The European Journal of Orthodontics Advance Access published March 15, 2012

European Journal of Orthodontics 1 of 7
doi:10.1093/ejo/cjs023

Treatment timing of MARA and fixed appliance therapy of Class II malocclusion

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SUMMARY The objective of this study is to evaluate the effect of timing on Mandibular Anterior Repositioning Appliance (MARA) and fixed appliance treatment of Class II malocclusion in a prospective clinical trial. The treated sample consisted of 51 consecutively treated patients at prepubertal (n = 21), pubertal (n = 15), and postpubertal (n = 15) stages of development. Control groups for the three treated groups were generated from growth data of untreated Class II subjects. Lateral cephalograms were digitized and superimposed via cephalometric software at T1 (pre-treatment) and T2 (after comprehensive treatment). The T1–T2 changes in the treated groups were compared to those in their corresponding control groups with Mann–Whitney tests with Bonferroni correction. Mandibular elongation was greater at the pubertal stage (Co–Gn +2.6 mm, with respect to controls). Headgear effect on the maxilla was greater in the pre-peak sample (Co–A −1.9 mm, with respect to controls). Dentoalveolar compensations (proclination of lower incisors, extrusion and mesialization of lower molars, and reduction in the overbite) were significant in the pre-peak and post-peak groups. Optimal timing for Class II treatment with MARA appliance is at the pubertal growth spurt, with enhanced mandibular skeletal changes and minimal dentoalveolar compensations.

Introduction

Treatment timing of Class II malocclusion has been a controversial topic in the orthodontic literature for the last decades (King *et al.*, 1990; Sadowsky, 1998; Yang and Kiyak, 1998; Tulloch *et al.*, 2004; Johnston, 2006; Wheeler *et al.*, 2006; Dolce *et al.*, 2007). The effect of treatment timing of Class II malocclusion with functional appliances has been described abundantly. McNamara *et al.* (1985) compared the effects produced by the Fränkel type 2 appliance in a younger group (aged less than 10.5 years) versus an older group. In the same period, Pancherz and Hägg (1985) and Hägg and Pancherz (1988) evaluated the treatment effects of Herbst appliance according to statural height, while Hansen *et al.* (1991) considered hand and wrist radiographs. Malmgren *et al.* (1987) had assessed already pre-peak, peak, and post-peak treatment effects of activator combined with high-pull headgear by means of the same biological indicator. Baccetti *et al.* 2000, Baccetti *et al.* 2009a and Faltin *et al.* (2003) analysed timing-related dentoskeletal effects of Twin Block, Bionator, cervical headgear, and Class II elastics therapies. The common findings of all these studies revealed that optimal timing for Class II functional appliances is during or slightly after the onset of the pubertal peak in growth velocity. When compared with treatment performed before the peak, later treatment produces more favourable effects like greater skeletal contribution to molar correction and larger increments in total mandibular length (Pancherz and Hägg, 1985; Malmgren *et al.*, 1987; Baccetti *et al.*, 2000, 2009a; Pancherz, 2002; Faltin *et al.*, 2003; Tulloch *et al.*, 2004; Cozza *et al.*, 2006). Treatment after the peak enhances dentoalveolar modifications rather than skeletal changes (Malmgren *et al.*, 1987; Baccetti *et al.*, 2009a). Specific studies regarding the effect of treatment timing on the outcomes of the Mandibular Anterior Repositioning Appliance (MARA) are lacking in the literature. Recently, Gönner *et al.* (2007) analysed the effects of MARA, and Frye *et al.* (2009) studied the effects of a fixed functional appliance (Functional Mandibular Advancer) very similar to MARA. However, both studies compared different group of patients according to chronological age without untreated controls.

The purpose of this prospective clinical trial, therefore, was to investigate the role of timing in the treatment of Class II malocclusion with MARA and fixed appliances with respect to Class II untreated control data. Timing of treatment was defined on the basis of a biological indicator of individual skeletal maturity, i.e. the cervical vertebral maturation method. Pre-peak, peak, and post-peak samples were evaluated as to dentoskeletal effectiveness of concurrent MARA and fixed appliance therapy.

