

# INFLUENCE OF ORTHOPEDIC TREATMENT ON HARD AND SOFT FACIAL STRUCTURES OF INDIVIDUALS PRESENTING WITH CLASS II, DIVISION 1 MALOCCLUSION. A COMPARATIVE STUDY

*A INFLUÊNCIA DO TRATAMENTO ORTOPÉDICO NAS ESTRUTURAS FACIAIS DE INDIVÍDUOS COM MÁ OCLUSÃO DE CLASSE II, 1ª DIVISÃO. UM ESTUDO COMPARATIVO*

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## ABSTRACT

The purpose of this investigation was to comparatively evaluate the cephalometric changes in soft and hard tissues related to treatment of Class II, division 1 malocclusion with activator-headgear and Bionator appliances. Twenty-four individuals formed the activator-headgear group and twenty-five comprised the Bionator group, while other twenty-four presenting the same malocclusion did not receive any intervention and served as controls. Lateral headfilms were taken at the beginning and at the end of the observation period and were digitized with computerized cephalometrics; cephalometric analysis was performed and the results were submitted to statistical test. According to the methodology employed, our findings suggested that both appliances do not significantly alter the growth path, and also they were not able to modify the posterior inferior height and the sagittal and vertical position of the upper lip. The lower lip and the soft menton were only slightly modified by the orthopedic appliances, but the mentolabial sulcus showed a significant decrease in deepness compared to the control group. Of statistical significance, only the anterior inferior hard and soft facial heights and the lower lip height increased more in the treated groups. **UNITERMS:** Malocclusion; Orthopedics; Removable appliances.

## RESUMO

Esta pesquisa teve por objetivo avaliar, comparativamente, as alterações cefalométricas tegumentares e esqueléticas, decorrentes do tratamento das má oclusões de classe II, 1ª divisão, com o ativador combinado com a ancoragem extrabucal e com o bionator. O grupo tratado com o ativador combinado com a ancoragem extrabucal foi composto por 24 indivíduos e o grupo tratado com o bionator compreendeu 25 pacientes, enquanto que outros 24 indivíduos compuseram o grupo controle, apresentando a mesma má oclusão, porém sem terem sido submetidos a nenhuma terapia ortodôntica. Obteve-se telerradiografias laterais de todos os indivíduos no início e final do período de observação que foram digitalizadas e seus traçados cefalométricos computadorizados realizados e submetidos ao teste estatístico. De acordo com a metodologia empregada, os resultados sugerem que ambos os aparelhos não foram capazes de alterar, significativamente, o padrão de crescimento facial assim como a altura facial posterior inferior e o posicionamento sagital e vertical do lábio superior. Os aparelhos ortopédicos alteraram ligeiramente o lábio inferior e o mento tegumentar, porém o sulco mentolabial foi significativamente reduzido nos grupos tratados em comparação com o grupo controle. As alturas faciais esquelética e tegumentar, bem como a altura do lábio inferior foram significativamente aumentadas com a terapia ortopédica, alcançando diferença estatística em relação ao grupo controle. **UNITERMOS:** Má oclusão; Ortopedia; Aparelhos Removíveis.

## INTRODUCTION

It has been reported that the great majority of orthodontic patients present Class II malocclusions, varying on osseous, dental and facial aspects, resulting in a great variety of combined deformities. Thus, in order to treat these malocclusions, several appliances and methods of treatment have been developed.

Class II interceptive appliances can be generally divided into two groups: mechanical appliances, represented by headgear anchorage; and functional appliances, found in a greater variety of models, aiming at protruding the mandible and enhancing mandibular growth. As most Class II patients show retruded mandible<sup>9,12</sup>, protrusion is often desirable.

Two of the most common devices are Bionator, introduced by Balters<sup>5,6,7</sup> in the 1960s, and the activator, introduced by Andresen<sup>3</sup>, in 1908. Hasund apud Graber, Neumann<sup>11</sup>, in 1969, was the first professional to incorporate headgear forces into functional appliances, more commonly used when the malocclusion involves maxillary protrusion and long face patterns.

