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Is bodily advancement of the lower incisors possible?

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SUMMARY Some Class II malocclusions are due, at least in part, to a retruded lower dental arch relative to the mandibular body. The purpose of this study was to determine if a direct anterior force on the lower incisors could lead to bodily movement of these teeth. Twenty-seven patients (9 males, 18 females; mean age: 9.8 years) were treated with a reverse headgear (RHG) in the lower dental arch combined with labial root torque of the lower incisors. An activator was added to disclude the arches. This group was compared with 26 patients (10 males, 16 females; mean age: 9.7 years) treated with an activator combined with conventional posterior extraoral traction on the upper molars. All patients had a second stage of treatment with fixed appliances and Class II elastic wear. At the end of treatment, all patients had a Class I relationship and a normal overjet. Lateral cephalograms were taken before (T1), after the first stage (T2), and at the end of active (T3) treatment. Independent sample *t*-tests were used to assess the differences between the two groups of patients.

In the RHG group, despite the applied root torque, the lower incisors showed anterior crown tipping. Labial root displacement was not observed. At T2, this labial tipping partially relapsed. Furthermore, the use of RHG appeared to decrease bone apposition in the anterior part of the symphysis, leading to a reduction in width. Bodily advancement of the lower incisors was not achieved with the application of labial root torque and anteriorly directed force on the mandibular arch. The width limit of the lower anterior apical base should be respected during orthodontic treatment planning.

Introduction

Although most Class II malocclusions are the result of mandibular retrusion, some subjects show retrusion of the lower dental arch relative to the mandibular base. In these subjects, lower face height is often short, the symphysis is thick, and the lower incisors are retroclined so that pogonion seems prominent. These malocclusions are not very frequent, but they have a significant negative impact on the profile because the lower lip is retruded and interposed between the upper and lower incisors and, as a consequence, the chin appears to be prominent.

Due to stability considerations, the conventional way to treat these patients is to maintain the lower incisor position and to retract the upper dental arch. The anatomical limitations of the dentoalveolar process should be respected to avoid iatrogenic sequelae such as bone loss (Handelsman, 1996; Nauert and Berg, 1999).

Treatment of subjects with a Class II malocclusion with an increased overjet requires planning and mechanics that not only aim to achieve a good Class I occlusion and pleasing tooth alignment but also to position the dentition in the facial complex for optimal facial aesthetics (Arnett and Bergmann, 1993; Sarver, 1998). This often requires preservation of the upper dental sagittal position and forward displacement of the lower arch to obtain a Class I occlusion.

Some advancement of the lower dental arch can be obtained with a lip bumper or functional appliances, fixed or removable, but this movement is in most cases limited to labial crown tipping of the lower incisors. However, the long-term effect of these appliances, if any, are small since proclined lower incisors have a strong tendency to relapse (Valant and Sinclair, 1989; Hansen and Pancherz, 1992; Nelson *et al.*, 1993; Grossen and Ingervall, 1995). This labial tipping has been considered contraindicated because this type of movement could lead to gingival recession. However, Årtun and Grobéty (2001) did not find more recession in adolescent Class II patients with dentoalveolar retrusion treated by labial tipping of the lower incisors. The risk for the periodontal tissues does not seem to be greater with this type of movement. Moreover, it seems that proclination of the lower incisors does not cause gingival recession in children and adolescents (Ruf *et al.*, 1998). Controlled proclination, under maintenance of good oral hygiene, can be carried out in most adults without the risk of complications related to the periodontium. Although the prevalence of dehiscence increases, the amount of recession seems clinically irrelevant (Allais and Melsen, 2003).

By placing the lower incisor roots in cancellous bone, as Ricketts (1976) advises with bioprogressive therapy, it might be possible to displace the lower incisor apices anteriorly by bodily movement thus influencing the labial bony cortical plate and leading to a favourable change of the position of point B. Thus, it could be possible to obtain a stable relationship between the forward displaced dentoalveolar process and the body of the mandible. Moreover, this would have a favourable effect on facial aesthetics as the chin would seem less prominent and the labiomental fold less pronounced.

A treatment approach was therefore developed, in which the objective was to correct the Class II malocclusion not only by changing the position of the mandible by means of an activator but also by advancing the dentoalveolar arch on its mandibular base. Active forward traction was applied on the lower dental arch and labial root torque on the lower incisors (Pfeiffer and Grobéty, 1982). With this method, treatment had the smallest possible influence on the maxilla, so as to avoid retraction of the upper lip and have a favourable effect on the profile.

