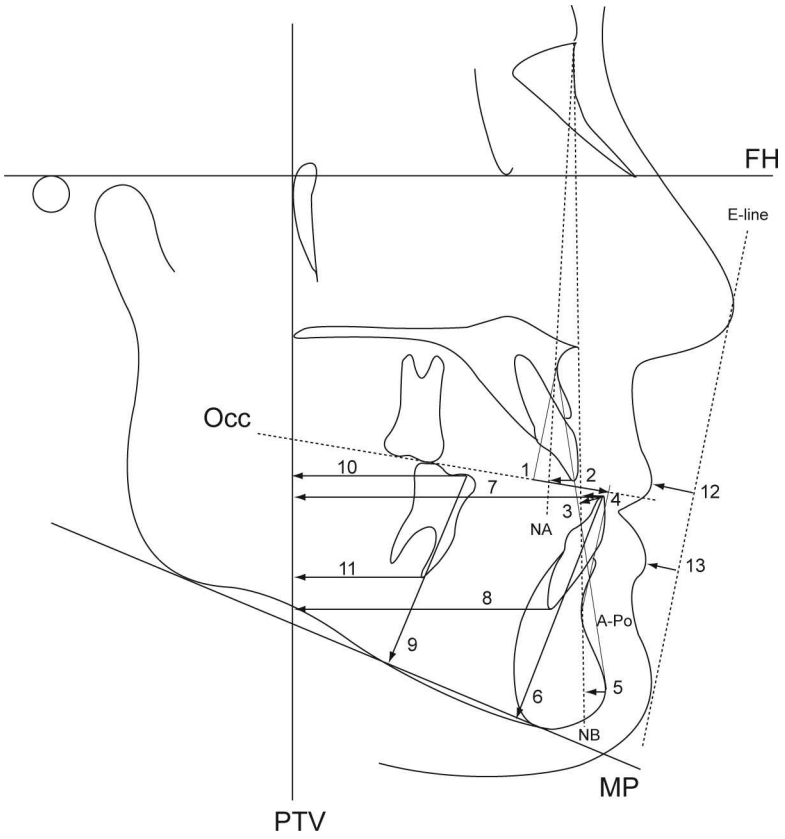

Figure 3. Cephalometric linear measurements: Horizontal movements evaluated relative to pterygoid vertical line (PTV), which was drawn perpendicular to the Frankfurt-Horizontal plane.1, Wits appraisal; 2, U1 to NA; 3, L1 to NB; 4, L1 to A-Po; 5, Po to NB; 6, L1e to MP: perpendicular distance from the edge of the lower incisor to mandibular plane; 7, L1e to PTV: perpendicular distance from the edge of the lower incisor to PTV; 8, L1a to PTV: perpendicular distance from the apex of the lower incisor to PTV; 9, L6c to MP: perpendicular distance from the top of mesial cusp of the lower first molar to mandibular plane; 10, L6c to PTV: perpendicular distance from the top of mesial cusp of the lower first molar to PTV; 11, L6a to PTV: perpendicular distance from the apex of mesial root of the lower first molar to PTV; 12, E-line to Upper lip; 13, E-line to Lower lip.

Model Analysis

No significant changes were found in arch depth or ICW between T1 and T2. IMW was increased 1.5 mm on average (SD 1.8 mm; $P < .05$) (Table 2). No significant changes were seen in any measurements between T2 and T3.

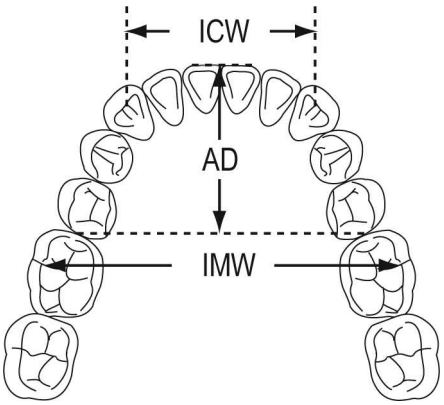

Figure 4. Model analysis. Three variables were measured to evaluate the changes in arch form. AD: arch depth, ICW: intercanine width, IMW: intermolar width.

DISCUSSION

In this study, J-hook headgears were applied to nongrowing patients having a moderate skeletal Class III malocclusion, reduced overbite, and lingually inclined lower molars. Patient cooperation in the wearing of the headgear was very good, because it was worn only at night and was easy to place directly on the lower arch wire. The use of the J-hook was stopped when a Class I molar relationship and adequate overbite and overjet were achieved. The mean duration of headgear use was 8.9 months.