Most studies reported that functional therapy is effective in anterior mandibular displacement, restriction of maxillary growth, enhancement of anterior and posterior inferior facial height, lingual tipping of the maxillary incisors and buccal tipping of the mandibular incisors. Unfortunately, only few studies reported about soft tissue changes and available data are controversial.

In 1993, Henriques, Freitas, Scavone Júnior<sup>15</sup> studied some soft tissue parameters and found that the upper lip followed the improvement in maxillary incisors inclination, leading to enhancement of the nasolabial and H.NB angle and reduction of nasal in relation to the H line. Henriques<sup>14</sup> compared the use of extraoral anchorage in three ways: cervical traction, associated with a removable appliance and in combination with the activator. Similar effects were found on the nasolabial angle.

Many authors have already mentioned that Bionator appliance therapy could improve balancing on facial height. However, this improvement had not been quantified yet. Then, in 1995, Lange, et al.<sup>20</sup> decided to study the changes caused by Bionator appliance therapy on the soft tissue compared to a control group. Results have demonstrated an increase in anterior inferior facial height and posterior facial height of treated individuals, as shown by the ENA-ME and Ar-Go measurements; improvement in facial convexity (G'.Sn.Pog'), due to mandibular advancement; and retraction of the upper lip and nasolabial angle opening, but with no statistical significance. However, most changes were seen on the lower lip - the mentolabial angle became more obtuse in response to labial elongation, resulting in a higher and thinner lip.

Due to the lack of studies reporting on facial analysis of treated and untreated cases, Morris, Illing, Lee<sup>21</sup> investigated the influence of treatment on profile and soft tissue morphology of patients, comparing Bionator appliance, Bass appliance and twin-block appliance treatment therapy. Despite of chin advancement, cephalometric results caused by Bionator appliance therapy showed significant reduction of

facial convexity when compared to the control group. Major increase was seen on the soft tissue facial height. The nasolabial and mentolabial sulcus measurements, as well as the anterior posterior position and thickness and height of upper and lower lip did not differ in both Bionator group and checking group. Authors reported few changes, probably due to their small dimension and great variability. Thus, these results cannot be considered to recommend the use of a proper device for a given treatment.

In 2002, Almeida, et al.<sup>2</sup>, on a discussion about the effects of Bionator appliance therapy on the soft tissue profile, reported that protrusion of the upper lip is decreased and that of the lower lip is increased. The nasolabial angle did not show any significant change.

Thus, the controversy presented by these articles has led to the accomplishment of this study, which aims at investigating the influence of functional orthopedics on the soft tissue profile, as well as the changes caused by the combination of activator-headgear appliance and Bionator appliance therapy in treatment, regardless of dental and skeletal effects.

## SUBJECTS AND METHODS

### Subjects

The sample was collected retrospectively, comprising 146 lateral cephalograms of 73 mesofacial patients treated at the orthodontic clinic of Bauru Dental School, University of Sao Paulo, Brazil, divided into three groups:

- Group A, 24 patients treated with the activator-headgear combination (14 males and 10 females) and initial age of 11y 3m and final 12y 7m;

- Group B, 25 patients treated with Bionator (13 males and 12 females) and initial age of 10y 11m and final 12y 5m;

- Group C, 24 patients (14 males and 10 females) that did not receive treatment.

First, all patients that had received treatment by the two types of appliances and those who did not receive treatment were included. Then, the initial cephalometric values were compared and only those who displayed similar cephalometric analyses were included in the sample.

### Appliances

The headgear used high pull traction and the patients of both appliances were instructed to use them during the whole day and at night. The acrylic over the mandibular teeth was trimmed once a month to allow eruption of the molars and premolars. The construction bite was made in an edge to edge position.

### Cephalometric Tracing

The cephalometric tracings were done in an appropriate cephalometric software using windows 98<sup>9</sup> and the analysis was specially constructed for this study.

## Data management

A “t” test and Dahlberg’s formula were used to analyze systematic and random methodological errors, respectively. Also, the “t” test was used for comparison between the manual and computer cephalometric tracings to confirm the reliability of the methodology, and the analyses of variance for evaluation of the compatibility of the initial values of the groups.

errors smaller than 1.5° or 1 mm are not clinically important. Analyses of the reliability of the cephalometric tracing method used demonstrated that the difference was significant only for three variables, showing good reproducibility, and the analyses of variance could not find statistical differences between the initial values of the three groups, except for one variable. This would confirm that they are very similar and any discrepancy found during the observation period could be attributed to the effect of the appliances.

