European Journal of Orthodontics 30 (2008) 572–579
doi:10.1093/ejo/cjn060

Comparison of the effects produced by headgear and pendulum appliances followed by fixed orthodontic treatment

Fernanda Angelieri, Renato Rodrigues de Almeida, Guilherme Janson, José Fernando Castanha Henriques and Arnaldo Pinzan
Department of Orthodontics, Bauru Dental School, University of São Paulo, Brazil

SUMMARY This study compared the effects produced by two different molar distalizers, namely cervical headgear (CHG) and the intraoral pendulum appliance, associated with fixed orthodontic appliances. The headgear group comprised 30 patients (19 females, 11 males), with an initial age of 13.07 years [standard deviation (SD) = 1.3], treated with CHG and fixed orthodontic appliances for a mean period of 3.28 years, and the pendulum group 22 patients (15 females, 7 males), with initial age of 13.75 years (SD = 1.86), treated with the pendulum appliance followed by fixed orthodontic appliances for a mean period of 4.12 years. Lateral cephalograms were taken at the start (T1) and on completion (T2) of orthodontic treatment. The pendulum and CHG groups were similar as to initial age, severity of the Class II malocclusion, gender distribution, initial cephalometric characteristics, and initial and final treatment priority index (TPI). Only treatment time was not similar between the groups, with a need for annualization for data for the pendulum group. The data were compared with independent *t*-tests.

There was significantly greater restriction of maxillary forward growth and improvement of the skeletal maxillomandibular relationship in the CHG group ($P < 0.05$). The maxillary molars were more mesially tipped and extruded and the mandibular molars more uprighted in the CHG group compared with the pendulum group ($P < 0.05$). There was more labial tipping of the mandibular incisors and greater overbite reduction in the pendulum group. The pendulum appliance produced only dentoalveolar effects, different from the CHG appliance, which restricted maxillary forward displacement, thus improving the skeletal maxillomandibular relationship.

Introduction

Treatment of Class II malocclusions, without significant skeletal involvement, consists of distalization of the maxillary molars, canines, and incisors to a Class I relationship (Moyers *et al.*, 1980). Headgear, which has been used for maxillary molar distalization (Ciger *et al.*, 2005), is often unsatisfactory from a clinical point of view (Doruk *et al.*, 2004).

The intraoral pendulum appliance was introduced by Hilgers (1992). Despite its efficacy for maxillary molar distalization, there are side-effects, including labial/mesial tipping and protrusion of the maxillary incisors and premolars, distal tipping of the maxillary molars, increase in lower anterior face height, clockwise mandibular rotation, and extrusion of the first premolars (Ghosh and Nanda, 1996; Byloff *et al.*, 1997; Bussick and McNamara, 2000). Consequently, these side-effects have to be corrected during the fixed appliance treatment phase (Hilgers, 1992; Ghosh and Nanda, 1996; Byloff and Darendeliler, 1997).

The distalizing effects of cervical headgear (CHG) and the pendulum appliance on the maxillary molars have been compared (Taner *et al.*, 2003). However, the effects produced by the CHG and pendulum appliances on completion of fixed orthodontic treatment have not been investigated. Therefore, the aim of this study was to compare the skeletal, dentoalveolar, and soft tissue changes in the craniofacial complex of patients treated with CHG or the pendulum appliance, followed by fixed orthodontic appliances.

Subjects and method

This retrospective study was approved by the Human Ethics Committee of the University of São Paulo, comprised 52 patients selected according to the following criteria: at least a bilateral half Class II molar relationship (cusp to cusp) (Andrews, 1975; Creekmore, 1997; Wheeler *et al.*, 2002) and the presence of all permanent teeth (excluding third molars). The patients were divided into two groups:

CHG group: 30 patients (19 females, 11 males), with an initial mean age of 13.07 years (range 10.33–15.5 years). All had a Class II division 1 malocclusion, 15 a full Class II, and 15 a half Class II molar relationship (Andrews, 1975; Creekmore, 1997; Wheeler *et al.*, 2002). The Class II molar relationship was corrected with CHG, with the outer bow at 15 degrees above the occlusal plane and a mean force of 450 g/side, recommended to be worn for 16 hours a day. The CHG was used for a mean period of 1.12 years. After correction of the molar relationship, the CHG was used only at night for the retention of molar distalization. Concurrently with the CHG, preadjusted fixed orthodontic appliances (Roth prescription, 0.022 × 0.028 inch) were placed. The fixed orthodontic treatment was performed conventionally, including

tooth alignment and levelling, interdigitation, and finishing procedures. Before interdigitation, quarter-inch Class II elastics were used for retraction of the maxillary canines and incisors. The mean treatment time was 3.28 years.

Pendulum group: 22 patients (15 females, 7 males), with an initial mean age of 13.75 years (range 11.16–17 years). All patients presented with a Class II division 1 malocclusion; 13 had a full Class II and nine a half Class II molar relationship. The Class II molar relationship was corrected with the pendulum appliance (Figure 1), fabricated as suggested by Hilgers (1992). The TMA coils were activated parallel to the midpalatal suture (Hilgers, 1992), delivering a force of approximately 250 g/side, for a mean period of 5.88 months. After achievement of a Class I molar relationship with nearly 2 mm of overcorrection, the pendulum appliance was removed and a Nance button associated with a CHG placed, with a force intensity of 400 g/side, which was worn at night to upright the molar roots after distalization (Gianelly, 1998). Subsequently, fixed orthodontic appliances were placed (Roth prescription, 0.022 × 0.028 inch). After conventional tooth alignment and levelling, the maxillary premolars were individually retracted. Anchorage was reinforced with quarter-inch Class II elastics for maxillary anterior tooth retraction, when the Nance button was removed and interdigitation and orthodontic finishing were performed. The mean treatment time was 4.12 years.

Dental cast analysis

To investigate the similarity of the groups regarding initial malocclusion severity and the occlusal results, the initial and final occlusal status of both groups were evaluated on dental casts using the treatment priority index (TPI) (Grainger, 1967).

Cephalometric analysis

Lateral cephalograms were obtained pre- (T1) and post- (T2) treatment following the fixed appliance therapy. The lateral cephalograms were taken with three cephalostats, with magnification factors of 6.0, 7.9, and 9.8 per cent.

Cephalometric tracing and landmark identification was performed on acetate paper by a single investigator (FA) and digitized (Numonics AccuGrid XNT, model A30TL.F, Numonics Corporation, Montgomeryville, Pennsylvania, USA). The data were stored on a computer and analyzed with the Dentofacial Planner 7.02 software (Dentofacial Planner Software Inc., Toronto, Ontario, Canada), which corrected the image magnification factors. The cephalometric variables analyzed are shown in Figure 2. Treatment changes were calculated as T2−T1.

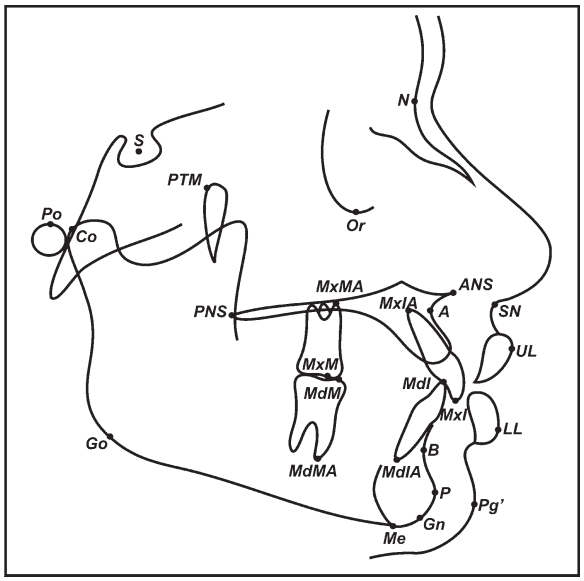

Figure 1 Pendulum appliance after distalization of the maxillary molars. [Reprinted from Angelieri. F, Almeida RR, Almeida MR, Fuziy A 2006. Dentoalveolar and skeleted changes associated with the pendulum appliance followed by fixed orthodontic treatment. American Journal of Orthodontics 129: 520–527, with permission from Elsevier]