By using a J-hook headgear, the lower incisors were moved 1.2 mm to the lingual and elongated 1.7 mm on average. These changes led to improvement of the interincisal relationship. They also produced a good soft tissue profile, reducing lower lip protrusion. In Japanese laypersons, lower lip protrusion is viewed as unattractive, especially in Class III facial profiles.[19,20]

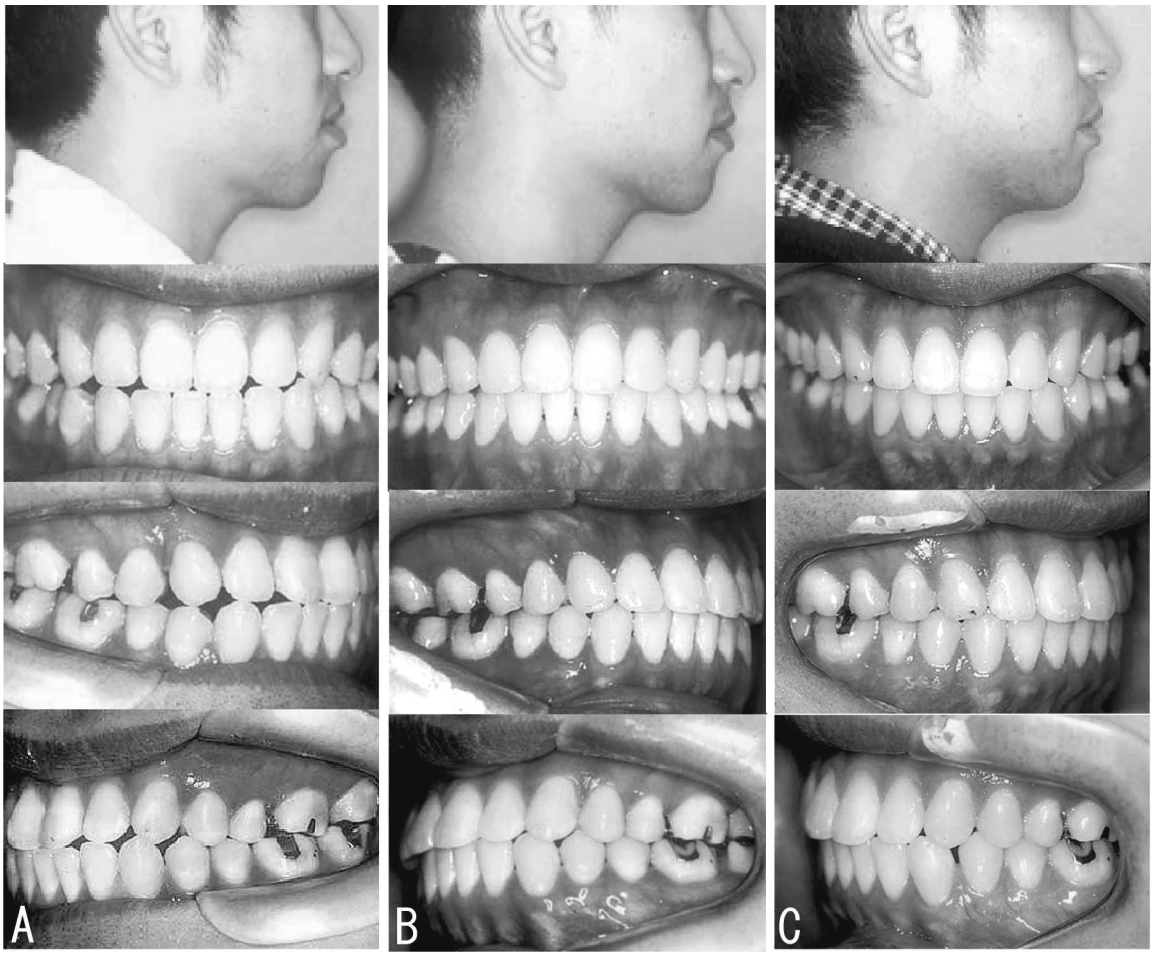

Figure 5. Photographs of pretreatment (A), posttreatment (B), and 5 years postretention (C).

Thus, lingual movement of the lower incisors by a J-hook headgear might provide improved facial attractiveness in Class III patients.