Subjects and methods

Fifty-one Class II patients were consecutively treated with the MARA combined with fixed appliances. Enrolment criteria for this prospective trial were wits greater than 2 degrees, full Class II or end-to-end molar relationships, and overjet greater than 4 mm. Patients were assigned to one of three groups according to their pre-treatment (T1) individual skeletal maturation as assessed by the cervical vertebral maturation method (Baccetti *et al.*, 2005): pre-peak group (MARApre, CS1 or CS2 at T1), peak group (MARApeak, CS3 at T1), and post-peak group (MARApost, CS4 or CS5 at T1). All patients were consecutively treated by the same operator (DT) who was blinded as to group assignment in terms of individual skeletal maturation. The assessment of the cervical vertebral stages for each subject was performed by one investigator and verified by a second one. Any disagreements were resolved to the satisfaction of both observers.

A first lateral cephalogram of the patients was taken at the start of the treatment (T1). A second lateral cephalogram (T2) was taken after the end of comprehensive MARA and fixed appliance treatment.

The control group consisted of data calculated on longitudinal series of untreated Class II subjects selected from the University of Michigan and Denver Child Growth Studies (Stahl *et al.*, 2008). The longitudinal series were derived from Class II subjects who matched the treated subjects for Class II dentoskeletal features, age, and skeletal maturation at T1 and T2. The use of historical controls was due to the lack of ethical reasons to leave Class II patients untreated at the developmental period (puberty) that is known to represent the optimal time for orthopaedic modifications (Baccetti *et al.*, 2000, 2009b).

Treatment protocol

The MARA (AOA, Sturtevant, Wisconsin, USA) was used according to the original design (Gönner *et al.*, 2007; Huanca Ghislanzoni *et al.*, 2011). Fixed appliances were started together with the MARA or after a few months of active treatment. The MARA differs from other contemporary non-compliance Class II devices like the Forsus Fatigue Resistant Device (Franchi *et al.*, 2011) or the Jasper Jumper (Stucki and Ingervall, 1998) because it is rigid and has no continuous upper arch–lower arch connection. It has an inclined plane that works as an obstacle to be avoided during closure thus forcing the lower jaw to move forward (Figure 1). This is supposed to induce a neuromuscular re-education while correcting the Class II

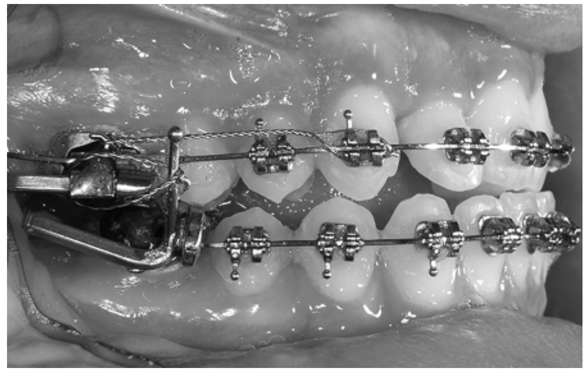

Figure 1 Intraoral view of the Mandibular Anterior Repositioning Appliance. The upper and lower elbows act as obstacles to be avoided inducing the mandible to close in a forward position.

dentoskeletal relationships. This appliance does not require the placement of attachments on teeth other than the first molars and allows concurrent use of other appliances (like fixed appliances or rapid maxillary expander) to better address specific patient needs and shorten treatment duration. The developers of the appliance (Toll *et al.*, 2010) recommend at least a 12 month treatment time to achieve a bite jumping or orthopaedic effect. A stepwise advancement protocol with 2–3 mm enhancement steps (Du *et al.*, 2002; Hägg *et al.*, 2008) was used up to a slight overcorrection of Class II dental relationship.