Until now, the possibility of displacing the lower incisors with labial root torque has not been demonstrated, although it was widely suggested (Ricketts, 1976). Therefore, the aim of the study was to investigate a group of patients treated with the above procedure, to determine if it is possible to displace the lower incisors bodily by means of labial root torque and the application of elastics between the lower incisors and face mask. Although this demanding procedure is no longer used, it was considered that it offers a unique opportunity to test the hypothesis that the anterior mandibular alveolar process can be displaced forward by orthodontic means.

Subjects and methods

Subjects

Fifty-three patients were selected retrospectively based on the following criteria (Table 1):

1. Class II molar relationship in the mixed dentition: at least a half-cusp unit Class II relationship for the first permanent molars.
2. Retruded lower dental arch, selected on the basis of a negative Holdaway ratio, i.e. the distance from the labial surface of the lower incisor to NB line was smaller than the distance from pogonion to the same NB line.
3. No previous orthodontic treatment.
4. Lateral cephalograms available for each patient at the initial documentation (T1), at the end of the first stage of treatment when the activator and headgear were discontinued (T2), and at the end of active treatment with fixed appliances (T3).
5. Class I interdigitation and a normal overjet at T3.

These 53 patients were divided in two groups. The experimental group included all patients treated by one author (DG) using a combination of a partial lower fixed appliance (2 × 4), elastics from a reverse headgear (RHG) on the lower arch, and an activator. Twenty-seven patients (RHG group) fulfilled the above criteria: 18 girls and 9 boys, between 7 years 5 months and 12 years 11 months of age (mean: 9.8 years; Table 1).

Another group of 26 patients (16 girls, 10 boys) between 8 years and 12 years 4 months of age (mean: 9.7 years), who met the same criteria and were treated by the same clinician, were selected from a larger pool of patients treated using a combination of a posterior extraoral traction and an activator (HG–activator group) in order to match the RHG group in terms of age and treatment duration (Table 1).

In each group, treatment started 3–6 months after T1. This first phase of treatment lasted on average 20 months and all patients continued with a second phase of fixed appliance treatment. All radiographs were taken with the same apparatus with no correction made for magnification.

Treatment modalities

Treatment started in the mixed dentition and during active growth with the objective of promoting forward growth of the mandible with the activator. In both groups, the removable appliances were ideally to be worn 12 hours/day.

In the RHG group, a partial fixed appliance was placed in the lower dental arch (2 × 4) with a rigid archwire applying labial root torque (stainless steel 0.0215 × 0.025 inch in a 0.022 × 0.028 inch slot) with active anterior traction during the evening and night by means of elastics from a Delaire face mask to the lower incisors. The points of force application were distal to the lower incisors on loops bent in the archwire or soldered hooks. The direction of the force was forward and upward because the elastics had to cross the mouth opening exactly between the lips in order to be

Table 1 Sample characteristics; gender distribution; age of the subjects at initial documentation (T1), after the first stage of treatment (T2), at the end of active treatment (T3); and duration of treatment stages in years, for both reverse headgear (RHG) and headgear–activator (HG–activator) groups.

Group	*N*	Gender	T1	Start of treatment	T2	T3	T2–T1	T3–T2	T3–T1
			Mean	Mean	Mean	Mean	Mean	Mean	Mean
RHG	27	9 boys, 18 girls	9.8	10.4	11.9	14.0	2.1	2.1	4.2
HG–activator	26	10 boys, 16 girls	9.7	10	11.9	14.0	2.2	2.2	4.3

comfortable for the patient (Figure 1). The force delivered by the elastics was 250 g per side. Labial root torque was placed in the lower incisor archwire so as to counteract the labial crown tip caused by use of the elastics.

The activator was of the Herren (1959) type. As the initial aim was to move the lower dental arch forward, the acrylic covered only the occlusal surfaces of the lower dental arch with the aim of neutralizing the extrusive component of the force of the elastics to the face mask. No acrylic covered the labial aspect of the lower incisors to allow their forward movement.

