Contents

I. A Clinical Review of the MBT™ Orthodontic Treatment Program
   Orthodontic Perspectives, Vol. IV No. 2, 1997

II. Space Closure Biomechanics Applied Using The MBT™ System Technique
    Hugo Trevisi, D.D.S.
    Orthodontic Perspectives, Vol. X No. 1, 2003

III. Anchorage Control During The Leveling Phase In Extraction And Non-Extraction Cases
     Using MBT™ System Technique
     Julio Wilson Vigorito, D.D.S., M.S., PhD, Gladys Cristina Dominguez-Rodriguez, D.D.S, M.S., PhD
     and André Tortamanto, D.D.S., M.S.
     Orthodontic Perspectives, Vol. X No. 1, 2003

IV. Practical Techniques for Achieving Improved Accuracy in Bracket Positioning
    Orthodontic Perspectives, Vol. VI No. 1, 1999

V. Arch Form Integrity
    Ryan Moses, D.M.D.
    Orthodontic Perspectives, Vol. XVII No. 2, 2010

VI. Orthodontic Treatment Using The Dental VTO And MBT™ System
    Dr. Hideyuki Iyano
    Orthodontic Perspectives, Vol. X No. 1, 2003

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A Clinical Review of the MBT™ Versatile+ Appliance System Orthodontic Treatment Program

By Dr. Richard McLaughlin, Dr. John Bennett and Dr. Hugo Trevisi


Treatment Philosophy of the MBT™ Appliance System

The MBT Appliance System philosophy of orthodontic treatment has been developed over a twenty year period of time and has involved the combined efforts of its three principle clinicians, along with the help of numerous other clinician colleagues. Their philosophy places emphasis on four critical areas of orthodontic treatment: 1. Treatment mechanics, 2. The pre-adjusted appliance, 3. Bracket placement technique, and 4. Arch form and archwire sequencing.

The MBT System philosophy is supported not only by a custom designed appliance, but also by worldwide continuing educational opportunities as well as a long awaited textbook.

MBT System Philosophy

The MBT System Philosophy of Orthodontic Treatment in Practice

1. Treatment Mechanics

Emphasis on dento-alveolar change

The major effect of orthodontic treatment is on the dento-alveolar structures. Thus the term “growth modification” in growing patients consists primarily in the modification of the growth and development of the dento-alveolar processes. While other orthopedic changes may be occurring in some patients, the majority of change is dento-alveolar, and, therefore, emphasis is placed on the management of these structures.

Use of Light, Continuous Forces

Intermittent forces have proven to be relatively ineffective in bringing about dental tooth movement; on the other hand, continuous forces are most effective in moving dental structures. Heavy forces have been shown to have a detrimental effect on the root structure while lighter forces have been shown to maximize biologic response and efficacy in tooth movement. Therefore, treatment planning is directed at providing light continuous forces on the teeth that need to be moved at any given time during orthodontic treatment.

Anchorage Control

A combination of extra-oral (facebows and “J” hooks) and intra-oral (palatal bars, lingual arches, Class II elastics, Class III elastics, Nance arches, Utility arches, etc.) methods of anchorage control are utilized in the MBT system.

Leveling and Aligning

The leveling and aligning stage of treatment consists of the following techniques:

• Use of Nitinol Heat-Activated nickel titanium wires during the aligning process
• The use of canine lace backs for cuspid control and retraction
• The use of bend backs to control forward movement of incisors
• The use of open coil springs to create space for blocked out teeth
• Early establishment and maintenance of arch form, followed by bringing malposed teeth into the primary arch form without arch form distortion

Overbite Control

Overbite control is best accomplished by using the following principles:

• Differentially controlling the eruption/extrusion (intrusive and extrusive forces) of the anterior and posterior segments
• Including second molars early in treatment for the opening of most deep bite cases
• Being aware that in most cases leveling and bite opening are not complete until rectangular wires have been in for one or two months
• Avoiding leveling of the posterior portion of the Curve of Spee in open bite cases

Space Closure

Space closure control is best accomplished by using the following principles:

• A .019 x .025” rectangular wire in the .022 bracket slot is preferred for effective sliding mechanics without major archwire deflection
• Sliding mechanics is accomplished with elastic module tie backs
• Incisor torque control is accomplished through bracket design and archwire bending