Cephalometric analysis

Lateral cephalograms were traced and measured using a digitizing software (Viewbox, ver. 3.0; DHAL, Kifissia, Greece; Halazonetis, 1994). There was no difference in cephalometric magnification between the cephalograms of patients and controls (8 per cent).

A customized analysis included measurements from the analyses of Steiner (1953), Jacobson (1975), Ricketts (1981), and McNamara (1984). A preliminary tracing was made on the T1 cephalogram for each patient and fiducial points were placed (two in the maxilla and two in the mandible). Fiducial markers were then transferred to the T2 tracings based on superimposition, via software, over anatomical stable structures (Björk and Skieller, 1972), as described by Stahl *et al.* (2008). This superimposition allowed for the description of the movement of the maxillary dentition relative to the maxilla and of mandibular dentition relative to the mandible.

Method error

All cephalograms were traced and superimposed by the same operator and were checked by a second operator to verify anatomical outlines, landmark placement, and tracing superimpositions. Any disagreements were resolved to the satisfaction of both observers who were blinded as to group assignment of examined cephalograms.

Twenty randomly selected cephalograms were re-digitized by the same operator and the variables were recalculated to determine the method error with the intraclass correlation coefficient (ICC). The ICCs ranged from 0.93 to 0.99 for linear measurements and from 0.94 to 0.98 for angular measurements. All recalculated measures were within 1 mm or 1 degree from the original.

Statistical analysis

Descriptive statistics were calculated for each cephalometric variable. A preliminary Shapiro–Wilk test revealed that data did not present with a normal distribution. The dentoskeletal modifications shown by each treated group (MARApre, MARApeak, and MARApost) were compared with the growth changes occurring in the corresponding control group with Mann–Whitney tests. Significance level was set at $P < 0.017$ following a Bonferroni correction due to multiple comparisons. The tests were carried out using a commercial statistical package (SPSS for Windows, release 12.0; SPSS Inc.).

Sample size for the treated and control groups was calculated considering a clinically significant difference of 2 degrees in the ANB angle with a standard deviation of 1.6 degrees (as derived from a previous study on the effects of MARA; Huanca Ghislanzoni *et al.*, 2011), a power of 0.80, and alpha of 0.05. The calculated sample size was 15 subjects in each group (SigmaStat 3.5; Systat Software, Point Richmond, California, USA).

Results

Mean age of the treated groups before and after therapy as well as duration of active MARA treatment and of comprehensive treatment (T1–T2) are reported in Table 1. As for individual skeletal maturation, patients in the MARApre group showed CS1, or CS2, or CS3 at T2; patients in the MARApeak group showed CS4 or CS5 at T2; and patients in the MARApost group showed CS6 at T2.

Results of the statistical comparisons of MARApre, MARApeak, and MARApost patients with their respective Class II control groups on the changes for all cephalometric variables during the T1–T2 observation interval are reported in Tables 2–4.

Table 1 Mean age and treatment duration of the treated groups: MARApre (prepubertal), MARApeak (pubertal), and MARApost (postpubertal).

	MARApre	MARApeak	MARApost
N	21	15	15
Age at T1 (years)	9.7 ± 1.2	11.4 ± 1.6	14.9 ± 1.8
Age at T2 (years)	11.9 ± 1.4	13.6 ± 1.6	17.0 ± 2.0
MARA active treatment (years)	1.6 ± 0.8	1.4 ± 0.7	1.4 ± 1.0
T1–T2 interval (years)	2.3 ± 1.0	2.3 ± 0.9	2.0 ± 0.8

MARApre group

Significantly smaller increases in maxillary sagittal position and length were recorded in the MARApre group versus respective controls, while no significant changes occurred in the mandibular skeletal measures. Therefore, the significant improvements in maxillary/mandibular parameters in the MARApre group versus controls were due mainly to the favourable maxillary skeletal changes. As to the vertical skeletal parameters, a significant downward rotation of the palatal plane relative to Frankfort plane was found in the treated group, which led to a significant decrease in the intermaxillary vertical skeletal relationships. All interdental measurements revealed statistically significant differences between the treated group and the controls. In particular, both overjet and overbite were reduced by over 3 mm, and molar relationship showed an improvement of 3 mm as well. No significant maxillary dentoalveolar changes were assessed in the treated group, while most of the mandibular dentoalveolar changes were significant. Lower incisors were significantly proclined, while lower first molars extruded and moved mesially by a significant amount.