In the HG-activator group, an activator was combined with posterior extraoral traction on the upper molars as described by Pfeiffer and Grobéty (1975). The aim of this first stage of treatment was to correct the Class II malocclusion by retraction of the upper dental arch and maxilla and, possibly, to promote forward growth of the mandible. In this group, the activator was constructed with long lingual flanges extending as far as possible into the floor of the mouth, in order to help keep the activator in the mouth and to provide an optimal orthopaedic effect. The lower incisors were capped with acrylic to reduce their proclination.

After completion of the first stage of therapy with both treatment methods, a second stage of treatment was carried out with fixed appliances in order to align the dental arches, to level the curve of Spee if required, and establish a 'perfect' Class I interdigitation, using Class II elastics for some months at the end of the fixed appliance treatment for almost all patients. During the second stage of treatment, activator and extraoral appliance wear was discontinued.

Cephalometric analysis

All tracings were made by pencil on acetate by one author (AS). To avoid errors due to the change in form of the lower incisor roots (e.g. apical resorption), a template of the lower incisors at T1 was constructed and transferred to the T2 and T3 cephalograms using the best fit method.

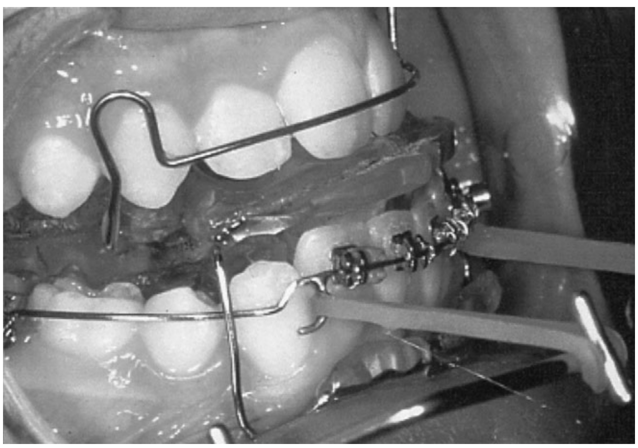

Figure 1 Activator and partial lower fixed appliance with Class II elastics attached to the reverse headgear.

A superimposition was first attempted on the following mandibular stable structures: the third molar germs (before appearance of the root), the stable structures in the symphysis, and the mandibular canal (Björk and Skieller, 1983). Using this method, however, the measurement error, both intra- and interexaminer was found to be large.

A different approach was then adopted using a co-ordinate system placed on each tracing; the x-axis being the mandibular plane from menton to gonion and the y-axis the perpendicular to the mandibular plane tangent to the posterior border of the symphysis (M-Perp.) (Sims and Springate, 1995). The posterior border of the symphysis was chosen over the anterior border because it was assumed that the RHG chin cup could have an effect on the latter.

The Viewbox 3 digitizing software (dHAL Software, Kifissia, Greece) was used for all measurements. These were based on dental, skeletal, and soft tissue cephalometric landmarks (Figures 2 and 3).

Statistical analysis

Independent sample t-test of the two groups, matched for age and treatment duration revealed no statistically significant differences between the groups at T1 (Table 2). Discriminant analysis showed no statistically significant discriminatory function for either cephalometric variables at T1 and treatment stage durations. Since the RHG group consisted of all available cases fulfilling the inclusion criteria, a power analysis would have been meaningless.

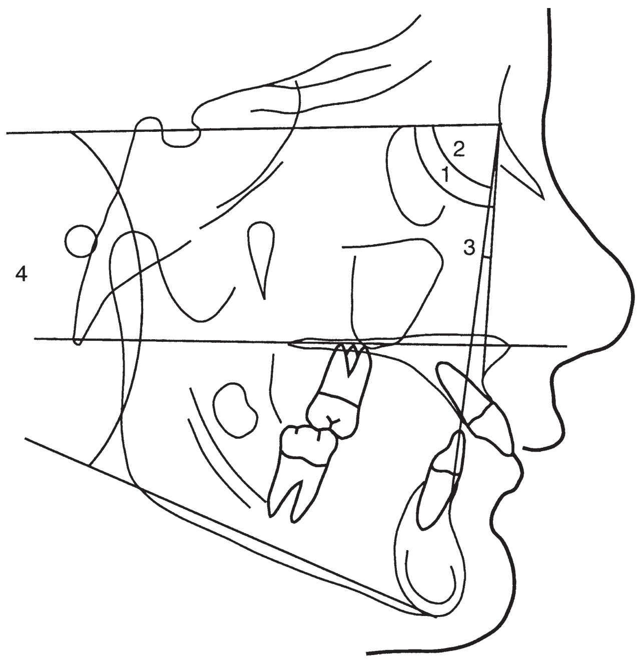

Figure 2 Angular cephalometric measurements: 1, SNA; 2, SNB; 3, ANB; and 4, maxillomandibular plane angle.

