Introduction

To obtain ideal goal in orthodontic treatment depends on several factors. Among others, one of the most important to be considered is the posterior tooth anchorage, principally in first premolar extraction cases. From approximately 1930 onwards, there has been concern among authors about posterior tooth anchorage control. To help avoid loss of anchorage during orthodontic treatment, Tweed suggested tip-back bends on posterior teeth.

Anchorage control can be divided into three types: namely, intraoral, extraoral or combination of both.

The most commonly used anchorage aids used currently are extraoral appliances, lip bumpers, lingual arches, transpalatal bars arches and Nance’s buttons. Each of these, when indicated, can be included within the context of dental anchorage, as each is fixed directly to the teeth. The efficiency of these anchorage aids depends on the treatment plan, because tooth movement in each phase of the treatment has a direct effect on the amount of the anchorage loss. Likewise, the prescription details of the preadjusted appliance used are also relevant. We can also clinically verify that the types of wires and their physical characteristics play an important role in posterior tooth anchorage control. In the 70’s, Andrews introduced the technique of the preadjusted appliances and simultaneously there occurred technological advances not only in terms of quality but also in the features of wires and accessories.

Vigorito (1996) studied tooth movement and anchorage problems during the leveling phase and states that posterior teeth undergo the consequences of the different forces and consequently move either mesially or in a buccal mesial direction. In these cases the author used an extraoral appliance in the upper arch and a lip bumper in the lower one.

McLaughlin & Bennett (1989) observed that after the transition from the edgewise to straightwire technique, there was an increase tendency for teeth to incline buccally, concluding that for this and for others reasons, a higher demand on anchorage control was necessary.

McLaughlin et al. (1997) presented a review on MBT™ System orthodontic planning. This technique uses a series of intra- and extraoral devices: palatal bars, lingual arches, Class II and III elastics, Nance’s buttons and utility arches. The alignment and leveling phase includes:

- Use of thermo-activated NiTi arch wires,
- Use lace-back ligature to control canine retraction,
- Use of cinch back bends to control anterior movement of the incisors,
- Use of open coil to obtain space,
- Set and maintain arch form from the beginning of treatment.

Moresca & Vigorito (2002) studied the effect of two different anchorage devices, namely, headgear and Nance’s button on upper teeth of Class II patients treated with the MBT System technique in which leveling was obtained by thermo-activated arches. The results showed that there was anchorage loss in the cases that used Nance’s buttons and stability in those that used the headgear.

Vigorito & Moresca (2002) studied the effect of the use of the thermo-activated wires on lower molars and incisors during the leveling phase in which a lingual arch was the anchorage device.

Aim of the Study

To evaluate the possible variation of the position of lower first molars and incisors during the alignment and leveling phase in extraction and non-extraction Class II/1 adolescents, treated with an MBT System preadjusted appliance where a lingual arch was used as the anchorage control device.
Material and Methods

The sample was composed of 30 Brazilian adolescents of both sexes with permanent dentition with Class II/1 malocclusion. The patients were divided into three groups as follows: Group I: 17 patients with a mean age of 15y., 5m. (ranging from 13y. 7m. to 17y. 1m.). Group II: 8 patients with a mean age of 14y., 4m. (ranging from 13y. to 15y. 9m.). Group III: 5 patients with a mean age of 14y., 2m. (ranging from 12y. 10m. to 15y. 9m.).

Groups I and II had the first bicuspids extracted during treatment, while Group III was treated without extractions.

Lateral cephalograms and plaster models were obtained from each patient before and after leveling phase. The initial radiograph was obtained after installing the anchorage system but before the extraction of the bicuspids and beginning the leveling phase. The average time between the radiographs was 12 months.

Orthodontic treatment took place in the Department of Orthodontics and Pediatric Dentistry of the University of São Paulo, by students of the Master of Science Course, under the supervision of the Authors.

The first clinical step was the installation of the fixed lingual arch as an anchorage device. Afterwards, all the brackets were bonded directly according to the position table recommended by McLaughlin & Bennett (1995). After taking the radiographs and extracting the bicuspids, the leveling phase was started on Groups I and II. On all patients, bilaterally, lace-backs of 0.25mm ligature wire was used from the hook of the molar tube to the cuspid bracket. In patients with negative model discrepancy in the anterior region, the ligatures were activated in order to obtain an initial verticalization of the cuspids. When there was no model discrepancy, the lace-backs were not activated and they were changed every three weeks.