MARAPeak group

No significant changes were recorded for the maxillary skeletal parameters while a significantly greater increase in mandibular length (2.6 mm) was recorded in the group treated at the peak with respect to the controls. This latter significant change led to significant improvements in both the Wits and the maxillo/mandibular differential (−2.5 and 3.2 mm, respectively). No significant changes were assessed for the vertical skeletal parameters with the exception of a significant decrease in the intermaxillary vertical skeletal relationships. The overjet was significantly reduced by 3 mm and molar relationship showed a significant improvement of 2.8 mm. No significant maxillary dentoalveolar changes were assessed in the treated group.

MARAPost group

No significant changes were recorded either for the maxillary or for the mandibular skeletal parameters in the sagittal plane. However, the maxillary/mandibular parameters presented with significant improvements. No significant changes were found for the vertical skeletal parameters. The overjet was significantly reduced by 1.9 mm, the overbite was reduced significantly by 2.6 mm, and molar relationship showed a significant improvement of 2.7 mm. No significant maxillary dentoalveolar changes were assessed in the treated group while most of the mandibular dentoalveolar changes were significant. Lower incisors were proclined and intruded while first molars extruded significantly.

Table 2 Descriptive statistics and statistical comparisons in the pre–peak groups. SD, standard deviation.

	MARApre		Controls		Statistical comparisons		
	Mean	SD	Mean	SD	Net difference	*P*	Significance
Maxillary skeletal							
Pt A to nasion perpendicular (mm)	−1.1	1.7	0.2	0.2	−1.3	0.015	*
Co–Pt A (mm)	1.3	1.9	3.2	1.7	−1.9	0.007	*
Mandibular skeletal							
Pg to nasion perpendicular (mm)	0.7	4.1	0.7	0.4	0.0	0.910	ns
Co–Gn (mm)	5.8	3.2	4.7	2.4	1.1	0.241	ns
Maxillary/mandibular							
Wits (mm)	−2.5	3.4	0.1	0.1	−2.6	0.000	*
Maxillary/mandibular difference (mm)	4.5	3.1	1.5	0.8	3.0	0.000	*
Vertical skeletal							
FH to palatal plane (°)	1.0	2.2	−1.1	0.7	2.1	0.005	*
FH to mandibular plane (°)	0.7	2.4	−0.1	0.1	0.8	0.284	ns
Palatal plane to mandibular plane (°)	−0.4	2.0	1.0	0.8	−1.4	0.009	*
CoGoMe (°)	0.2	1.9	−0.6	0.6	0.8	0.089	ns
Interdental							
Overjet (mm)	−3.4	3.0	−0.2	0.3	−3.2	0.000	*
Overbite (mm)	−2.0	3.1	1.1	0.8	−3.1	0.000	*
Molar relationship (mm)	3.5	2.7	0.5	0.2	3.0	0.000	*
Interincisal angle (°)	−8.3	14.1	2.6	2.0	−10.9	0.006	*
Maxillary dentoalveolar							
U1–FH (°)	1.6	10.9	−1.7	1.6	3.3	0.170	ns
U1 horizontal (mm)	0.5	2.0	0.7	0.4	−0.2	0.715	ns
U1 vertical (mm)	0.5	1.7	0.7	0.4	−0.2	0.562	ns
U6 horizontal (mm)	1.4	2.1	1.2	0.7	0.2	0.950	ns
U6 vertical (mm)	1.3	1.7	1.6	0.9	−0.3	0.920	ns
Mandibular dentoalveolar							
L1 to mandibular plane (°)	6.0	7.8	−0.8	0.5	6.8	0.001	*
L1 horizontal (mm)	1.7	2.0	0.2	0.1	1.5	0.003	*
L1 vertical (mm)	1.2	1.5	1.6	0.9	−0.4	0.118	ns
L6 horizontal (mm)	2.6	1.8	0.9	0.4	1.7	0.001	*
L6 vertical (mm)	2.4	0.9	0.8	0.4	1.6	0.000	*

ns, not significant.
*$P < 0.017$.

