

# Effects of mandibular protraction appliance associated to fixed appliance in adults

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**Objective:** This retrospective study aimed to conduct a cephalometric evaluation of the skeletal, dental and soft tissue effects resulting from treatment of adult patients presenting Class II malocclusion, performed with a Mandibular Protraction Appliance (MPA) combined with a fixed orthodontic appliance.

**Methods:** The sample consisted of telerradiographs obtained before and after treatment of 9 adult patients (initial mean age of 22.48 years) with bilateral Class II, division 1, malocclusion. Paired t test ( $p < 0.05$ ) was applied to compare initial and final values.

**Results:** t test revealed an increase in anteroinferior facial height and posterior facial height. The dental changes include: extrusion of upper incisors, buccal inclination, protrusion of lower incisors, mesialization and extrusion of mandibular molars. Regarding the soft tissue component, there was an increase in nasolabial angle in addition to upper lip retrusion.

**Conclusions:** The effects of treating Class II malocclusion adult patients, by means of using Mandibular Protraction Appliance (MPA) combined with a fixed appliance were mostly observed in the mandibular arch, and consisted of buccal inclination, protrusion and intrusion of incisors, and mesialization and extrusion of the molars.

**Keywords:** Angle Class II Malocclusion. Functional orthodontic appliances. Mandibular advancement. Adult.

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**How to cite this article:** Furquim BD, Henriques JFC, Janson G, Siqueira DF, Furquim LZ. Effects of mandibular protraction appliance associated to fixed appliance in adults. *Dental Press J Orthod.* 2013 Sept-Oct;18(5):46-52.

**Submitted:** November 24, 2009 - **Revised and accepted:** December 29, 2010

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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## INTRODUCTION

Treatment of adult patients has become a reality in orthodontic practice for many years.<sup>1,2,3</sup> For cases of adult patients with mandibular deficiency, two treatment approaches are usually available. The first is compensatory, involving premolar extractions, allowing retraction of upper incisors and, as a result, overjet correction, while the second is surgical, repositioning the mandible more anteriorly.<sup>4</sup>

In addition to these two more traditional treatment options, functional fixed appliances constitute yet a third alternative to treat Class II malocclusion without extraction or surgery.<sup>4-12</sup>

The Herbst appliance was the first fixed functional appliance designed for the correction of Class II malocclusion, and also the first one described for this purpose in adult patients.<sup>8</sup> Besides the Herbst appliance, there are other fixed functional appliances effective in the correction of Class II malocclusion such as the Jasper Jumper, the MARA, the AMF and MPA.<sup>5,6,7,13</sup> The Mandibular Protraction Appliance (MPA) stands out for its easy fabrication, low cost and swift installation.<sup>14</sup>

Some studies have compared the treatment of Class II malocclusion with MPA associated to other appliances in adolescent patients.<sup>13,15</sup> Clinical cases of adult patients treated with MPA can be found in the literature.<sup>16,17,18</sup> But no research has yet been conducted to investigate treatment with MPA in a group of adult patients. Thus, this retrospective study aimed to conduct a cephalometric evaluation of the skeletal, dental and soft tissue effects resulting from treatment with MPA in combination with fixed appliance in adult patients presenting with Class II malocclusion.

## MATERIAL AND METHODS

In selecting the sample, the following inclusion criteria were applied:

1. Presence of early bilateral Class II, division 1, malocclusion.
2. Absence of agenesia and no permanent teeth missing.
3. Absence of supernumerary teeth.
4. Treatment conducted exclusively with MPA combined with a fixed orthodontic appliance.
5. Class I molar relationship with a reduced overjet at the end of treatment.

Patients were defined as adults based on the cervical vertebral maturation method for evaluation of mandibular growth proposed by Baccetti et al.<sup>21</sup> Patients in the fifth cervical vertebral maturation stage (CVMS V) and above were considered adults. Evaluation was performed using the initial telerradiograph. Patients who raised any doubt as to their classification were excluded from the sample.

The sample consisted of nine Brazilian Caucasian adults (6 females and 3 males) presenting bilateral Class II division 1 malocclusion. The patients had an initial mean age of 22.48 years (S.D. = 5.64, ranging from 15.14 to 29.69 years.) The mean follow-up period was 4.01 years, and the final mean age of the patients was 26.50 years. The patients were treated by experienced professors.