Figure 2 Lateral cephalometric landmarks: S, sella; N, nasion; Or, orbitale; Po, porion; A, subspinale; B, supramentale; P, pogonion; Gn, gnathion; Me, menton; Go, gonion; ANS, anterior nasal spine; PNS, posterior nasal spine; Co, condylion; PTM, pterygomaxillary fissure; SN, subnasal; UL, upper lip; LL, lower lip; Pg′, tegumental pogonion; MxM, mesiobuccal cusp of the maxillary first molar; MxMA, mesiobuccal root apex of the maxillary first molar; MdM, mesiobuccal cusp of the mandibular first molar; MdMA, mesiobuccal root apex of the mandibular first molar; MxI, incisal border of the maxillary central incisor; MxIA, root apex of the maxillary central incisor; MdI, incisal border of the mandibular central incisor; MdIA, root apex of the mandibular central incisor. Variables measured on the lateral cephalograms: A–N-perp, distance from point A to N-perp line (perpendicular line to Frankfort plane through point N); P–N-perp, distance from point P to N-perp line; SN.Go.Gn, angle between the SN line and the mandibular plane (Go–Gn); N–Me, distance from N to Me points; LAFH, lower anterior face height; MxI.PP, angle between the palatal plane and the long axis of the maxillary central incisor (MxI–MxIA); MxI–PP, (maxillary incisor dentoaveolar height) distance from point MxI to the palatal plane; MxI–PTV, distance from point MxI to the PTV line (perpendicular line to Frankfort plane through PTM point) MxM–PP, angle between the palatal plane and the long axis of the maxillary first molar (MxM–MxMA); MxM–PP, distance from point MxM to the palatal plane; MxM–PTV, distance from point MxM to the PTV line (perpendicular line to Frankfort plane through PTM point); MdI–MP, distance from point MdI to the mandibular plane (Go–Me) − mandibular incisor dentoalveolar height; MdI–PTV, distance from point MdI to the PTV line; MdM–MP, angle between the mandibular plane (Go–Me) and the long axis of the mandibular first molar (MdM–MdMA); MdM–MP, distance from point MdM to the mandibular plane (Go–Me); MdM–PTV, distance from MdM point to PTV line; UL–SnPg′, distance from point UL to the SnPg′ line; LL–SnPg′, distance from point LL to the SnPg′ line.

Error study

Cephalograms and dental casts of 20 randomly selected patients (10 from each group) were retraced, redigitized, and remeasured by the same examiner 15 days after the first evaluation. The errors were evaluated with Dahlberg's (1940) formula and the systematic error with dependent *t*-tests (Houston, 1983).

Statistical analysis

The CHG and pendulum groups were compared with respect to initial age, treatment time, and initial and final TPI with independent *t*-tests. Intergroup Class II malocclusion severity and gender distribution were analyzed with chi-square tests.

The CHG and pendulum appliance changes were also compared with independent *t*-tests, at a significance level of $P < 0.05$.

Results

There were systematic errors for five of the cephalometric measurements: (overjet, overbite, LAFH, N–Me, and MdI–MP variables) and the range of errors varied from 1.01 (Co–Gn) to 1.65 (MxM.PP), indicating good reproducibility. The errors were considered acceptable (Keeling *et al.*, 1989; McNamara *et al.*, 1990; Fidler *et al.*, 1995; Pollard and Mamandras, 1995).

The groups were compatible regarding initial age, initial and final TPI, Class II malocclusion severity, and gender distribution (Tables 1 and 2). However, the pendulum group had a greater final age and treatment time. The pendulum treatment changes were therefore annualized to the corresponding CHG treatment time (McNamara *et al.*, 1990; Keeling *et al.*, 1998; Toth and McNamara, 1999; Mills and McCulloch, 2000). Therefore, all patients in the pendulum group had their treatment changes, for each variable, divided by their treatment time (of each patient individually), and then multiplied by the mean treatment time of the CHG group. Cephalometrically, the pendulum group had a greater mandibular incisor dentoalveolar height than the CHG group (Table 3).