## RESULTS

### Group Comparisons (Table 3)

### Methodology reliability

The analyses showed no statistically significant errors in the methodology. Like Houston<sup>16</sup> and Sandler<sup>25</sup> stated,

**TABLE 1-** Mean and median initial and final ages, sex and observation period for Groups A, B and C

Group	SEX		INITIAL AGE	FINAL AGE	PERIOD
	Male	Fem.	Mean	Mean	Mean
A	14	10	11y 03m	12y 07m	16.04m
B	13	12	10y 11m	12y 05m	17.52m
C	14	10	10y 00m	11y 09m	15.58m

**TABLE 2-** Cephalometric measurements prescription

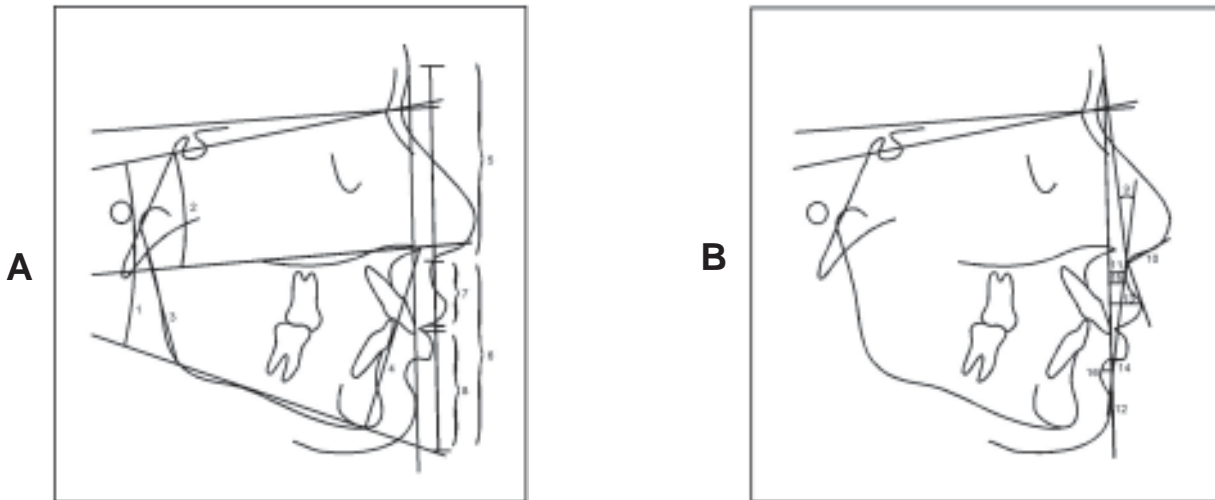
VARIABLES	DESCRIPTION
<b>VERTICAL MEASUREMENTS</b>	
1. SN.GoMe	Mandibular plane angle to anterior cranial base
2. SN.PP	Palatal plane angle to anterior cranial base
3. Ar-Go	Posterior inferior facial height
4. ENA-Me	Anterior inferior facial height
5. G'-Sn	Anterior superior facial height in the soft tissue profile
6. Sn-Me'	Anterior inferior facial height in the soft tissue profile
7. Sn-Stms	Upper lip height
8. Stmi-Me'	Lower lip height
<b>HORIZONTAL MEASUREMENTS</b>	
9. Gn.Sn.Pog'	Facial convexity angle
10. ANL	Upper lip angle to nasal base
11. A'-Gv	Maxillary protrusion in the soft tissue profile to the vertical line Gv
12. Pog'-Gv	Mandibular protrusion in the soft tissue profile to the vertical line Gv
13. Ls-Gv	Upper lip protrusion to the vertical line Gv
14. Li-Gv	Lower lip protrusion to the vertical line Gv
15. Sls-Gv	Upper lip sulcus deepness to the vertical line Gv
16. Sli-Gv	Lower lip sulcus deepness to the vertical line Gv

**DISCUSSION**

Sexual dimorphism was present on three parameters, corresponding to inclination of the palatal plane and skeletal and tegument anterior inferior facial heights. This has been already demonstrated by other authors in previous studies<sup>11, 21</sup> and illustrates the more vertical facial growth tendency of

females.