As this was a retrospective study, the telerradiographs were taken at different centers. The anatomical tracing and landmarks were scanned on a flatbed Numonics AccuGrid XNT, model A30TL.F (Austin, Texas/USA). Dentofacial Planner 7.02 software (Toronto, Ontario - Canada) was used for measuring the cephalometric variables since this computer program automatically corrects the radiographic image magnification. Midplane tracing was performed on bilateral structures, except for the molars, given that the more distally positioned molar was used as reference.

Intraexaminer error was determined by taking new measurements of 15 telerradiographs, either initial or final, after an interval of 30 days since the first measurement. Systematic errors were analyzed by dependent test as described by Houston.<sup>19</sup>

For evaluation of casual errors the Dahlberg test was utilized, which shows the average change between the first and second measurements. The test is performed by the formula  $S^2 = \Sigma d^2 / 2n$ , where  $S^2$  is the error variance,  $d$  represents the difference between the first and second measurement, and  $n$  is the number of measurement pairs.<sup>20</sup> Random error was calculated using a Microsoft Excel XP spreadsheet.

Kolmogorov-Smirnov test was used to assess if the values had a normal distribution, thus allowing the dependent t test to be performed. The latter was performed to compare the mean cephalometric values at the beginning and end of treatment.

Statistical tests were carried out using Statistica software. Results where  $p < 0.05$  were considered to be statistically significant.

## RESULTS

Only two variables (1-PTV and 1-PP) exhibited systematic error approximately one month after the first measurement, and random errors ranged from 0.28 for SML to 2.80 for 1.PP (Table 1).

MPA revealed no significant changes in the maxilla or mandible. As regards growth pattern, only the linear variables (anteroinferior facial height and posterior facial height) changed.

Incisor extrusion was the only significant change noted in the maxillary dentoalveolar component. On the other hand, the mandibular dentoalveolar component showed buccal inclination, incisor protrusion, and molar mesialization and extrusion. The treatment achieved significant correction of overjet and overbite as well as molar relationship. Regarding the soft tissue component, the nasolabial angle increased and the upper lip retracted relative to line E.

## DISCUSSION

This study evaluated the dental, skeletal and soft tissue effects of correcting Class II malocclusion in a group of adult patients using Mandibular Protraction Appliances (MPAs). The Cervical Vertebral Maturation Method for assessment of mandibular growth,<sup>21</sup> and the patient's chronological age were the criteria used to classify patients as adults. Given that no other researcher has ever evaluated the effects of MPA on adult patients, the results will be compared with those of other studies that evaluated fixed functional appliances other than MPAs for correction of Class II malocclusion in adults or young adults .

It is noteworthy that the effects observed in this study result from treatment carried out with MPAs and fixed appliances. Further studies are warranted to evaluate not only the overall effects of treatment, but also specific effects observed in the period when the MPA was in place.

### Skeletal effects

Other studies are in agreement with the results in terms of MPA effects on the maxilla. Treatment with MPA in a group with initial mean age of 15 years and five months was also unable to produce effects in the maxilla.<sup>6</sup> Nalbantgil et al<sup>7</sup> assessed the effects of Jasper Jumper in a group with an initial mean age of 16.5 years, and reported it had limited effects on the

maxilla. Moreover, no significant differences were found between the beginning and end of treatment. However, in comparison with the control group, the authors suggested that Jasper Jumper inhibited the growth potential of the maxilla.

As in the present study, Nalbantgil et al<sup>7</sup> observed no significant effects on mandibular growth in patients with an initial mean age of 16.5 years treated with Jasper Jumper. However, significant changes were observed in the maxillomandibular relationship. Gönner et al<sup>5</sup> observed greater reduction (3 degrees) in the ANB angle, and in older patients (33.7 years / SD 7.9) treated with MARA.

With regard to growth pattern, only the linear variables (anteroinferior facial height and posterior facial height) increased, which can also be construed as a result of late changes in craniofacial growth. Nalbantgil et al<sup>7</sup> also observed no changes in the growth pattern. Ruf and Pancherz<sup>12</sup> observed that the SN.GoGn angle did not change during the Herbst phase, which is consistent with studies of Herbst in children. Decreases in the SN.GoGn angle during the fixed appliance phase and throughout the observation period as well as mandibular advancement caused a reduction in the convexity of the skeletal and soft tissue profile. The opposite seems to have occurred with controls, of which convexity increased over time.