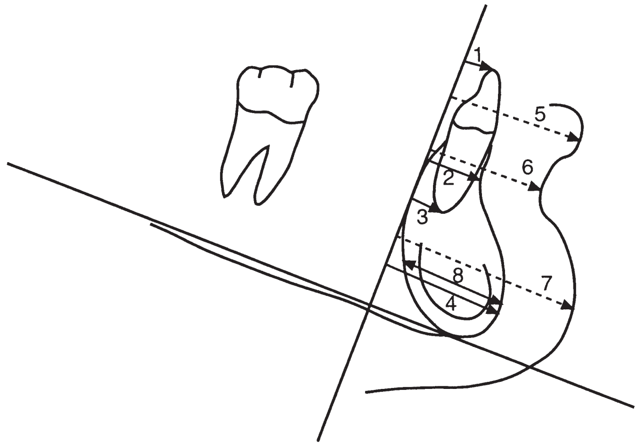

Figure 3 Linear cephalometric measurements (distances from a perpendicular to the mandibular plane tangent to the posterior border of the symphysis): 1, lower incisal edge; 2, point B; 3, lower incisor apex; 4, pogonion; 5, labrale inferior; 6, soft point B; 7, soft pogonion. 8, width of the symphysis measured parallel to the mandibular plane.

Instead, the 95 per cent confidence intervals of the mean differences were calculated (Tables 2 and 3).

In order to estimate the error of the method, randomly selected cephalograms of over 25 per cent of the total sample (15 patients) were traced and measured twice after an interval of 2 weeks, by two authors (AS and CS). The systematic error, evaluated by paired *t*-tests, was not significant. The error of the method according to Dahlberg (1940) ranged between 0.17 mm for soft pogonion to M-perp and 0.35 mm for the width of the symphysis.

The studied variables followed a normal distribution and so independent sample *t*-tests were used to assess the differences between the two groups of patients at T1, T2, and T3. The significance level was set to 0.05.

Results

Discriminant analysis did not reveal any statistically significant discriminatory function of both cephalometric variables at T1 or treatment stage durations.

First stage of treatment

At T2, ANB in the HG–activator group showed an average decrease of 3.8 degrees, while in the RHG group, the average decrease was 0.9 degrees ($P < 0.001$; Tables 2 and 3). This difference was due to the influence of treatment on SNA which was decreased in the HG-activator group by 2.1 degrees, while a slight increase of 0.5 degrees occurred for this angle in the RHG group ($P < 0.001$). On the other hand, only a small difference between the groups was observed in the change in SNB which increased by 1.4 and 1.7 degrees in the RHG and HG–activator group, respectively.

In the vertical plane, the mandibular plane angle (SN–MeGo) increased slightly in both groups, but without a statistically significant difference.

Locally, around the mandibular symphysis, some differences were found. The distance from the lower incisal edge to the *y*-axis, i.e. the perpendicular to the mandibular plane tangent to the posterior border of the symphysis, increased in the RHG group by an average of 4.0 mm, while this distance remained relatively stable in the HG-activator group ($P < 0.001$). The distance from the lower incisal apex to the *y*-axis remained fairly stable in both groups with a mean difference of less than 0.1 mm and no statistically significant difference between treatments.

Point B also remained stable in relation to the *y*-axis with no statistically significant difference between the treatment approaches. The distance from pogonion to the *y*-axis and the width of the symphysis showed small but statistically significant differences: while they were reduced in the RHG group by an average of −0.7 mm, they slightly increased in the HG-activator group ($P < 0.01$).

For the soft tissues in relation to the *y*-axis, there were statistically significant differences for the lower lip which came forward in the RHG group ($P < 0.001$), while it moved backward in the HG-activator group. There was no statistically significant difference in the position of soft pogonion between the groups.

Second stage of treatment

ANB continued to decrease in both groups, an average of 1.3 degrees in the HG-activator group and 1.9 degrees in the RHG group mainly due to the decrease in SNA between T2 and T3 in both groups (Tables 2 and 3). SNA therefore remained smaller in the HG-activator group at the end of treatment. SN–MeGo remained fairly stable.