The growth pattern had small changes and there were no relevant differences between the treated and untreated patients, regardless of the appliance used, showing little influence in the mandibular<sup>1,7,9,17,18,19,21,23,26</sup> and palatal plane inclination<sup>9,12,17,19,23</sup> (figure 2A).



**FIGURE 1-** Cephalometric tracings. A- Vertical measurements. B- Horizontal measurements

**TABLE 3-** Mean changes, standard deviation and variance analyses for comparison of groups A, B and C, taking into account the sexual dimorphism

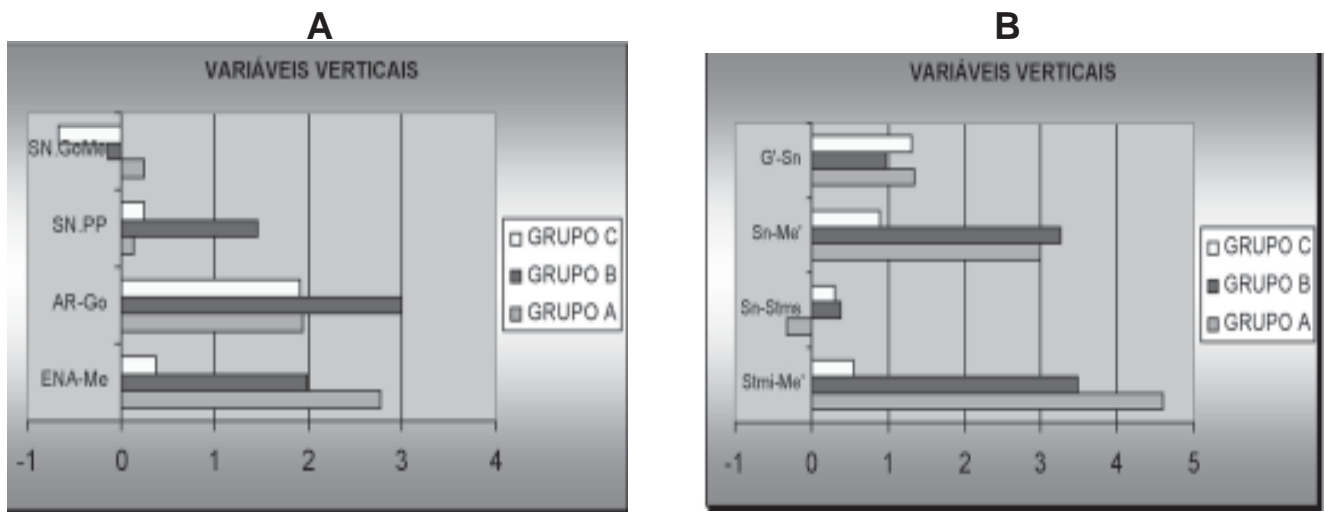
Variables	GRUPOS						ANOVA ("P")		
	Activator + AEB		Bionator		Control		Group	Sex	Interaction
	Mean	S.D.	Mean	S.D.	Mean	S.D.			
SN.GoMe	0.24°	2.59°	-0.13°	2.37°	-0.66°	1.75°	0.339	0.842	0.573
SNPP	0.14°	3.02°	1.46°	2.85°	0.24°	2.01°	0.167	0.020*	0.376
Ar-Go	1.73mm	2.79°	2.88°	2.79°	1.84°	2.55°	0.295	0.869	0.711
ENA-Me	2.89mm	1.91mm	2.00mm	2.25mm	0.32mm	1.51mm	0.000**	0.012*	0.518
G'-Sn	1.35mm	3.15 mm	0.96mm	4.26mm	1.31mm	3.19mm	0.849	0.421	0.213
Sn-Me'	3.10mm	2.60 mm	3.26mm	2.08mm	0.96mm	2.22mm	0.001**	0.017*	0.589
Sn-Stms	-0.32mm	1.69 mm	0.38mm	1.52mm	0.31mm	1.37mm	0.162	0.837	0.373
Me'-Stmi	4.61mm	3.08 mm	3.48mm	2.29mm	0.56mm	2.39mm	0.000**	0.330	0.745
G'.Sn.Pog'	-1.42°	3.14°	-1.66°	3.34°	-0.39°	1.99°	0.244	0.975	0.719
ANL	4.76°	15.75°	-5.42°	12.73°	-3.85°	30.54°	0.227	0.240	0.973
A'-Gv	0.27 mm	2.35 mm	0.54mm	3.01mm	-0.14mm	1.25mm	0.592	0.330	0.388
Pog'-Gv	2.07 mm	4.60 mm	3.29mm	6.69mm	0.27mm	2.50mm	0.098	0.554	0.124
Ls-Gv	-0.34 mm	3.20 mm	0.52mm	3.66mm	0.01mm	1.63mm	0.509	0.656	0.407
Li-Gv	1.71 mm	3.88 mm	2.46mm	3.78mm	0.25mm	2.06mm	0.079	0.766	0.138
Sls-Gv	-0.21 mm	2.63 mm	0.37mm	3.11mm	-0.23mm	1.36mm	0.582	0.358	0.598
Sli-Gv	2.11 mm	4.42 mm	3.04mm	4.01mm	-0.02mm	2.26mm	0.017*	0.508	0.058