### Dental effects

In agreement with the present study, Nalbantgil et al<sup>7</sup> noted extrusion in upper incisors as a result of treatment with Jasper Jumper. They also observed retraction of the upper incisors and distal tipping of the molar crown, which was not observed in this study. This may have been due to the fact that patients in this study were older (22.41 years) than patients evaluated by Nalbantgil et al<sup>7</sup> (16.5 years.) Given that the lower lip droops with aging,<sup>22</sup> extrusion of upper incisors can be regarded as an advantage afforded by this treatment.

The lower dentoalveolar component exhibited significant changes in nearly all variables (buccal inclination, incisor protrusion and intrusion, mesialization and extrusion of molars), except for the vertical position of the incisors as these remained unchanged.

Ruf and Pancherz<sup>11</sup> showed the dental and facial adjustments they achieved in adolescents and young adults. In both groups, Class II and overjet correction

**Table 1** - Results of paired t test and Dahlberg's formula applied to variables studied to estimate random and systematic errors, respectively.

VARIABLES	1st measurement	2nd measurement	Difference between means	Dahlberg	p
	Mean ± SD	Mean ± SD			
<b>Maxillary Component</b>					
SNA (degrees)	80.19 ± 4.28	80.77 ± 4.85	0.57	1.93	0.435
A-Nperp (mm)	2.40 ± 4.12	1.53 ± 4.37	-0.87	1.84	0.207
Co-A (mm)	85.93 ± 3.61	86.45 ± 4.00	0.52	0.90	0.118
<b>Mandibular Component</b>					
SNB (degrees)	76.23 ± 4.12	76.85 ± 4.52	0.61	1.26	0.193
Pog-Nperp (mm)	0 ± 5.91	-1.28 ± 6.29	-1.28	1.96	0.072
Co-Gn (mm)	108.21 ± 5.73	108.15 ± 5.75	-0.06	0.79	0.844
Go-Gn (mm)	72.86 ± 4.96	73.58 ± 5.02	0.72	1.87	0.308
Co-Go (mm)	53.21 ± 6.51	52.09 ± 6.16	-1.12	2.22	0.175
<b>Maxillomandibular relationship</b>					
ANB (degrees)	3.97 ± 2.48	3.92 ± 2.30	-0.05	0.90	0.893
NAP (degrees)	4.44 ± 6.74	4.14 ± 6.18	-0.30	1.17	0.501
Co-A/Co-Gn (mm)	79.47 ± 2.11	79.99 ± 1.77	0.51	0.93	0.137
<b>Growth pattern</b>					
FMA (degrees)	20.09 ± 7.74	21.21 ± 7.19	1.12	2.17	0.165
SN.GoGn (degrees)	29.28 ± 9.13	28.58 ± 8.84	-0.70	1.91	0.334
SN.PP (degrees)	7.75 ± 5.62	8.14 ± 4.59	0.39	1.73	0.559
AIFH (mm)	63.39 ± 3.73	62.63 ± 3.55	-0.76	1.54	0.184
S-GO (mm)	74.97 ± 7.81	74.55 ± 7.81	-0.43	1.10	0.306
<b>Maxillary dentoalveolar component</b>					
1.PP (degrees)	101.93 ± 9.72	106.75 ± 5.74	4.82	2.80	0.150
1-PP (mm)	28.26 ± 1.90	27.49 ± 2.01	-0.77	0.98	0.024*
1.NA (graus)	15.81 ± 9.34	17.86 ± 8.94	2.05	2.21	0.085
1-NA (mm)	2.77 ± 3.26	3.17 ± 3.21	0.40	1.03	0.304
1-PTV	56.10 ± 5.01	55.28 ± 5.90	-0.82	1.17	0.050
6-PP (mm)	22.54 ± 1.27	22.47 ± 1.23	-0.07	0.47	0.682
6-PTV	27.34 ± 4.21	26.33 ± 4.32	-1.01	1.75	0.116
<b>Mandibular dentoalveolar component</b>					
IMPA (degrees)	102.81 ± 6.60	102.71 ± 5.85	-0.10	1.54	0.892
1.NB (degrees)	31.39 ± 7.06	31.59 ± 6.18	0.21	1.50	0.720
1-NB (mm)	4.95 ± 2.21	4.74 ± 2.41	-0.21	0.79	0.479
1-PM (mm)	38.09 ± 2.19	38.11 ± 2.38	0.02	1.54	0.973
1-PTV	52.62 ± 4.80	51.59 ± 5.74	-1.03	1.28	0.021*
6-PM (mm)	29.86 ± 2.49	29.84 ± 2.72	-0.02	1.17	0.964
6-PTV	28.25 ± 4.45	27.31 ± 4.75	-0.94	1.67	0.126
<b>Dental relationships</b>					
T.H. (mm)	3.48 ± 0.74	3.69 ± 0.65	0.21	0.45	0.221
T.V. (mm)	3.33 ± 0.97	3.02 ± 1.21	-0.31	0.42	0.221
Molar relationship	-0.91 ± 1.65	-0.99 ± 1.62	-0.07	0.30	0.520
<b>Soft tissue component</b>					
ANL	111.29 ± 6.65	111.41 ± 5.52	0.12	2.88	0.914
SML	6.03 ± 0.97	6.02 ± 0.84	-0.01	0.28	0.950
UL-E	-4.21 ± 1.96	-4.14 ± 1.91	0.07	1.38	0.900
LL-E	-2.09 ± 2.91	-1.81 ± 2.70	0.28	1.68	0.663
UL-Pog'Sn	2.70 ± 1.14	2.92 ± 1.23	0.22	0.83	0.486
LL-Pog'Sn	1.41 ± 2.42	1.67 ± 2.22	0.26	1.26	0.588