The changes produced by both treatment protocols are shown in Table 4. There was a significant restriction of maxillary forward displacement and improvement in maxillomandibular relationship in the CHG group as compared with the pendulum group (Figure 3). The maxillary molars in the CHG group showed greater mesial tipping and extrusion compared with the pendulum group. There was more labial tipping of the mandibular incisors and greater overbite reduction in the pendulum group. The mandibular molars had greater distal tipping, i.e. more uprighting in the CHG compared with the pendulum group.

Discussion

Only one study was found in the literature comparing the effects of CHG and the pendulum appliance, which was carried out during maxillary molar distalization (Taner *et al.*, 2003). Due to the side-effects caused by the pendulum appliance during distalization of the maxillary molars,

Table 1 Intergroup comparison of treatment time, initial and final ages, initial and final Treatment Priority Index (TPI) for the cervical headgear (CHG) and pendulum appliance groups (*t*-tests).

Variables	CHG, $n = 30$		Pendulum, $n = 22$		P
	Mean	SD	Mean	SD	
Initial age	13.07	1.30	13.75	1.86	0.1274
Final age	16.35	1.15	17.87	1.91	0.0012*
Treatment time	3.28	0.73	4.12	0.98	0.0009*
Initial TPI	6.37	2.08	6.05	1.63	0.552
Final TPI	0.95	1.12	0.73	1.19	0.494

*$P < 0.05$.

Table 2 Intergroup comparison of Class II malocclusion severity and gender distribution (chi square).

	Cervical headgear		Pendulum		χ^2	P
	Half cusp Class II	Full cusp Class II	Half cusp Class II	Full cusp Class II		
	15	15	9	13	0.42	0.516
Patients	Male	Female	Male	Female		
	11	19	7	15	0.13	0.716
Percentage of patients	36.67	63.33	31.82	68.18		

Table 3 Intergroup comparison of the initial cephalometric characteristics (*t*-tests).

Variables	Cervical headgear, $n = 30$		Pendulum, $n = 22$		P
	Mean	SD	Mean	SD	
Maxillary components					
SNA	82.29	3.2	82.16	3.05	0.88
A–N-perp	2.14	2.89	1.85	2.7	0.712
Co–A	85.67	4.41	86.45	5.22	0.56
Mandibular components					
SNB	77.85	3.47	77.69	2.62	0.861
P–N-perp	−1.96	5.13	−2.41	4.08	0.735
Co–Gn	107.32	5.89	109.1	4.83	0.252
Maxillomandibular relationship					
ANB	4.45	2.01	4.46	1.55	0.984
Vertical components					
SN.Go.Gn	30.45	4.72	31.3	5.71	0.559
FMA	22.8	3.91	23.56	5.06	0.542
N–Me	108.76	5.05	109.59	6.46	0.752
LAFH	61.04	4.38	62.7	4.59	0.192
SN.PP	7.37	3.27	6.38	3.62	0.307
Maxillary dentoalveolar components					
MxI.PP	113.48	8.27	109.55	6.81	0.074
MxI–PP	26.38	2.37	27.67	2.64	0.069
MxI–PTV	55.16	4.97	54.9	3.9	0.841
MxM.PP	97.56	7.5	96.92	6.47	0.747
MxM–PP	20.67	2.53	21.27	2.35	0.392
MxM–PTV	23.83	3.39	25.62	3.4	0.067
Mandibular dentoalveolar components					
IMPA	97.13	6.48	98.66	4.99	0.361
MdI–MP	37.1	2.69	38.65	2.54	0.041*
MdI–PTV	49.88	3.87	50.48	3.61	0.569
MdM.MP	92.39	4.93	94.54	4.79	0.122
MdM–MP	27.42	2.36	28.51	2.08	0.09
MdM–PTV	23.4	3.52	24.75	3.34	0.171
Dental relationships					
Overjet	5.28	3.08	4.42	1.4	0.227
Overbite	3.53	1.52	4.43	1.88	0.063
Molar	0.43	1.28	0.87	0.69	0.152
Soft tissue profile					
UL–SnPg′	4.48	1.81	5.16	1.83	0.187
LL–SnPg′	2.89	2.39	3.6	2.51	0.306

*$P < 0.05$.

which must be corrected during fixed orthodontic treatment, it is important to compare the effects of both distalizers after completion of orthodontic treatment.