Færøvig's study[10] of Class III treatment showed that the mandibular incisors were retroclined 1.7 mm (SD 2.0 mm) and elongated 1.5 mm (SD 1.8 mm) with a single mandibular incisor extraction. These findings suggest that the change in lower incisors in our study is similar to those in single-incisor extraction cases. However, it might be difficult to achieve both proper Class I occlusion and adequate interincisal relationship when one lower incisor is extracted, and would be impossible to make the upper and lower dental midlines coincident. Therefore, treatment of Class III malocclusion with a single-tooth extraction might be a compromise in comparison with nonextraction treatment. Otherwise, some clinicians might choose bilateral premolar extraction in such mild-to-moderate Class III cases. In these cases, the lack of an opposing tooth for the upper second molar is usually a result of the Class III molar occlusion ensuing from lower premolar extraction if the lower third molars do not erupt into ideal positions. Furthermore, most orthodontic patients prefer to be treated without extractions. Therefore, treatment using high-pull J-hook headgear to the lower arch might be a proper alternative for moderate Class III cases compared with extraction treatment.

In this study, the lower first molars were tipped to the distal 9.8° without extrusion. The brackets on these teeth had a −6° angulation,[17] which might be an efficient way to tip molars distally with a high-pull J-hook headgear. Distal tipping of lower molars induces occlusal plane changes, resulting in improvement of the Class III occlusion. On the other hand, the mandibular plane angle did not change significantly because the lower molars did not extrude during treatment.

This implies that changes due to the headgear were limited to horizontal ones. On the other hand, the treatment results of using the MEAW with Class III elastics include tipping back of all the lower teeth and elongation of the upper molars, resulting in a clockwise rotation of the mandible. In deep bite cases, clockwise rotation of mandible is effective for improving the Class III jaw relationship. However, in patients having an an

Table 1. Cephalometric Analysis[a]

	T1		T2–T1 (n = 14)				T3–T2 (n = 10)			
Variable	Mean	SD	Mean	SD	*P* Value	Significance	Mean	SD	*P* Value	Significance
Angle (degrees)										
ANB	0.2	1.0	−0.2	1.0	.5094	NS	−0.1	0.2	>.9999	NS
SNB	80.4	2.2	−0.3	0.5	.0684	NS	−0.1	0.2	>.9999	NS
Y-axis	69.8	2.9	0.2	0.5	.1797	NS	−0.1	0.3	>.9999	NS
FMA	26.9	4.6	0.1	0.7	.7792	NS	−0.2	0.7	.4452	NS
FH/Occ	8.5	3.3	−4.5	2.3	.0010	**	1.5	1.3	.0107	*
U1/FH	117.6	5.6	4.7	5.0	.0062	**	−1.5	2.0	.0277	*
L1/MP	89.0	7.4	−4.0	4.6	.0158	*	1.1	2.1	.0924	NS
L6/MP	81.8	4.6	−9.8	4.5	.0010	**	−0.2	3.5	.9528	NS
Interincisal angle	126.1	9.5	−1.8	8.0	.4510	NS	0.0	3.2	.8658	NS
Linear (mm)										
Wits appraisal	−6.0	2.8	3.2	2.1	,0010	**	−0.2	0.9	.5898	NS
U1 to NA	6.5	2.0	2.0	1.7	.0033	**	−0.6	0.9	.0845	NS
L1 to NB	6.6	2.5	−1.2	1.6	.0077	**	0.5	0.7	.0405	*
L1 to A-Po	5.6	2.6	−1.3	1.9	.0211	*	0.4	1.1	.2878	NS
Po to NB	1.8	1.1	0.1	0.8	.4314	NS	0.2	0.3	.1025	NS
L1e to MP	44.5	3.8	1.7	1.0	.0010	**	0.0	0.5	.7740	NS
L1e to PTV	58.0	4.2	−1.2	1.6	.0280	*	0.4	0.5	.0754	NS
L1a to PTV	48.1	4.0	0.7	0.9	.0217	*	0.5	0.7	.0280	*
L6c to MP	36.0	3.6	0.1	0.9	.4412	NS	0.3	0.6	.1824	NS
L6c to PTV	31.8	3.2	−1.5	0.9	.0010	**	0.1	0.6	.3401	NS
L6a to PTV	25.5	3.4	2.0	1.3	.0015	**	−0.1	0.8	.5519	NS
Overjet	0.0	1.2	2.8	1.4	.0009	***	−0.3	0.5	.0977	NS
Overbite	0.2	0.8	1.8	0.7	.0008	***	−0.2	0.4	.2568	NS
E line to upper lip	−3.5	2.4	0.4	2.6	.8936	NS	0.1	1.1	>.9999	NS
E line to lower lip	0.5	3.2	−1.1	1.8	.0451	*	−0.3	1.0	.2809	NS