Locally, at the symphysis and in relation to the *y*-axis, the lower incisal edges in the RHG group moved slightly backward after marked advancement during the first stage of treatment, while in the HG-activator group, the lower incisal edges, which did not change in the first stage of treatment, advanced during the fixed appliance phase ($P < 0.001$). At T3, there was no notable difference in the position of the lower incisal edges between the groups.

The lower incisal apices remained stable in relation to the *y*-axis at the back of the symphysis in both groups and during the whole of treatment. Pogonion advanced very slightly in both groups during the second stage of treatment. At T3, the width of the symphysis remained smaller in the RHG group than in the HG-activator group by approximately 1 mm.

For the soft tissue measurements, the differences between both groups at T3 were not statistically significant.

Discussion

The findings of the present study show that the use of RHG on the lower arch in combination with labial root torque applied by a heavy lower archwire did not, as expected, cause a bodily advancement of the lower incisors. The

Table 2 Mean values and standard deviations (SD) for the reverse headgear (RHG) and headgear–activator (HG–activator) groups at initial documentation (T1), after the first stage of treatment (T2), and at the end of active treatment (T3). An independent samples *t*-test was used to test for significant differences.

	T1							T2							T3						
	RHG		HG–activator		P	95% CI		RHG		HG–activator		P	95% CI		RHG		HG–activator		P	95% CI	
	Mean	SD	Mean	SD		Lower	Upper	Mean	SD	Mean	SD		Lower	Upper	Mean	SD	Mean	SD		Lower	Upper
LIE M-perp. (mm)	4.8	2.6	5.5	1.0	NS	−0.7	2.1	8.8	2.5	6.1	1.1	**	−4.4	−0.9	8.0	2.8	7.6	1.2	NS	−2.3	1.5
LIA M-perp. (mm)	3.7	1.6	3.8	0.1	NS	−0.8	0.9	3.9	1.6	3.8	0.5	NS	−1.0	0.8	3.5	1.3	3.7	0.4	NS	−0.7	1.1
B M-perp. (mm)	7.8	1.7	8.1	0.7	NS	−0.7	1.1	8.1	1.6	8.4	1.0	NS	−0.7	1.2	7.9	1.7	8.3	0.1	NS	−0.8	1.4
Pog. M-perp. (mm)	15.2	1.6	15.3	3.3	NS	−0.7	0.9	14.5	1.7	15.5	2.7	*	0.1	1.9	14.8	1.7	15.8	1.5	*	0.0	1.9
L. inf. M-perp. (mm)	21.4	3.0	22.4	2.5	NS	−0.5	2.5	23.7	2.7	22.0	0.5	NS	−3.5	0.1	22.9	3.0	23.0	1.8	NS	−1.9	2.0
Soft B M-perp. (mm)	16.8	2.0	16.9	1.6	NS	−0.9	1.3	18.2	1.8	17.5	0.4	NS	−1.9	0.4	18.4	2.0	18.4	0.1	NS	−1.3	1.4
Soft pog. M-perp. (mm)	23.6	2.2	23.4	3.5	NS	−1.4	1.1	23.3	1.9	23.7	1.8	NS	−0.8	1.7	24.3	1.9	24.9	1.3	NS	−0.7	1.8
Width of the symphysis (mm)	15.0	1.4	15.3	3.1	NS	−0.5	1.1	14.3	1.5	15.4	2.3	*	0.2	1.9	14.7	1.6	15.8	2.0	*	0.2	2.1
SNA (°)	80.6	4.2	80.5	3.5	NS	−2.3	2.0	81.1	4.5	78.4	3.8	*	−5.1	−0.4	79.6	4.2	77.4	3.9	NS	−4.4	0.1
SNB (°)	75.4	3.9	74.5	3.0	NS	−2.9	1.0	76.8	3.9	76.1	3.4	NS	−2.8	1.4	77.2	3.5	76.5	3.5	NS	−2.6	1.3
ANB (°)	5.2	1.7	6.0	2.0	NS	−0.2	1.9	4.3	1.6	2.2	1.5	***	−2.9	−1.2	2.4	1.6	0.9	1.7	**	−2.4	−0.6
SN–GoMe (°)	28.7	4.7	30.1	4.2	NS	−1.0	4.0	30.5	4.7	30.7	4.8	NS	−2.4	2.9	29.7	4.6	30.2	5.7	NS	−2.5	3.4

Table 3 Mean changes, standard deviation (SD) and 95 per cent confidence interval (CI) of the difference for the reverse headgear (RHG) and headgear–activator (HG–activator) groups between different stages of treatment (T1 at initial documentation, T2 after the first stage of treatment, T3 at the end of active treatment). An independent samples *t*-test was used to test for significant differences.