The CHG group patients were selected from the files of the Department of Orthodontics at Bauru Dental School and the pendulum appliance patients clinically selected and treated by an orthodontist. Initially, the pendulum sample consisted of 31 patients (Fuziy *et al.*, 2006), and in order to match the groups was reduced to 22 patients. Nevertheless, the number of patients in each group was statistically satisfactory (Burkhardt *et al.*, 2003; Angelieri *et al.*, 2006). The age range of the pendulum group, from 11.16 to 17 years, may be criticized for including non-growing patients. However, only two patients were older than 17 years and the others aged 11.16 to 16.16 years, similar to the CHG group.

The pendulum and CHG groups were similar as to initial age, severity of Class II malocclusion, gender distribution, initial cephalometric characteristics, and initial and final TPI. Therefore, a good statistical similarity was observed between the groups, which allowed cephalometric comparison without the need for a control group, (McNamara *et al.*, 1990; Burkhardt *et al.*, 2003) since craniofacial growth of both groups would be similar.

However, the intergroup treatment time was not statistically compatible, with a longer mean treatment time of 0.84 years for the pendulum group. This longer treatment time was expected due to several factors. First, the CHG was worn by the patients simultaneously with the fixed orthodontic appliance. This was not possible with the pendulum appliance, which had to be used for 5.88 months before placement of fixed orthodontic appliances and a Nance button to retain the molar distalization. Moreover, during CHG maxillary molar distalization, no protrusive effects occurred at the maxillary incisors, canines, and premolars. These teeth are usually

Table 4 Comparison of the effects produced by cervical headgear (CHG) and pendulum appliances (annualized data, *t*-tests).

Variables	CHG, $n = 30$		Pendulum, $n = 22$		P
	Mean	SD	Mean	SD	
Maxillary components					
SNA	−1.24	1.53	0.26	1.1	0.000*
A–N-perp	−1.03	2.35	0.52	2.07	0.017*
Co–A	1.4	2.42	1.88	2.82	0.509
Mandibular components					
SNB	0.43	1.38	0.24	1.42	0.628
P–N-perp	1.26	4.67	0.92	3.25	0.77
Co–Gn	5.37	4.16	3.58	4.49	0.145
Maxillomandibular relationship					
ANB	−1.67	1.21	0.01	1.33	0.000*
Vertical components					
SN.Go.Gn	−0.61	1.52	−0.16	1.96	0.35
FMA	−0.65	2.6	−0.25	1.87	0.542
N–Me	5.42	3.72	3.76	4.44	0.15
LAFH	3.01	2.13	2.77	3.39	0.759
SN.PP	0.58	1.41	0.19	1.53	0.336
Maxillary dentoalveolar components					
MxI.PP	0.71	10.47	1.44	8.08	0.786
MxI–PP	1.41	1.85	0.51	1.58	0.071
MxI.PTV	0.54	3.93	1.16	2.56	0.525
MxM.PP	−5.79	5.68	−0.53	4.43	0.001*
MxM–PP	2.65	1.64	1.65	1.5	0.029*
MxM–PTV	1.65	3.03	0.5	1.81	0.119
Mandibular dentoalveolar components					
IMPA	1.98	4.83	5.41	5.95	0.026*
MdI–MP	0.93	2	0.74	1.85	0.723
MdI–PTV	2.78	2.41	2.54	2.86	0.749
MdM.MP	6.1	4.12	1.98	3.83	0.001*
MdM–MP	1.71	1.47	1.34	1.35	0.366
MdM–PTV	3.46	2.97	2.48	2.69	0.229
Dental relationships					
Overjet	−2.23	2.77	−1.38	1.11	0.18
Overbite	−0.94	1.47	−1.75	1.34	0.047*
Molar	−1.81	1.65	−1.98	1.31	0.682
Soft tissue profile					
UL–SnPg′	−0.61	1.31	−0.75	0.86	0.675
LL–SnPg′	0.16	1.37	0.18	1.54	0.963