\*p < 0.05.

Table 2 - Comparison between initial and final mean values by paired t test.

VARIABLES	Initial (n = 9)	Final (n = 9)	Difference between means	P
	Mean ± SD	Mean ± SD		
<b>Chronological age</b>				
Age	22.48 ± 5.64	26.50 ± 6.32	4.01	0.000*
<b>Maxillary component</b>				
SNA (degrees)	79.83 ± 6.52	80.24 ± 6.87	0.41	0.255
A-Nperp (mm)	-0.54 ± 3.29	0.07 ± 4.16	0.61	0.215
Co-A (mm)	85.01 ± 8.06	85.20 ± 7.77	0.19	0.537
<b>Mandibular component</b>				
SNB (degrees)	76.70 ± 6.44	77.13 ± 5.93	0.43	0.279
Pog-Nperp (mm)	-3.28 ± 5.38	-1.92 ± 5.47	1.36	0.169
Co-Gn (mm)	109.82 ± 8.34	110.38 ± 7.74	0.56	0.219
Go-Gn (mm)	73.43 ± 4.75	73.90 ± 4.92	0.47	0.110
Co-Go (mm)	53.07 ± 7.85	53.49 ± 7.00	0.42	0.407
<b>Maxillomandibular relationship</b>				
ANB (degrees)	3.14 ± 2.57	3.12 ± 3.20	-0.02	0.959
NAP (degrees)	2.38 ± 6.94	2.33 ± 8.04	-0.04	0.957
Co-A/Co-Gn (mm)	77.41 ± 4.22	77.19 ± 4.30	-0.22	0.422
<b>Growthpattern</b>				
FMA (degrees)	23.18 ± 7.73	22.76 ± 7.75	-0.42	0.378
SN.GoGn (degrees)	30.41 ± 11.13	30.06 ± 10.53	-0.36	0.439
SN.PP (degrees)	7.64 ± 5.44	7.02 ± 5.36	-0.62	0.271
AIFH (mm)	63.18 ± 6.17	64.86 ± 5.36	1.68	0.010*
S-GO (mm)	74.14 ± 10.19	75.58 ± 9.50	1.43	0.011*
<b>Maxillary dentoalveolar component</b>				
1.PP (degrees)	114.51 ± 9.65	111.23 ± 5.94	-3.28	0.192
1-PP (mm)	26.71 ± 3.13	28.22 ± 3.00	1.51	0.027*
1.NA (degrees)	27.06 ± 12.10	23.94 ± 8.98	-3.11	0.220
1-NA (mm)	6.41 ± 4.24	4.79 ± 3.71	-1.62	0.064
1-PTV	57.21 ± 4.25	56.54 ± 5.30	-0.67	0.441
6-PP (mm)	22.69 ± 2.48	23.03 ± 2.37	0.34	0.339
6-PTV	27.07 ± 3.34	27.36 ± 4.19	0.29	0.809
<b>Mandibular dentoalveolar component</b>				
IMPA (degrees)	99.62 ± 4.77	105.37 ± 4.53	5.74	0.000*
1.NB (degrees)	29.14 ± 4.94	35.13 ± 4.48	5.99	0.000*
1-NB (mm)	4.93 ± 2.41	5.78 ± 2.02	0.84	0.023*
1-PM (mm)	39.10 ± 3.31	38.16 ± 2.92	-0.94	0.124
1-PTV	51.59 ± 5.36	53.32 ± 4.96	1.73	0.053*
6-PM (mm)	28.59 ± 3.56	30.87 ± 2.84	2.28	0.001*
6-PTV	26.63 ± 4.35	29.72 ± 4.13	-3.09	0.027*
<b>Dental relationships</b>				
T.H. (mm)	5.62 ± 2.76	3.22 ± 0.57	-2.40	0.035*
T.V. (mm)	3.08 ± 1.75	1.48 ± 1.24	-1.60	0.008*
Molar relationship	0.43 ± 2.06	-2.06 ± 0.30	-2.49	0.007*
<b>Soft tissue component</b>				
ANL	108.19 ± 11.05	109.32 ± 12.46	1.13	0.007*
SML	6.34 ± 1.22	6.12 ± 1.34	-0.22	0.548
UL-E	-3.36 ± 2.38	-4.36 ± 1.94	-1.00	0.006*
LL-E	-2.08 ± 2.84	-2.13 ± 2.42	-0.06	0.888
UL-Pog'Sn	3.27 ± 1.91	2.94 ± 1.77	-0.32	0.365
LL-Pog'Sn	1.37 ± 2.53	1.68 ± 2.04	0.31	0.539

