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

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 depth 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.
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, protrusion is often desirable.

Two of the most common devices are Bionator, introduced by Balters in the 1960s, and the activator, introduced by Andresen, in 1908. Hasund apud Graber, Neumann, 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 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 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. decided to study the changes caused by 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 1m 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 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.

RESULTS

Methodology reliability

The analyses showed no statistically significant errors in the methodology. Like Houston¹⁶ and Sandler²⁵ stated, errors smaller than 1.5° or 1mm 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.

Group Comparisons (Table 3)

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

<table>
<thead>
<tr>
<th>Group</th>
<th>SEX</th>
<th>INITIAL AGE</th>
<th>FINAL AGE</th>
<th>PERIOD</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>Mean</td>
<td>Mean</td>
</tr>
<tr>
<td>A</td>
<td>Male</td>
<td>14</td>
<td>11y 03m</td>
<td>12y 07m</td>
</tr>
<tr>
<td>B</td>
<td>Fem.</td>
<td>10</td>
<td>10y 11m</td>
<td>12y 05m</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>14</td>
<td>10y 00m</td>
<td>11y 09m</td>
</tr>
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</table>

TABLE 2- Cephalometric measurements prescription

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>VERTICAL MEASUREMENTS</td>
<td></td>
</tr>
<tr>
<td>1. SN.GoMe</td>
<td>Mandibular plane angle to anterior cranial base</td>
</tr>
<tr>
<td>2. SN.PP</td>
<td>Palatal plane angle to anterior cranial base</td>
</tr>
<tr>
<td>3. Ar-Go</td>
<td>Posterior inferior facial height</td>
</tr>
<tr>
<td>4. ENA-Me</td>
<td>Anterior inferior facial height</td>
</tr>
<tr>
<td>5. G'-Sn</td>
<td>Anterior superior facial height in the soft tissue profile</td>
</tr>
<tr>
<td>6. Sn-Me'</td>
<td>Anterior inferior facial height in the soft tissue profile</td>
</tr>
<tr>
<td>7. Sn-Stms</td>
<td>Upper lip height</td>
</tr>
<tr>
<td>8. Stmi-Me’</td>
<td>Lower lip height</td>
</tr>
<tr>
<td>HORIZONTAL MEASUREMENTS</td>
<td></td>
</tr>
<tr>
<td>10. ANL</td>
<td>Upper lip angle to nasal base</td>
</tr>
<tr>
<td>11. A’-Gv</td>
<td>Maxillary protrusion in the soft tissue profile to the vertical line Gv</td>
</tr>
<tr>
<td>12. Pog’-Gv</td>
<td>Mandibular protrusion in the soft tissue profile to the vertical line Gv</td>
</tr>
<tr>
<td>13. Ls-Gv</td>
<td>Upper lip protrusion to the vertical line Gv</td>
</tr>
<tr>
<td>14. Li-Gv</td>
<td>Lower lip protrusion to the vertical line Gv</td>
</tr>
<tr>
<td>15. Sls-Gv</td>
<td>Upper lip sulcus deepness to the vertical line Gv</td>
</tr>
<tr>
<td>16. Sli-Gv</td>
<td>Lower lip sulcus deepness to the vertical line Gv</td>
</tr>
</tbody>
</table>
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\(^1\),\(^2\) 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\(^1\),\(^7\),\(^8\),\(^9\),\(^17\),\(^18\),\(^19\),\(^21\),\(^23\),\(^26\) and palatal plane inclination\(^9\),\(^12\),\(^17\),\(^19\),\(^21\) (figure 2A).

**TABLE 3**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Activator + AEB</th>
<th>Bionator</th>
<th>Control</th>
<th>ANOVA (&quot;P&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>SN.GoMe</td>
<td>0.24°</td>
<td>2.59°</td>
<td>-0.13°</td>
<td>2.37°</td>
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<tr>
<td>SN.Pp</td>
<td>0.14°</td>
<td>3.02°</td>
<td>1.46°</td>
<td>2.85°</td>
</tr>
<tr>
<td>Ar.Go</td>
<td>1.73mm</td>
<td>2.79°</td>
<td>2.88°</td>
<td>2.79°</td>
</tr>
<tr>
<td>ENA-Me</td>
<td>2.89mm</td>
<td>1.91mm</td>
<td>2.00mm</td>
<td>2.25mm</td>
</tr>
<tr>
<td>G’Sn</td>
<td>1.35mm</td>
<td>3.15mm</td>
<td>0.96mm</td>
<td>4.26mm</td>
</tr>
<tr>
<td>Sn-Me’</td>
<td>3.10mm</td>
<td>2.60mm</td>
<td>3.26mm</td>
<td>2.08mm</td>
</tr>
<tr>
<td>Sn-Stms</td>
<td>-0.32mm</td>
<td>1.69mm</td>
<td>0.38mm</td>
<td>1.52mm</td>
</tr>
<tr>
<td>Me’-Stmi</td>
<td>4.61mm</td>
<td>3.08mm</td>
<td>3.48mm</td>
<td>2.29mm</td>
</tr>
<tr>
<td>G’Sn.Pog’</td>
<td>-1.42°</td>
<td>3.14°</td>
<td>-1.66°</td>
<td>3.34°</td>
</tr>
<tr>
<td>ANL</td>
<td>4.76°</td>
<td>15.75°</td>
<td>-5.42°</td>
<td>12.73°</td>
</tr>
<tr>
<td>A’-Gv</td>
<td>0.27mm</td>
<td>2.35mm</td>
<td>0.54mm</td>
<td>3.01mm</td>
</tr>
<tr>
<td>Pog’-Gv</td>
<td>2.07mm</td>
<td>4.60mm</td>
<td>3.29mm</td>
<td>6.69mm</td>
</tr>
<tr>
<td>Ls-Gv</td>
<td>-0.34mm</td>
<td>3.20mm</td>
<td>0.52mm</td>
<td>3.66mm</td>
</tr>
<tr>
<td>Li-Gv</td>
<td>1.71mm</td>
<td>3.88mm</td>
<td>2.46mm</td>
<td>3.78mm</td>
</tr>
<tr>
<td>Sls-Gv</td>
<td>-0.21mm</td>
<td>2.63mm</td>
<td>0.37mm</td>
<td>3.11mm</td>
</tr>
<tr>
<td>Sli-Gv</td>
<td>2.11mm</td>
<td>4.42mm</td>
<td>3.04mm</td>
<td>4.01mm</td>
</tr>
</tbody>
</table>

**FIGURE 1** - Cephalometric tracings. A- Vertical measurements. B- Horizontal measurements
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\textsuperscript{1,7,12,13,17} and Bionator\textsuperscript{9,18,22} 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\textsuperscript{1,12,13,18,21,22,25}. 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\textsuperscript{26}, who verified approximately 1mm/year of nasal height growth.

Concerning the lip behavior, the main alternations 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.\textsuperscript{20}. 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 \textsuperscript{1,7,9,10,12,13,17,19,21,23,25}, the physical obstruction of the incisors will be eliminated,
allowing normal position of the lip. There were similar
changes on upper lip height between groups, reflecting the
results of Lange et al.\(^\text{20}\) and Morris, Illing, Lee\(^\text{21}\). 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
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\(^\text{1,10,21}\). The great individual variability and standard
deviation could have made the statistical test unable to find
behavior discrepancies in this variable\(^\text{24}\).

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\(^\text{10}\)). These data support the observations
of Lange, et al.\(^\text{20}\) and Morris, Illing, Lee\(^\text{21}\). 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 (figures 3B). This result
was already mentioned on a previous study\(^\text{1}\) 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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