*$P < 0.05$.

distalized to a Class I relationship, consequent to the action of the transseptal fibres (Taner *et al.*, 2003). On the other hand, several side-effects occur due to the intraoral nature of the pendulum appliance, including protrusion and labial tipping of the maxillary incisors and mesialization and mesial inclination of the maxillary premolars, which must be corrected during fixed appliance treatment (Ghosh and Nanda, 1996; Byloff *et al.*, 1997; Taner *et al.*, 2003; Angelieri *et al.*, 2006), probably increasing the treatment time.

Due to the longer treatment time for the pendulum group, the data of this group were annualized. Annualization of data allows scientifically reliable comparison that is very close to the actual changes, especially if the difference between treatment times is small, as in the present study, of only 0.84 years (McNamara *et al.*, 1990; Keeling *et al.*, 1998; Toth and McNamara, 1999; Mills and McCulloch, 2000).

Skeletal changes

There was statistically significant restriction and redirection of maxillary forward displacement in the CHG group compared with the pendulum group (SNA angle and A–N-perp distance—Table 4). This occurs due to the orthopaedic action of high-magnitude forces in the maxilla (450 g/side) from the CHG (Klein, 1957; Blueher, 1959; Creekmore, 1967; Gandini *et al.*, 2001). Consequently, there was a statistically significant improvement of the skeletal maxillomandibular relationship with the CHG (ANB angle).

The similar mandibular effects observed in the groups were expected since both appliances act primarily on the maxillary dental arch. The increase in mandibular sagittal dimensions observed in both groups was related to normal mandibular sagittal growth (Klein, 1957; Creekmore, 1967; Burkhardt *et al.*, 2003; Angelieri *et al.*, 2006).

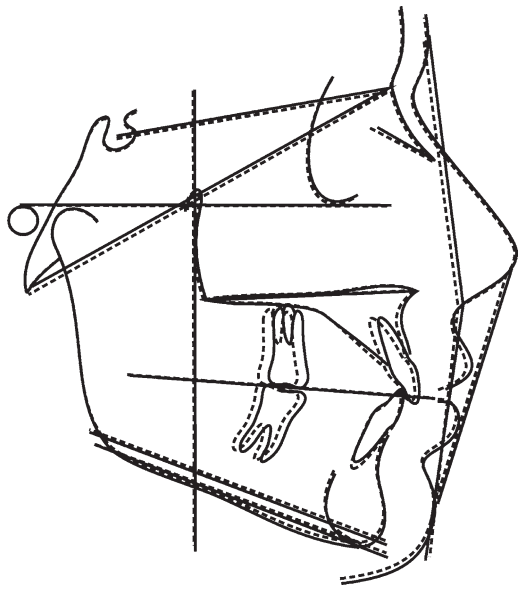

Figure 3 Superimposition of the final average cephalometric tracings of the groups: cervical headgear group, dashed line; pendulum group, continuous line.

With regard to the vertical components, in general, the groups showed similar changes. During distalization of the maxillary first molars with the CHG and pendulum appliances, there was clockwise rotation of the mandibular plane (Blueher, 1959; Wieslander, 1974; Hilgers, 1992; Ghosh and Nanda, 1996; Byloff and Darendeliler, 1997; Bussick and McNamara, 2000) due to extrusion of the maxillary molars (Wieslander, 1974; Kim and Muhl, 2001) in the CHG group and distal inclination of the molar crowns after distalization in the pendulum group (Hilgers, 1992; Ghosh and Nanda, 1996; Byloff and Darendeliler, 1997; Bussick and McNamara, 2000). However, this rotation of the mandibular plane is corrected during fixed orthodontic treatment after use of CHG (Ciger *et al.*, 2005) or the pendulum appliance (Burkhardt *et al.*, 2003; Angelieri *et al.*, 2006), probably due to the inherent growth pattern of each individual (Kim and Muhl, 2001; Ciger *et al.*, 2005), returning to the initial values in the final stage.