Overjet (Class II-Class III) Correction

Class II and Class III correction is accomplished by using a combination of headgear, Class II and Class III elastics, and functional appliances. These appliances are used in combinations that bring about the best opportunity for continuous forces on the dento-alveolar processes.
**Finishing**

Finishing involves three main processes:

- The correction of mistakes made earlier in treatment (bracket positioning, torque control, anchorage control etc.)
- Over-correction as needed (periodontal, alveolar-sutural, muscular, and growth)
- Settling of cases in light wires for approximately six weeks (minimum) prior to debanding

**Retention**

Retention is accomplished using a combination of bonded retainers for the lower anterior segment, wrap around upper retainers to allow for continued arch settling, and some positioners as well as some clear acrylic full coverage retainers.

**2. MBT™ Appliance Bracket System**

**Victory Series™ Brackets** – Figures 1, 2, 3 show a good candidate for this small steel bracket, as evidenced by the patient’s short clinical crowns.

**Clarity™ Brackets** – Figures 4, 5, 6 show Clarity metal-reinforced ceramic brackets on her upper teeth, aesthetic brackets for an aesthetic appearance during treatment.

**Full Size Twin Brackets** – Figures 7, 8, 9 show a patient with large teeth, a difficult malocclusion and poor hygiene. The larger bracket will maximize base surface area and increase control.

**APC™ System**

In addition to the MBT Versatile+ appliance types available, our offices also appreciate the option of APC adhesive coating on our brackets. The efficiency and simplified inventory management has been most beneficial for staff and patients.
MBT™ Appliance Features

**Reduced Upper and Lower Anterior Tip**

<table>
<thead>
<tr>
<th></th>
<th>Upper Anterior Tip</th>
<th>Lower Anterior Tip</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Central</td>
<td>Lateral</td>
</tr>
<tr>
<td>Andrews’ norms</td>
<td>3.59°</td>
<td>8.04°</td>
</tr>
<tr>
<td>Sebata’s data</td>
<td>4.25°</td>
<td>7.74°</td>
</tr>
<tr>
<td>Watanabe’s data</td>
<td>3.11°</td>
<td>3.99°</td>
</tr>
<tr>
<td>MBT™ Appliance</td>
<td>4.0°</td>
<td>8.0°</td>
</tr>
<tr>
<td>Original SWA</td>
<td>5.0°</td>
<td>9.0°</td>
</tr>
<tr>
<td>Roth SWA</td>
<td>5.0°</td>
<td>9.0°</td>
</tr>
</tbody>
</table>

Table 1  Anterior Tip

Table 1 shows anterior tip measurements: Andrews’ non-orthodontic normal study, two Japanese studies, the MBT Versatile+ Appliance, the Original Straight-Wire Appliance™ and the Roth Appliance.

The anterior tip measurements for the original Straight-Wire Appliance are all greater than those found in Andrews’ research. This was presumably done to control what Andrews referred to as the “wagon wheel” effect that torque places on anterior crown tip. This is somewhat similar to the compensating anti-tip, anti-rotation and power arms built into the extraction brackets for the treatment of bicuspid extraction cases.

*As palatal root torque is added to the anterior segment, mesial crown tip is reduced

It has been observed by the authors that with light continuous force mechanics, tip is well controlled by the pre-adjusted appliance. Using “lacebacks” and “bendbacks” during leveling and aligning, and elastic modules “tie-backs” during space closure, very little adverse tipping occurs during these stages of treatment. By the finishing stage of treatment, completely levelled upper and lower rectangular wires are normally in place, indicating that full expression of both anterior and posterior crown tip has occurred. Thus, additional tip is not seen to be necessary in the anterior segments.

Also, additional anterior tip creates a significant drain on molar anchorage, Figure 10, 11. If the original research values for tip are used, a total of 10° less distal root tip in the upper anterior segment and 12° less distal root tip in the lower anterior segment is needed (compared against the Original Straight-Wire Appliance).

- Figures 10 and 11 show the difference in root positions with MBT Versatile+ Appliance and two SWA.

- Figure 12. The MBT Appliance provides anterior tip measurements that correspond to Andrews’ norms. This reduced tip provides a significant reduction in anchorage needs.

- Figure 13: This X-ray shows a case treated with a bracket with excessive cuspid tip. This is what the MBT Versatile+ bracket was designed against.