	T2–T1							T3–T2							T3–T1						
	RHG		HG–activator		P	95% CI		RHG		HG–activator		P	95% CI		RHG		HG-activator		P	95% CI	
	Mean	SD	Mean	SD		Lower	Upper	Mean	SD	Mean	SD		Lower	Upper	Mean	SD	Mean	SD		Lower	Upper
LIE M-perp. (mm)	4.0	1.8	0.6	0.1	***	−4.5	−2.3	−0.8	1.7	1.5	0.1	***	1.2	3.4	3.2	2.1	2.1	0.2	NS	−2.3	0.1
LIA M-perp. (mm)	0.2	1.0	0.0	0.4	NS	−0.7	0.4	−0.4	0.9	−0.1	0.9	NS	−0.5	1.0	−0.2	1.0	−0.1	0.5	NS	−0.6	0.8
B M-perp. (mm)	0.3	0.9	0.3	0.3	NS	−0.5	0.6	−0.2	1.0	−0.1	0.9	NS	−0.5	0.7	0.1	1.2	0.2	0.6	NS	−0.7	0.9
Pog. M-perp. (mm)	−0.7	0.9	0.2	0.6	***	0.4	1.4	0.3	0.8	0.3	1.2	NS	−0.5	0.4	−0.4	1.1	0.5	1.8	**	0.3	1.4
L. inf. M-Perp. (mm)	2.3	1.8	−0.4	2.0	***	−4.1	−1.3	−0.8	1.6	1.0	1.3	***	0.8	2.7	1.5	2.1	0.6	0.7	NS	−2.4	0.5
Soft B M-perp. (mm)	1.5	1.1	0.5	1.3	**	−1.6	−0.3	0.1	1.1	1.0	0.3	**	0.2	1.5	1.6	1.5	1.5	1.6	NS	−1.0	0.8
Soft Pog M-perp. (mm)	−0.3	1.4	0.3	1.6	NS	−0.2	1.4	1.0	0.9	1.1	0.5	NS	−0.4	0.7	0.7	1.3	1.4	2.1	NS	−0.1	1.6
Width of the symphysis (mm)	−0.7	0.9	0.1	0.8	**	0.2	1.3	0.3	0.7	0.4	0.4	NS	−0.3	0.5	−0.4	1.0	0.5	1.1	**	0.3	1.4
SNA (°)	0.5	1.8	−2.1	1.9	***	−3.7	−1.6	−1.5	1.9	−0.9	2.1	NS	−0.5	1.7	−1.0	2.0	−3.1	2.9	**	−3.4	−0.7
SNB (°)	1.4	1.8	1.7	1.5	NS	−0.7	1.2	0.4	1.6	0.4	1.6	NS	−0.9	0.9	1.8	2.1	2.1	2.0	NS	−0.9	1.4
ANB (°)	−0.9	1.6	−3.8	1.9	***	−3.9	−1.9	−1.9	1.6	−1.3	1.5	NS	−0.3	1.4	−2.8	1.6	−5.1	2.0	***	−3.3	−1.3
SN–GoMe (°)	1.8	2.5	0.6	2.1	NS	−2.6	0.0	−0.8	1.9	−0.6	1.9	NS	−0.8	1.3	1.0	3.1	0.0	2.6	NS	−2.6	0.6

*$P < 0.05$, **$P < 0.01$, and ***$P < 0.001$; NS, not significant.

pressure exerted by the RHG on the chin, however, led to decreased bone apposition at the anterior border of the symphysis, manifested in a reduction of the symphysis width and of the prominence of the symphysis. Thus, in Class II patients with severe lower dentoalveolar retrusion, a first stage of treatment in the mixed dentition combining RHG and labial torque applied to the lower incisors did not succeed in advancing the lower incisors bodily.