During the observation period, no difference could be found on the increment in posterior inferior facial height between groups (figure 2A), though many investigations that analyzed activator-headgear combination<sup>1,7,12,13,17</sup> and Bionator<sup>9,18,22</sup> revealed more increase with treatment secondary to mandibular advancement. However, as to the anterior inferior facial height, the discrepancy was evident (figure 2A), showing statistically significantly more improvement in response to treatment with the appliances, as occurred in other studies<sup>1,12,13,18,21,22,25</sup>. This behavior was followed by the corresponding tegument facial height (figure 2B), thus with larger values, probably because of the major nasal base stability in comparison with the anterior nasal spine.

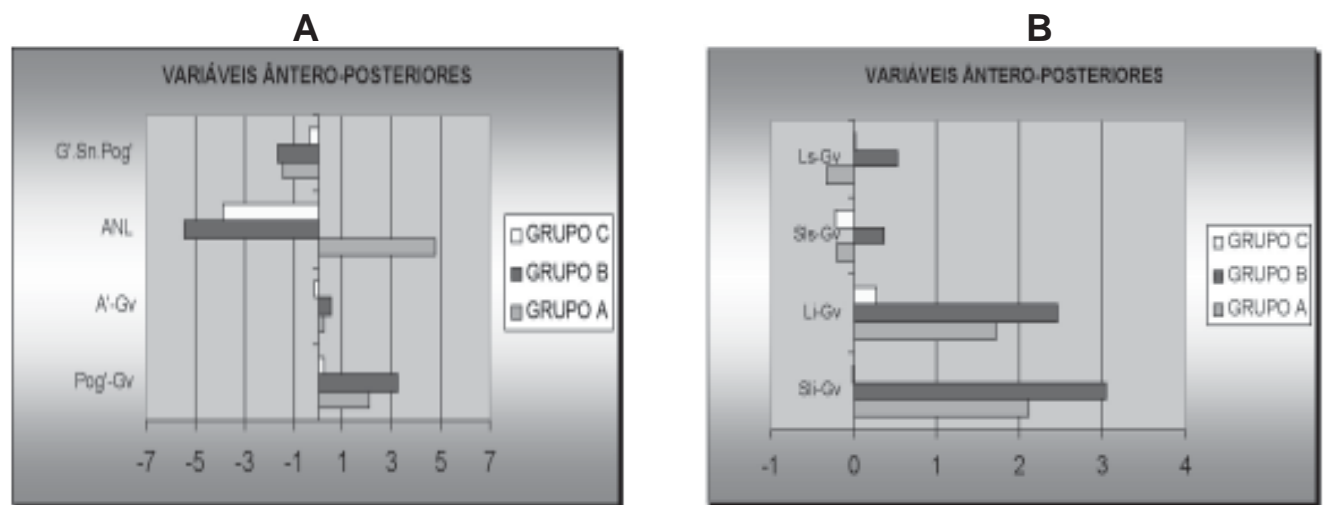
As expected, the anterior superior facial height showed similar changes in all groups, as there is no influence from treatment in this region (figure 2B). However, the knowledge

of how much it increases with growth provides important information about facial height proportions. The magnitude of the changes obtained supports the results of Wisth<sup>26</sup>, who verified approximately 1mm/year of nasal height growth.