Dental effects

The maxillary first molars presented significantly greater mesial tipping in the CHG group compared with the pendulum group. This crown distalization with concomitant root movement is provided by directing the distalizing force coincident or close to the centre of resistance of the maxillary first molars, thus providing tooth movement close to bodily movement (Klein, 1957; Kim and Muhl, 2001). With both the CHG and pendulum appliance, there is initially distal crown tipping (more accentuated with the pendulum) (Wieslander, 1974; Ghosh and Nanda, 1996; Byloff and Darendeliler, 1997; Bussick and McNamara, 2000; Taner *et al.*, 2003). During the later stages of fixed appliance treatment, the molar roots are distalized and the molar will exhibit net mesial tipping at the end of treatment (Burkhardt *et al.*, 2003; Chiu *et al.*, 2005; Piva *et al.*, 2005; Angelieri *et al.*, 2006).

Moreover, CHG produced a downward force vector, which led to statistically significantly greater extrusion of the maxillary first molars than the pendulum appliance, in agreement with the findings of other studies (Klein, 1957; Wieslander, 1974; Kim and Muhl, 2001). Furthermore, in the pendulum group, there was a smaller extrusion of the maxillary molars, probably due to intrusion of these teeth as a result of the action of the TMA coils (Byloff and Darendeliler, 1997). However, this statistically significant greater extrusion in the CHG group did not cause a greater clockwise mandibular rotation, as previously reported (Kim and Muhl, 2001; Phan *et al.*, 2004).

There was similar mesialization of the maxillary molars in both groups. The entire maxillary dentoalveolar complex was kept antero-posteriorly stable throughout orthodontic treatment with the maxillary molar distalizers. Whereas the maxillary dentoalveolar complex was kept sagittally stable, mandibular growth continued, correcting the Class II malocclusion by mesialization of the mandibular molars associated with antero-posterior stability of the maxillary molars. This was demonstrated by the greater mesialization of the mandibular first molars compared with the maxillary first molars in both groups. After achievement of a Class I molar relationship with CHG or pendulum appliances, there may be mesialization of the first molars due to normal forward maxillary displacement with growth. Otherwise, the process would produce a Class III molar relationship (Burkhardt *et al.*, 2003; Chiu *et al.*, 2005; Piva *et al.*, 2005; Angelieri *et al.*, 2006).

To retract the maxillary incisors, canines, and premolars that were mesialized during distalization of the maxillary molars with the pendulum appliance without anchorage loss of the distalized molars, there was an extensive use of Class II elastics in this group. This probably caused significantly greater labial tipping of the mandibular incisors and less uprighting of the mandibular first molars in the pendulum group compared with the CHG group.

There was significantly greater overbite correction with the pendulum appliance, probably as a consequence of the greater labial tipping of the mandibular incisors observed in this group, which led to relative intrusion of these teeth, with greater correction of the deep bite (Braun *et al.*, 1996; Alqabandi *et al.*, 1999).

Soft tissue profile

Due to the predominantly similar antero-posterior changes of the maxillary and mandibular incisors, the upper and lower lips also demonstrated similar changes. The mild retrusion of the upper lip in both groups may be explained by the greater mandibular sagittal anterior displacement

compared with the maxilla, which caused forward displacement of the Sn–Pg′ line, leading to apparent retrusion of the upper lip. On the other hand, protrusion of the lower lip in both groups was probably a result of labial tipping and protrusion of the mandibular incisors.

Conclusions

Both distalizers were effective in correcting the Class II malocclusions. The pendulum appliance produced only dentoalveolar effects, while the CHG appliance, which restricted maxillary forward displacement, improved the skeletal maxillomandibular relationship.

Address for correspondence

Dr Fernanda Angelieri
Av Santa Rosa 233
Jd Santa Rosa
Porto Feliz
São Paulo SP 18540-000
Brazil
E-mail: fernandaang@yahoo.com.br

Funding

Partially funded by Conselho Nacional de Desenvolvimento Cientifico e Tecnológico.

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