Thus reduced tip significantly reduces the need for anchorage control, which normally translates into a reduced need for patient cooperation. Since the MBT Versatile+ measurements are identical to Andrews’ original research figures, there is no compromise in ideal static occlusion. And if the condyles are in centric relation, there is no compromise in ideal functional occlusion as described by Roth.

![Fig. 10](image1.png)

![Fig. 11](image2.png)

![Fig. 12](image3.png)

![Fig. 13](image4.png)
**Upper Posterior Tip**

Table 2 shows posterior tip measurements for the upper bicuspids and molars: Andrews’ non-orthodontic normal study¹, two Japanese studies²,³, the MBT™ Versatile+ Appliance, the Original Straight-Wire Appliance⁴ and the Roth Appliance⁵.

<table>
<thead>
<tr>
<th>Upper Posterior Tip</th>
<th>1st Bi</th>
<th>2nd Bi</th>
<th>1st Molar</th>
<th>2nd Molar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrews' norms</td>
<td>2.7°</td>
<td>2.8°</td>
<td>5.7°</td>
<td>0.4°</td>
</tr>
<tr>
<td>Sebata's data</td>
<td>3.5°</td>
<td>6.2°</td>
<td>5.2°</td>
<td>-0.3°</td>
</tr>
<tr>
<td>Watanabe's data</td>
<td>4.7°</td>
<td>5.2°</td>
<td>4.9°</td>
<td>4.1°</td>
</tr>
<tr>
<td>MBT™ Appliance</td>
<td>0°</td>
<td>0°</td>
<td>0°</td>
<td>0°</td>
</tr>
<tr>
<td>Original SWA</td>
<td>2.0°</td>
<td>2.0°</td>
<td>5.0°</td>
<td>5.0°</td>
</tr>
<tr>
<td>Roth SWA</td>
<td>0°</td>
<td>0°</td>
<td>0°</td>
<td>0°</td>
</tr>
</tbody>
</table>

Table 2  Upper Posterior Tip  * Effective tip is 5°

For the MBT Versatile+ Appliance, 0° of tip, as opposed to 2° of tip, was selected for all upper bicuspid brackets to place the crowns in a slightly more upright position, (in a Class I direction). It also provides for slightly reduced anchorage needs for the upper arch.

The buccal groove is the reference for crown tip in the upper molars. This buccal groove shows a 5° angulation to a line drawn perpendicular to the occlusal plane. There are two methods of achieving 5° of effective tip in the upper first and second molars.

If a 5° bracket is used, the band must be seated more gingivally at the distal aspect to position bracket wings parallel to buccal groove. (Fig 14a). This makes band positioning more difficult. When using these 5° brackets, it is frequently necessary to trim band material from the distal of the band. If the 5° bracket is used and the band is placed parallel to the occlusal plane, it provides an excessive 10° of actual tip to the upper first and second molars (Fig. 14b).

Alternatively, the authors prefer to use a 0° crown tip bracket with the band and bracket slots placed parallel to the occlusal plane. This introduces the correct 5° of tip in the upper molars, as measured from the buccal groove (Fig. 14c) and is easier to seat. The new Unitek™ Narrow Contoured Molar Bands have been extremely easy to use and are a welcome addition to the MBT system.

In summary, then, all of the upper posterior brackets are provided with 0° of crown tip for the reasons described above.

**Lower Posterior Crown Tip**

Table 3 shows tip measurements for the lower bicuspids and lower molars: Andrews’ non-orthodontic normal study¹, two Japanese studies²,³, the MBT Versatile+ Appliance, the Original Straight-Wire Appliance⁴ and the Roth Appliance⁵.

The authors observed that torque is rather poorly controlled with the pre-adjusted appliance system. This is due to the fact that the torque movement is a difficult one since less than 1mm of contact between the bracket and the archwire must bring about this movement. In general, here lies the greatest challenge to bracket design in the pre-adjusted appliance. In the majority of orthodontic cases, because of this lack of torque control, torque tends to be lost in the upper incisors during overjet reduction and space closure. The lower incisors frequently tend to procline forward during Curve of Spee leveling and when eliminating lower incisor crowding. This incisor torque factor, along with the tip and tooth size factors, frequently prevents posterior teeth from fitting into a Class I relationship.