\*p &lt; 0.05.

was promoted mostly by dental changes and to a lesser extent by skeletal changes.<sup>10</sup> Adolescent patients showed greater mandibular growth, whereas young adult patients exhibited greater molar mesialization and consequently greater protrusion of the lower incisors. Gönner et al<sup>5</sup> observed an increase of more than 5° in the IMPA of adult patients (33.7 years) treated with MARA combined with fixed appliances. Conversely, Nalbantgil et al<sup>7</sup> observed — in addition to lower incisor protrusion — intrusion of these same teeth, as was the case in the present study.

Buccal inclination of lower incisors and its impact on periodontal status is controversial. Some studies have seen protrusion as a risk factor for gingival recession since an association between recession and buccal movement has been observed.<sup>22-25</sup> Others did not note such association.<sup>26,27,28</sup> To Melsen and Al-lais,<sup>29</sup> other predisposing factors for gingival recession should be taken into account such as gingival biotype, visible plaque and inflammation.

A positive relationship between the patient's age and the severity of bone loss has been identified.<sup>30,31</sup> According to Ko-Kimura et al,<sup>32</sup> the prevalence of black spaces in post-orthodontic treatment is greater in patients over twenty years old, and these spaces are linked to resorption of the alveolar crest. The average prevalence of black spaces found in the adult orthodontic population post-treatment, regardless of the initial crowding, was 38%,<sup>33</sup> and 43% in adolescents after correction of incisor crowding, according to Burke.<sup>34</sup> Tanaka et al<sup>35</sup> demonstrated that due to crowding the interdental papilla can be crushed and it is only after the dental malocclusions have been corrected that black space may become evident. Tuverson<sup>36</sup> reported that since triangular teeth have no contact areas, but rather contact points, these teeth are more unstable

and more susceptible to crowding. According to Olsson and Lindhe,<sup>37</sup> patients with triangular maxillary central incisors (slender and tall) tend to develop more gingival recession than those patients with wider and shorter maxillary central incisors, since there seems to be a relationship between “gingival biotype” and shape of the upper central incisor.

How maxillary incisors are positioned determines to a great extent the motivation that drives adult patients to seek orthodontic treatment. Few of these patients even notice skeletal abnormalities.<sup>38</sup> Therefore, preventive care should be provided for as long as there is orthodontic movement, mainly protrusive movement, in patients with thin gum / triangular incisor “biotype.” Special attention should be paid when these features are associated with some degree of crowding and/or visible plaque and inflammation.

#### Soft tissue effects

Retrusion of the upper lip in terms of variable LL-E and an increased nasolabial angle were observed. These changes may have been influenced by nose growth, since the upper lip remained unchanged in terms of variable UL-Pog'Sn, consistent with the unchanged position of upper incisors in the sagittal direction. Despite the fact that protrusion and labial inclination of the lower incisors did occur, the lower lip did not protrude.

#### CONCLUSIONS

The effects of treating Class II malocclusion in adults using a Mandibular Protraction Appliance combined with fixed orthodontic appliance were mostly observed in the mandibular arch, and consisted of buccal inclination, incisor protrusion, and mesialization and extrusion of the molars. Incisor extrusion was the only significant change observed in the maxillary arch.

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