[a] Wilcoxon signed rank test: * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; NS, not significant; SD, standard deviation; 1e, incisal edge of the lower incisor; L1a, apex of the lower incisor; L6c, mesial cusp of the lower first molar; L6a, apex of the mesial root of the lower first molar. PTV, pterygoid vertical line.

open-bite tendency, we need to avoid this clockwise rotation as much as possible. Because many Japanese Class III patients have a steep mandibular plane angle, treatment with high-pull J-hook headgear might be useful.

In the model analysis, IMW was slightly increased after treatment. In Færøvig's study,[10] IMW was unchanged, although ICW was decreased. Thus, the increase of IMW in our present study must be a result of molar distal tipping along the lower dental arch, and

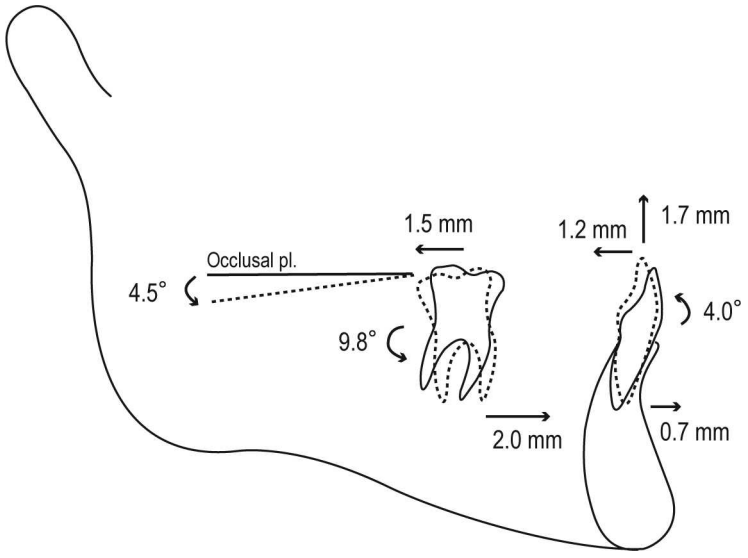

Figure 6. Schematic illustration of changes in incisor and molar positions pre- and posttreatment.

Table 2. Model Analysis[a]

	T1		T2–T1				T3–T2			
Variable (mm)	Mean	SD	Mean	SD	*P* Value	Significance	Mean	SD	*P* Value	Significance
Intercanine width	26.6	1.8	0.2	1.2	.7534	NS	0.0	0.1	.1797	NS
Intermolar width	48.6	3.6	1.5	1.8	.0167	*	−0.1	0.5	.4615	NS
Arch depth	24.3	1.9	0.2	1.3	.5066	NS	−0.1	0.5	.2476	NS

[a] Wilcoxon signed rank test: S, standard deviation; NS, not significant. * $P < .05$.

it stresses the need for archwire coordination between upper and lower molar widths during treatment.

During the retention period, there was minimal horizontal relapse of the upper and lower incisors, but most variables showed no significant changes. This indicates that the treatment results were fairly stable for the mean retention period of approximately 4 years. However, in the future, long-term stability should be evaluated by the records of patients long out of retention.

The effectiveness of using a J-hook headgear on the lower arch for the uprighting the lower molars was clearly demonstrated in this study. Recently, the use of skeletal anchorage has become a new treatment strategy in treating adult Class III patients,[21–23] providing sufficient anchorage to tip back the lower dentition without patient cooperation. However, some orthodontic patients hesitate to tolerate such invasive procedures as placing screws or plates into their jaw bone through the gingiva.[24,25] For such a patient, molar uprighting with J-hook headgear is suitable and is still considered an effective method.

CONCLUSIONS

- High-pull J-hook headgear on the lower arch resulted in lingual tipping and elongation of the lower incisors and distal tipping of the molars. Accordingly, the lower dental arch was moved distally and the occlusal plane showed a counterclockwise rotation. As a result of these changes, proper molar Class I relationships were achieved without clockwise rotation of the mandible.

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