<table>
<thead>
<tr>
<th>Lower Posterior Tip</th>
<th>1st Bi</th>
<th>2nd Bi</th>
<th>1st Molar</th>
<th>2nd Molar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrews' norms</td>
<td>1.3°</td>
<td>1.5°</td>
<td>2.0°</td>
<td>2.9°</td>
</tr>
<tr>
<td>Sebata's data</td>
<td>2.5°</td>
<td>6.7°</td>
<td>5.7°</td>
<td>7.3°</td>
</tr>
<tr>
<td>Watanabe's data</td>
<td>3.8°</td>
<td>3.9°</td>
<td>3.7°</td>
<td>3.9°</td>
</tr>
<tr>
<td>MBT™ Appliance</td>
<td>2.0°</td>
<td>2.0°</td>
<td>0°</td>
<td>0°</td>
</tr>
<tr>
<td>Original SWA</td>
<td>2.0°</td>
<td>2.0°</td>
<td>2.0°</td>
<td>2.0°</td>
</tr>
<tr>
<td>Roth SWA</td>
<td>-1.0°</td>
<td>0°</td>
<td>-1.0°</td>
<td>-1.0°</td>
</tr>
</tbody>
</table>

Table 3  Lower Posterior Tip  * Effective tip is 2°

**Incisor Torque**

Table 4 shows anterior torque values: Andrews’ non-orthodontic normal study¹, two Japanese studies²,³, the MBT Versatile+ Appliance, the Original Straight-Wire Appliance⁴ and the Roth Appliance⁵.

<table>
<thead>
<tr>
<th>Anterior Torque</th>
<th>Upper Central</th>
<th>Upper Lateral</th>
<th>Lower Central</th>
<th>Lower Lateral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrews’ norms</td>
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<tr>
<td>Sebata’s data</td>
<td>9.42°</td>
<td>7.48°</td>
<td>3.55°</td>
<td>1.66°</td>
</tr>
<tr>
<td>Watanabe’s data</td>
<td>12.8°</td>
<td>10.4°</td>
<td>0.71°</td>
<td>0.53°</td>
</tr>
<tr>
<td>MBT™ Appliance</td>
<td>17.0°</td>
<td>10.0°</td>
<td>-6.0°</td>
<td>-6.6°</td>
</tr>
<tr>
<td>Original SWA</td>
<td>7.0°</td>
<td>3.0°</td>
<td>-1.0°</td>
<td>-1.0°</td>
</tr>
<tr>
<td>Roth SWA</td>
<td>12.0°</td>
<td>8.0°</td>
<td>-1.0°</td>
<td>-1.0°</td>
</tr>
</tbody>
</table>

Table 4  Anterior Torque
Because of these factors there is generally a need for greater palatal root torque of the upper incisors and labial root torque for more uprighting of the lower incisors (Figure 15). For all these reasons, the authors recommend +17° of torque for the upper central incisors, +10° of torque for the upper lateral incisors, and -6° of torque for the lower incisors.

In Figure 16 the MBT™ Versatile+ Appliance provides increased palatal root torque for the upper incisors (a, b) and increased labial root torque for the lower incisors (c), the most common requirements in orthodontic cases.

**Upper Cuspid, Bicuspid and Molar Torque**

Table 5 shows upper cuspid, bicuspid and molar torque values: Andrews’ non-orthodontic normal study, two Japanese studies, the MBT Versatile+ Appliance, the Original Straight-Wire Appliance™+ and the Roth Appliance.

<table>
<thead>
<tr>
<th>Upper Cuspid Torque</th>
<th>1st Bi</th>
<th>2nd Bi</th>
<th>1st Molar</th>
<th>2nd Molar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrews’ norms</td>
<td>-7.3°</td>
<td>-8.5°</td>
<td>-8.9°</td>
<td>-11.5°</td>
</tr>
<tr>
<td>Sebata’s data</td>
<td>0.7°</td>
<td>-6.5°</td>
<td>-6.5°</td>
<td>-1.7°</td>
</tr>
<tr>
<td>Watanabe’s data</td>
<td>-5.3°</td>
<td>-6.0°</td>
<td>-7.2°</td>
<td>-9.8°</td>
</tr>
<tr>
<td>MBT™ Appliance</td>
<td>-7.0°</td>
<td>-7.0°</td>
<td>-7.0°</td>
<td>-14.0°</td>
</tr>
<tr>
<td>Original SWA</td>
<td>-7.0°</td>
<td>-7.0°</td>
<td>-7.0°</td>
<td>-9.0°</td>
</tr>
<tr>
<td>Roth SWA</td>
<td>-2.0°</td>
<td>-7.0°</td>
<td>-7.0°</td>
<td>-14.0°</td>
</tr>
</tbody>
</table>