Concerning the lip behavior, the main alterations in lower facial height were found to be originated from the lower lip, furthermore showing statistical difference between the control and experimental groups (figure 2B). This was also found in a study conducted by Lange et al.<sup>20</sup>. This result may be assigned to elongation of the lower lip, since it should be considered that the lower lip is frequently positioned behind the maxillary anterior teeth in Class II cases, and this led to lip deflection and deep mentolabial sulcus. As the orthopedic treatment induces lingual tipping of the maxillary incisors and proclination of the mandibular incisors, and then a reduction in overjet<sup>1,7,9,10,12,13,17,19,21,23,25</sup>, the physical obstruction of the incisors will be eliminated,



**FIGURE 2-** Vertical variables. Mean group changes. A - Pattern of growth and skeletal facial heights (posterior inferior and anterior inferior). B - Soft tissue facial heights (anterior superior, anterior inferior, lower and upper lips). Group A (■), B (■) e C (□)



**FIGURE 3-** Antero-posterior variables. Mean groups changes. A - Soft tissue convexity, nasolabial angle, maxillary and mandibular protrusion. B - Upper and lower lips protrusion and upper and lower lips deepness. Group A (■), B (■) e C (□)

allowing normal position of the lip. There were similar changes on upper lip height between groups, reflecting the results of Lange et al.<sup>20</sup> and Morris, Illing, Lee<sup>21</sup>. These authors mentioned the weak capacity of appliances to influence this structure (figure 2B).

The soft tissue convexity showed small decrease in all groups, yet which was more pronounced in groups A and B, though not significantly (figure 3A). Nasolabial angle did not differ between groups, but the direction of change was evidently distinct (figure 3A). While the combined activator-headgear appliance showed an increase in nasolabial angle, the other two caused a decrease, probably because of the major influence that this appliance has on maxillary growth<sup>1,10,21</sup>. The great individual variability and standard deviation could have made the statistical test unable to find behavior discrepancies in this variable<sup>24</sup>.

Labial protrusion at the level of point A', as of point labrale superius, did not demonstrate clear modifications in any group, and they were statistically similar (figures 3A and B, table III). This was also observed for the upper lip sulcus, as demonstrated by other investigators (Genecov, Sinclair, Dechow<sup>10</sup>). These data support the observations of Lange, et al.<sup>20</sup> and Morris, Illing, Lee<sup>21</sup>. On the other hand, lower lip behavior was more influenced by the appliances. Sulcus depth decreased significantly more in experimental groups than in the control, following its increase in height, and also showed more lip protrusion, though the values did not achieve statistical significance (figure 3B). This result was already mentioned on a previous study<sup>1</sup> and also occurred on the soft menton (figure 3A).

The different behavior tendency of the experimental groups in relation to the control should be considered. In this context, more subjects should be included in further studies, what would induce reduction in individual variability and, with a longer period of observation, could probably provide more capacity for the statistical test to find group discrepancies.

## SUMMARY AND CONCLUSIONS

The purpose of this study was to evaluate the influence of Class II, division 1 treatment either with activator combined with extra-oral anchorage or Bionator on the soft tissue profile, growth pattern and facial heights. Twenty-four subjects were maintained as controls. Based on the methodology employed, the following was concluded:

- 1- The growth pattern was not significantly altered with treatment.
- 2- Posterior inferior facial height increased similarly in all groups, but the anterior showed significantly more increment in the two treated groups in relation to the control.
- 3- There was no difference in the soft tissue profile between groups as to the anterior superior facial height changes. On the other hand, the inferior followed its skeletal corresponding structure, meaning that it increased much more with treatment than without it, and was even more pronounced.

4- There was no or little influence of treatment on the upper lip and nose.

5- The lower lip demonstrated to be more influenced by treatment, though the only variable that expresses sulcus depth showed statistically significant changes between treated and untreated groups. The observation period was too small to detect differences on anterior soft menton advancement between all groups.

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