Discussion

Clinical studies on the effects of the MARA are scarce in the literature (Pangrazio-Kulbersh *et al.*, 2003; Gönner *et al.*, 2007; Siara-Olds *et al.*, 2010; Huanca Ghislanzoni *et al.*, 2011), with no previous controlled clinical trial that investigated into the ideal treatment timing for this appliance. In order to provide this missing information, the present study analysed the skeletal and dentoalveolar changes produced by the MARA and fixed appliance treatment in three different groups of individuals at different stages of skeletal maturation (before, during, and after the pubertal growth spurt).

Independently from the skeletal maturity of the treated patients, the comprehensive MARA and fixed appliance treatment proved to be effective in terms of significant improvement of Class II dentoskeletal parameters (Wits, maxilla/mandibular differential, overjet, and molar relationship), in agreement with previous short-term and long-term reports (Pangrazio-Kulbersh *et al.*, 2003; Gönner *et al.*, 2007; Siara-Olds *et al.*, 2010; Huanca Ghislanzoni *et al.*, 2011). Different timing of therapy influenced significantly the relative contributions of dentoskeletal changes to the final occlusal outcomes.

The outcomes of the study demonstrated that the pubertal growth spurt, in the permanent dentition, is the most favourable period to accomplish a greater amount of mandibular skeletal effects and a smaller amount of dental compensation at the lower arch with respect to pre- or post-peak periods. Treatment with MARA and fixed appliances at a pre-peak developmental stage was able to induce favourable outcomes at the level of the maxillary skeletal structures that presented with a smaller amount of sagittal advancement and length when compared with untreated Class II control data. The so-called 'headgear-effect' that has been described previously as a possible effect of the Herbst appliance (Pancherz and Hägg, 1985; Hansen *et al.* 1991) was found also in patients treated with the MARA before puberty. The prepubertal stage of development in presence of residual sutural activity of the maxillary skeletal structures allowed for the favourable outcome in the maxilla, thus confirming previous observations in a sample

Table 3 Descriptive statistics and statistical comparisons in the peak groups. SD, standard deviation.