The leveling phase was undertaken in Group I using three arches as follows:
1. 0.016” NiTi thermo-activated arch wire (OrthoForm II – 3M Unitek).
2. 0.019” x 0.025” NiTi thermo-activated arch wire (OrthoForm II – 3M Unitek).
3. 0.019” x 0.025” stainless steel arch.

In Groups II and III the arches sequence used for the leveling phase was the following:
1. 0.014” stainless steel arch.
2. 0.016” stainless steel arch.
3. 0.018” stainless steel arch.
4. 0.020” stainless steel arch.
5. 0.019” x 0.025” stainless steel arch.

In Group II the rectangular arches had passive torque in the incisors region and neutral torque in the cuspids and molar area. The leveling wires received cinch back bends distally to the second molar tube.

When crowding was observed in Group I patients, segmented arches were used and extended from the second molar to the cuspid. In these cases the anterior teeth were included in the arch only when sufficient space was obtained and risk of undesired buccal movement avoided.

In Group III, in two out of five subjects, stripping was performed. In the other three patients, the teeth were leveled in a routine manner. Rectangular arches were placed with neutral torque in the anterior and posterior region.

Cephalometric Tracing

Cephalometric tracing was made on lateral cephalograms before and after leveling phase. The following points were marked: Gonion (Go), Menton (Me), Mesial of the crown of lower 1st molar (C6) and correspondence root apex (R6), Incisal edge (C1) and apex of the lower incisors (R1) and line S (perpendicular to Go-Me and tangent to the rearmost point of the sinphysis), (Fig. 1).

![Cephalometric Tracing](image)

Results and Discussion

Biomechanical control has been of paramount importance since the beginning of orthodontic treatment. Consequently all professionals should know well all the factors that could affect the biomechanics used to correct malocclusions. So, to correct malocclusions with 1st bicuspid extraction, it is important to know that closing the extraction space will cause a loss anchorage of posterior teeth even using anchorage devices. On the other hand, in non extraction cases, during the leveling phase, the loss of anchorage could depend on treatment planning and on the choice of the different parts of the appliance such as the wire type, the anchorage system, the way arches are constructed and the prescription of the brackets and tubes. The anchorage loss could influence the management of the treatment goal dramatically. The same considerations could be made concerning the orthodontic movements in the incisor area.

Tables I, II and III show the results of the observed phases and their statistical analyses.

Table IV shows the comparison of the mean differences between beginning and end of the leveling phase of the three different groups.
TABLE I. Comparison of mean values measured before (T1) and after (T2) aligning phase in Group I

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>SD</th>
<th>T2</th>
<th>SD</th>
<th>difference</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6-S</td>
<td>13.88</td>
<td>2.7</td>
<td>13.35</td>
<td>3.06</td>
<td>-0.53</td>
<td>2.496*</td>
</tr>
<tr>
<td>R6-S</td>
<td>13.94</td>
<td>3.1</td>
<td>13.03</td>
<td>3.05</td>
<td>-0.91</td>
<td>4.615***</td>
</tr>
<tr>
<td>C-R6.GoMe</td>
<td>90.35</td>
<td>7.55</td>
<td>89.15</td>
<td>8.1</td>
<td>-1.21</td>
<td>1.768**</td>
</tr>
<tr>
<td>C1-S</td>
<td>7.91</td>
<td>2.25</td>
<td>6.24</td>
<td>2.31</td>
<td>-1.68</td>
<td>5.228***</td>
</tr>
<tr>
<td>R1-S</td>
<td>4.91</td>
<td>1.38</td>
<td>4.97</td>
<td>1.43</td>
<td>0.06</td>
<td>-0.293</td>
</tr>
<tr>
<td>C-R1.GoMe</td>
<td>97.41</td>
<td>4.8</td>
<td>93.41</td>
<td>4.37</td>
<td>-4</td>
<td>4.636***</td>
</tr>
</tbody>
</table>

*P<.05; **P<.01; ***P<.001; x, Value

TABLE II. Comparison of mean values measured before (T1) and after (T2) aligning phase in Group II