Labial tipping of the lower incisors occurred instead. This tipping was not counteracted efficiently by the labial root torque applied by the heavy archwire. Moreover, this movement relapsed during the second stage of treatment with fixed appliances. At T3, no significant differences in the position of the lower incisors between this treatment approach (RHG) and the classic activator–headgear combination were observed. There was proclination of the lower incisors in both groups during the first stage of treatment for the RHG group and during the second stage of treatment in the HG-activator group. The latter could be the result of the more intensive use of Class II elastics during the fixed appliance stage. In most patients, the position of the lower apices of the incisors was stable.

With the bioprogressive technique, Ricketts (1976) recommended intrusion of the lower incisors so that the apices would be displaced in an area of cancellous bone. In this zone of least resistance, it could be expected that treatment mechanics would be more efficient in moving the roots of the incisors. This is possibly the reason why, in the present study, an increased variability of point B changes was observed in the RHG group when compared with the HG-activator group, possibly due to the different amounts of vertical displacement of the lower incisors in all subjects.

The force of 250 g per side applied by the elastics on the Delaire RHG was distributed on the four lower incisors and two molars. The lower incisors were proclined despite the labial root torque applied by the archwire. This probably means that the torquing moment of the archwire was inferior to the tipping moment created by the RHG elastics.

As would have been expected, the posterior extraoral traction on the upper molars had an impact on the maxilla, with retraction of point A, as described by Aelbers and Dermaut (1996) and Antonarakis and Kiliaridis (2007).

The use of RHG and the subsequent pressure exerted on the chin caused an unforeseen effect: the distance from pogonion to the posterior border of the symphysis, namely the width of the symphysis, which increased during growth in the HG-activator group, remained unchanged or even diminished in some patients. During normal growth, Björk and Skieller (1983) considered the external surface of the bony chin as a stable structure to be employed for local mandibular superposition. Using this method, Buschang *et al.* (1992) observed that pogonion stayed almost unchanged and that point B moved lingually. Enlow (1975), on the other hand, stated that with normal growth, there is apposition around the bony chin and the external surface of the body of the mandible. This was found in the HG-activator group. On the contrary, in the RHG group, in most of the patients, there was no apposition, and some even showed resorption. This is in agreement with Wendell *et al.* (1985) who inferred that resorption was a consequence of the pressure of the chin cup on the chin area. It can be thus concluded that regular pressure on the chin during growth may induce resorption or inhibit apposition at pogonion.

It could be speculated that in some Class II malocclusion subjects with a retruded lower dental arch accompanied by a strong chin and a marked labiomental fold, RHG wear might have a positive aesthetic impact, as it would be expected that the soft tissue in front of the lower incisors would follow the dental movement and advance. In the present sample, this clinical effect was however small.

This retrospective study was based on material collected in one orthodontic office where complete records were taken for all patients on a routine basis after each stage of treatment. Two groups of treated patients were compared, so in both groups, the effects of treatment were added to changes due to growth. Since both groups of patients were comparable for age, malocclusion, and skeletal pattern before treatment, it can be presumed that in both groups the growth trends were largely comparable and that the differences observed between the two groups at the end of active treatment were mainly due to the different treatment approaches.

Although an attempt was first made in the present study to superimpose on the stable structures of the mandible (Björk and Skieller, 1983), this method was abandoned because of the significant measurement error observed. This was possibly due to the difficulty in locating the structures in the posterior region of the mandible, for example the mandibular canal, and because the patients were quite young at T1, meaning that often the germs of the third molars were not visible.

Furthermore, since there was the possibility that the form of the symphysis may change in some patients, the decision was taken not to superimpose on the anterior part of the symphysis and to use the analysis proposed by Sims and Springate (1995). Remodelling of the lower mandibular border during the observation period could have occurred, but this would have influenced the two groups equally since both groups had comparable values for the mandibular plane angle before and after treatment.

Conclusion

In two comparable groups of patients with Class II malocclusions, due in part to a retruded lower dental arch, two different treatment modalities were used. During the first stage of treatment, the application of RHG forces on the lower dental arch combined with labial incisor root torque, when compared with an HG-activator combination, resulted in the following:

1. no bodily anterior movement of the lower incisors, but labial tipping;
2. a more posterior position of pogonion and a reduction of the width of the symphysis;
3. no antero-posterior effect on the maxilla.

These effects were still present at the end of the second phase of treatment.

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