	MARApeak		Controls		Statistical comparisons		
	Mean	SD	Mean	SD	Net difference	P	Significance
Maxillary skeletal							
Pt A to nasion perpendicular (mm)	−0.4	2.2	0.4	0.2	−0.8	0.064	ns
Co–Pt A (mm)	3.7	3.0	4.2	1.0	−0.5	0.328	ns
Mandibular skeletal							
Pg to nasion perpendicular (mm)	2.6	3.2	1.5	0.5	1.1	0.372	ns
Co–Gn (mm)	8.6	3.1	6.0	1.7	2.6	0.015	*
Maxillary/mandibular							
Wits (mm)	−2.1	2.0	0.4	0.2	−2.5	0.000	*
Maxillary/mandibular difference (mm)	4.9	1.7	1.7	0.9	3.2	0.000	*
Vertical skeletal							
FH to palatal plane (°)	0.5	2.4	−1.0	0.5	1.5	0.024	ns
FH to mandibular plane (°)	−1.1	1.8	−0.8	0.2	−0.3	0.884	ns
Palatal plane to mandibular plane (°)	−1.6	1.7	0.2	0.5	−1.8	0.003	*
CoGoMe (°)	−0.2	1.7	−0.6	0.3	0.4	0.177	ns
Interdental							
Overjet (mm)	−2.9	1.3	0.1	0.2	−3.0	0.000	*
Overbite (mm)	−1.2	2.4	0.3	0.5	−1.5	0.029	ns
Molar relationship (mm)	2.9	1.9	0.1	0.2	2.8	0.000	*
Interincisal angle (°)	−3.2	14.3	2.1	1.3	−5.3	0.372	ns
Maxillary dentoalveolar							
U1–FH (°)	2.8	11.3	−1.2	1.0	4.0	0.048	ns
U1 horizontal (mm)	0.5	2.0	1.0	0.3	−0.5	0.506	ns
U1 vertical (mm)	0.5	1.4	0.7	0.3	−0.2	0.708	ns
U6 horizontal (mm)	1.4	1.9	1.7	0.6	−0.3	0.128	ns
U6 vertical (mm)	1.9	1.5	2.0	0.8	−0.1	0.901	ns
Mandibular dentoalveolar							
L1 to mandibular plane (°)	1.5	6.6	−0.1	0.4	1.6	0.119	ns
L1 horizontal (mm)	0.4	1.6	0.2	0.1	0.2	0.247	ns
L1 vertical (mm)	0.8	1.2	1.6	0.5	−0.8	0.033	ns
L6 horizontal (mm)	2.0	2.2	1.0	0.5	1.0	0.270	ns
L6 vertical (mm)	2.4	1.3	1.5	0.5	0.9	0.096	ns

ns, not significant.
*$P < 0.017$.

treated with the headgear, fixed appliances, and Class II elastics at the same stage in skeletal maturation (Baccetti *et al.*, 2000). The early treatment group showed some significant changes in the vertical parameters with a decrease in the intermaxillary skeletal divergency counteracted by a significant amount of reduction in the overbite (−3.1 mm on average when compared to controls). As to the dentoalveolar level, the significant modifications were located at the lower arch with proclination of the lower incisors. The lack of sagittal support due to the loss of the lower second deciduous molars, which was common at some stage of the therapy in pre-peak patients, was only partially counteracted by the fixed appliance and the thick lingual arch connecting the molar bands. This may have accounted for the extrusion and mesialization of the lower first molars. These effects are very similar to those described following the use of Class II elastics in combination with fixed appliances (Baccetti *et al.*, 2000).

The group of patients who received their treatment during the growth spurt in the permanent dentition showed a significant enhancement of mandibular length, with a net 2.6 mm increase with respect to untreated controls. This result highlights the role of pubertal skeletal maturation of the condylar cartilage as a significant factor improving the responsiveness of Class II patients to orthopaedic/orthodontic treatment, and it confirms previous data of ample literature at this regard (McNamara *et al.*, 1985; Pancherz and Hägg 1985; Hägg and Pancherz 1988; Malmgren *et al.*, 1987; Baccetti *et al.*, 2000, 2009a,b; Faltin *et al.*, 2003; Cozza *et al.*, 2006). It has been shown that functional jaw orthopedics at the pubertal spurt followed by fixed appliances is a viable therapeutical option also in patients with unfavourable Class II skeletal patterns, although skeletal changes are of minor entity (Baccetti and McNamara, 2010). The adequate duration of active treatment with MARA (about 1 year and a half) as well as the stepwise reactivation of the appliance probably worked in favour of this significant mandibular change (Rabie and Al-Kalaly, 2008; Austin *et al.*, 2010). Supplemental mandibular lengthening induced by MARA at the pubertal

Table 4 Descriptive statistics and statistical comparisons in the post–peak groups. SD, standard deviation.