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>SD</th>
<th>T2</th>
<th>SD</th>
<th>difference</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6-S</td>
<td>14.21</td>
<td>2.7</td>
<td>13.78</td>
<td>3.19</td>
<td>-0.43</td>
<td>0.29</td>
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<tr>
<td>R6-S</td>
<td>15.56</td>
<td>1.37</td>
<td>15.16</td>
<td>2.16</td>
<td>-0.40</td>
<td>0.44</td>
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<tr>
<td>C-R6.GoMe</td>
<td>94.04</td>
<td>4.31</td>
<td>94.5</td>
<td>4.51</td>
<td>0.14</td>
<td>0.26</td>
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<tr>
<td>C1-S</td>
<td>10.14</td>
<td>4.61</td>
<td>8.24</td>
<td>4.51</td>
<td>-0.11</td>
<td>-0.14</td>
</tr>
<tr>
<td>R1-S</td>
<td>6.99</td>
<td>1.57</td>
<td>7.1</td>
<td>1.63</td>
<td>0.11</td>
<td>-0.14</td>
</tr>
<tr>
<td>C-R1.GoMe</td>
<td>97.94</td>
<td>7.91</td>
<td>95.84</td>
<td>7.73</td>
<td>-2.1</td>
<td>0.54</td>
</tr>
</tbody>
</table>

*P<.05; **P<.01; ***P<.001; x, Value

TABLE III. Comparison of mean values measured before (T1) and after (T2) aligning phase in Group III

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>SD</th>
<th>T2</th>
<th>SD</th>
<th>difference</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6-S</td>
<td>15.6</td>
<td>1.43</td>
<td>15.5</td>
<td>1.7</td>
<td>-0.10</td>
<td>0.101</td>
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<td>R6-S</td>
<td>17.46</td>
<td>2.83</td>
<td>17.6</td>
<td>2.7</td>
<td>0.14</td>
<td>-0.80</td>
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<td>C-R6.GoMe</td>
<td>94.7</td>
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<td>95.4</td>
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<td>-0.209</td>
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<td>C1-S</td>
<td>7.9</td>
<td>1.7</td>
<td>8.3</td>
<td>1.8</td>
<td>0.40</td>
<td>0.263</td>
</tr>
<tr>
<td>R1-S</td>
<td>3.6</td>
<td>1.7</td>
<td>3.94</td>
<td>1.9</td>
<td>0.34</td>
<td>-0.141</td>
</tr>
<tr>
<td>C-R1.GoMe</td>
<td>100.9</td>
<td>1.5</td>
<td>100.8</td>
<td>1</td>
<td>-0.10</td>
<td>0.537</td>
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</tbody>
</table>

*P<.05; **P<.01; ***P<.001; x, Value

TABLE IV. Comparison of the differences between Groups I vs. II; II vs. III; I vs. III

<table>
<thead>
<tr>
<th></th>
<th>I vs. II</th>
<th>P</th>
<th>II vs. III</th>
<th>P</th>
<th>I vs. III</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6-S</td>
<td>-0.53</td>
<td>-0.44</td>
<td>-0.19</td>
<td>-0.44</td>
<td>-0.608</td>
<td>-0.53</td>
</tr>
<tr>
<td>R6-S</td>
<td>-0.91</td>
<td>-0.40</td>
<td>-1.115</td>
<td>-0.40</td>
<td>-0.731</td>
<td>-0.40</td>
</tr>
<tr>
<td>C-R6.GoMe</td>
<td>-1.21</td>
<td>0.46</td>
<td>-1.63</td>
<td>0.46</td>
<td>-0.161</td>
<td>-0.40</td>
</tr>
<tr>
<td>C1-S</td>
<td>-1.68</td>
<td>-0.60</td>
<td>-2.496*</td>
<td>-0.60</td>
<td>-2.375*</td>
<td>-0.60</td>
</tr>
<tr>
<td>R1-S</td>
<td>0.06</td>
<td>0.11</td>
<td>-0.203</td>
<td>0.11</td>
<td>-0.834</td>
<td>0.06</td>
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<tr>
<td>C-R1.GoMe</td>
<td>-4</td>
<td>-2.10</td>
<td>-1.368</td>
<td>-2.10</td>
<td>-2.431*</td>
<td>-4</td>
</tr>
</tbody>
</table>

*P<.05; **P<.01; ***P<.001; x, Value

Posterior Teeth – First Lower Molars

When assessing the results of Tables I, II and III, it was noticed that the crowns of the first lower molars from the beginning of the treatment through the end of the leveling phase have mesialized significantly in Group I, whereas they have remained stable in the other two groups. Thus, a loss of anchorage of –0.53mm occurred on each side of the lower arch (variable C6-S). The same occurred with the variable R6-S. There was a loss of anchorage in Group I, while Groups II and III were stable. Therefore, when thermo-activated wires were used, the anchorage of the posterior teeth became more jeopardized, even with the use of a fixed lingual arch as anchorage aid. We believe that the reciprocal forces produced by the thermo-activated arches are very abrupt and consequently they do not allow planning the dental movement with directional forces. In the Groups II and III the stainless steel wires tolerated a better control of the orthodontic forces owing to their biomechanical characteristics, not only on those teeth we wanted to move but also on those we wanted to make stable.