	MARApost		Controls		Statistical comparisons		
	Mean	SD	Mean	SD	Net difference	*P*	Significance
Maxillary skeletal							
Pt A to nasion perpendicular (mm)	−0.9	2.6	−0.1	0.2	−0.8	0.307	ns
Co–Pt A (mm)	−0.1	2.5	1.3	1.0	−1.4	0.023	ns
Mandibular skeletal							
Pg to nasion perpendicular (mm)	1.1	4.5	0.5	0.4	0.6	0.917	ns
Co–Gn (mm)	3.6	2.0	2.4	1.8	1.2	0.288	ns
Maxillary/mandibular							
Wits (mm)	−2.8	1.2	0.0	0.2	−2.8	0.000	*
Maxillary/mandibular difference (mm)	3.7	2.1	1.0	0.7	2.7	0.000	*
Vertical skeletal							
FH to palatal plane (°)	1.1	1.8	0.0	0.3	1.1	0.269	ns
FH to mandibular plane (°)	−0.1	1.9	−0.3	0.2	0.2	0.234	ns
Palatal plane to mandibular plane (°)	−1.3	1.7	−0.3	0.3	−1.0	0.545	ns
CoGoMe (°)	−0.4	1.8	−0.7	0.5	0.3	0.348	ns
Interdental							
Overjet (mm)	−2.2	2.1	−0.3	0.2	−1.9	0.000	*
Overbite (mm)	−2.6	3.1	0.0	0.3	−2.6	0.005	*
Molar relationship (mm)	2.9	2.0	0.2	0.2	2.7	0.000	*
Interincisal angle (°)	−6.0	14.8	0.6	0.8	−6.6	0.064	ns
Maxillary dentoalveolar							
U1–FH (°)	2.4	11.7	−0.1	0.5	2.5	0.349	ns
U1 horizontal (mm)	1.0	1.9	0.0	0.1	1.0	0.144	ns
U1 vertical (mm)	0.3	1.8	0.2	0.2	0.1	0.934	ns
U6 horizontal (mm)	1.4	1.9	0.4	0.4	1.0	0.196	ns
U6 vertical (mm)	0.3	0.8	0.6	0.5	−0.3	0.202	ns
Mandibular dentoalveolar							
L1 to mandibular plane (°)	3.7	6.0	−0.2	0.2	3.9	0.002	*
L1 horizontal (mm)	0.3	1.7	−0.1	0.1	0.4	0.380	ns
L1 vertical (mm)	−1.3	1.6	0.7	0.5	−2.0	0.001	*
L6 horizontal (mm)	1.4	2.9	0.3	0.2	1.1	0.063	ns
L6 vertical (mm)	1.9	1.2	0.5	0.4	1.4	0.001	*

ns, not significant.
*$P < 0.017$.

growth spurt compares well with that produced by the Herbst appliance at the same developmental period (Baccetti *et al.*, 2009b). It should be noted, however, that the significant amount of supplementary mandibular growth did not result in a significant advancement of point pogonion to nasion perpendicular, a favourable effect that has been described following Herbst treatment at puberty (Baccetti *et al.*, 2000). No significant dentoalveolar compensations were recorded for the MARApeak sample. In particular, treatment at the growth spurt did not reduce the overbite significantly; it did not induce proclination of the lower incisors nor effects on the horizontal and vertical positions of the lower molars. The lack of dentoalveolar side-effects was probably a major factor in favouring the prevalent skeletal component of Class II correction in the MARApeak group.

As to the postpubertal group, consistency in improvement for the dentoskeletal sagittal parameters with respect to the other two groups (pre-peak and peak) was associated with a significant decrease in the overbite and significant mandibular dentoalveolar effects. These outcomes were similar to those shown by the pre-peak group.

The samples investigated in this prospective study will be re-evaluated at a long-term observation. The posttreatment evaluation will allow to assess the stability of MARA and fixed appliance treatment of Class II malocclusion in relation to treatment timing.

Conclusions

Optimum treatment timing for MARA and fixed appliance therapy of Class II malocclusion appeared to be during the pubertal growth spurt in the permanent dentition. Mandibular length increments were larger and clinically significant at this time. The amount of dentoalveolar compensation (proclination of lower incisors, extrusion and mesialization of lower molars, and reduction in the overbite) was minimal when treatment was performed at puberty, while it was significant in patients treated before or after puberty.

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