The C-R6.GoMe angle did not suffer any significant change in any of the three studied groups, when the beginning and the end stages of leveling were compared, although in group I it occurred with a counter clockwise rotation of the molars and in the groups II and III, a clockwise rotation.

Comparing the three groups, I, II and III, the differences between the beginning and the end of leveling phase did not point out any statistically significant difference when the posterior teeth were considered.
Anterior Teeth – Lower Incisors

Assessing the cephalometric variable CI-S in Group I, an unusual fact can be noticed. From the beginning to the end of the leveling phase, the crowns of the lower incisors migrated, in several cases, to a lingual direction, in a very pronounced way. On average, the lingual movement of the crowns was around -1.68mm, since in the beginning the mean value was 7.91mm and in the end it was 6.24mm. The difference was statistically significant. We believe that this lingual movement can be explained by the movement of the thermo-activated NiTi arch inside the slot, which has a torque of -6 degrees. This movement may explain a higher request of anchorage on the posterior teeth, encouraging the loss. This fact was not observed in Groups II and III because the torque in the rectangular arches of Group III (stainless steel wires) besides being passive in the anterior area, did not present any lingual effect on the crowns of the incisors.

In Group III, the anterior teeth did not suffer any movement in lingual direction because the proximal contacts blocked this movement. In contrast, the crown moved in buccal direction. The root apices of the incisors remained stable in all three studied groups.

The angle between the long axis of the lower incisor and the mandibular plane (variable CR1.GoMe) showed a statistically significant difference in Group I, but none in Groups II and III.

When the three groups and the differences between the averages from the beginning and the end are compared, it is possible to notice statistically significant differences only for the C1-S and CR1.GoMe. The lower incisors suffered a much higher lingual movement of the crown in Group I compared with the ones of Groups II and III. Beside that, Group III showed significant differences of the CR1.GoMe angles when compared with those of Groups I and II, considering that in Group III the incisors suffered a buccal direction movement while in the other two groups there was a lingual direction movement.

Clinical Considerations

The obtained results in this research made us understand that the control of the anchorage of the posterior teeth of the dental arches is of great relevance to obtain the ideal goals in Orthodontics. The MBT™ Prescription is of excellent quality during the leveling stage of the dental arches, providing an outstanding placement of the teeth. The leveling and alignment of the dental arches accomplished by the three orthodontic wires, (two thermo-activated and one of stainless steel) used in Group I, can cause an undesired occlusal collapse, as a consequence of the uncontrolled performance of the thermo-activated rectangular wire. Because of its characteristics, it does not allow a suitable control of the posterior teeth anchorage, nor the control of the anterior teeth bending. The reciprocal actions of the dental movements become precarious. A tooth is “launched” against its neighbor without any control, and the actions of the rectangular wires work with a neutral torque in slots with different torque. There are cases where the molars mesialize 2.mm on each side and there are movements of anterior retraction of the incisors of 3.mm. Actually, we are not rejecting the use of this sequence of arches; we are just calling the attention upon the undesired biomechanical issue. Logically in those cases that the loss of anchorage is not important, the sequence of arches used in this paper becomes excellent, since the length of the clinical session would be highly reduced.

Because the Groups II and III used sequences with round and rectangular stainless steel wires, those facts did not occur, showing a better control of the dental movement during the leveling phase.

Conclusions

Group I: The first lower molars suffered a mesial movement of the crown and of the root, and the lower incisors bent into a lingual direction, in a counter clockwise movement, during the leveling phase. The anchorage arch, Fixed Lingual Arch, was considered unsatisfactory when anchoring requests were performed during the leveling phase, probably because of the use of thermo-activated rectangular arches.

Group II: There were no statistically significant differences found between the beginning and the end of the leveling phase for the molars and lower incisors. The leveling stainless steel, round and rectangular arches, with passive torque in the anterior area, allowed a better control of the posterior anchorage and incisor position.

Group III: There were found no statistically significant differences during the leveling phase. Both, molars and incisors, kept on stable.

When the comparison was made of the differences between Groups I, II and III, it was noticed statistically significance on the position of the crown of the incisors and the tipping of long axis in relation to the mandibular plane. ■

REFERENCES