The upper cuspid and bicuspid torque values of -7° have proven to be satisfactory in most cases, and have therefore been selected for the MBT Versatile+ Appliance. The upper molars, on the other hand, frequently show excessive buccal crown torque with palatal cusps “hanging down” which creates centric, balancing side and working side interferences. For this reason the authors prefer -14° of buccal root torque in these teeth, as opposed to only -9° of buccal root torque (Fig. 17a, b, c).

**Lower Cuspid, Bicuspid and Molar Torque**

Table 6 shows torque values for lower cuspid, bicuspid and molars: Andrews’ non-orthodontic normal study, two Japanese studies, the MBT Versatile+ Appliance, the Original Straight-Wire Appliance™ and the Roth Appliance.

There are three reasons for reducing the amount of lingual crown torque in the lower cuspid, bicuspid and molar areas: 1) Since lower cuspid and sometimes bicuspid often show gingival recession, they benefit from the roots being moved closer to the center of the alveolar process; 2) many orthodontic cases demonstrate narrowing in the maxillary arch with lower posterior segments that are compensated toward the lingual. These cases benefit from buccal uprighting of the lower posterior segment. 3) It has been consistently observed that lower second molars with -35° of torque consistently “roll in” linguually. Therefore, the authors have chosen to reduce the lingual crown torque, by 5° in the lower cuspid and bicuspids, by 10° in the lower first molars, and by 25° in the lower second molars (Fig. 18a, b and 19a, b, c).
**In-out Modifications of the MBT™ Versatile+ Appliance**

It has been observed by the authors that the in-out measurements (including molar rotation) for the original Straight-Wire Appliance™ have, for the most part, proven to be quite satisfactory. With the exception of severe rotations at the initiation of treatment (best handled by space opening in combination with facial and lingual rotation elastics) minimal modifications in archwires need to be made until the finishing stage of treatment. At that time some teeth may need to be over-rotated for stability (using rotation wedges) and first molars may need archwire offsets to complete their rotation.

One important in-out feature that has been added to the MBT Versatile+ appliance is because upper second bicuspid are frequently smaller in size than upper first bicuspsids. For this reason, an upper second bicuspid bracket has been provided with an additional 0.5mm of in-out compensation. This will allow for better alignment of central fossae in the upper arch and will also provide for relatively increased mesio-buccal rotation of the upper first molar. When upper second bicuspsids are similar in size to the upper first bicuspsids, an upper first bicuspid bracket can be used on the upper second bicuspsids.

- **Figure 19a, b, c** Progressive buccal crown torque in the lower posterior segments (cuspids through molars) provides uprighting of these areas, which are frequently inclined lingually.

- **Figure 20** A patient in need of posterior buccal crown torque.

- **Figure 21** An upper second bicuspid bracket with an additional 0.5 mm of in-out compensation is provided for the common situation in which upper second bicuspsids are smaller than upper first bicuspsids.

- **Figure 22** Patient with smaller 2nd bicuspid

**MBT Appliance Versatility**

- **Inversion of upper lateral incisor brackets** (Fig. 23, 24, 25). This is beneficial in cases with palatally displaced laterals requiring labial root torque for proper stability.

- **Same tip and torque in lower incisor brackets.** With the same lower incisor brackets, inventory is simplified and the possibility of confusion during bracket placement is minimized.
• Inversion of cuspid brackets with prominent cuspid roots. (Figure 26, 27). This adjustment allows for movement of the cuspid roots away from the cortical plate and into the center of the alveolar process.

• 0° cuspid brackets with hook for extraction cases. (Figure 28). Many orthodontists prefer to have a hook on their cuspid bracket, and the zero degree torque value also allows the cuspid to move away from the cortical plate for easier retraction.

• Inversion of upper cuspid brackets when cusps are in the lateral position. (Figure 29, 30, 31). This adjustment allows the cuspid root to move palatally and assume a position and appearance that more closely resembles the lateral incisor.

• Same tip and torque in upper bicuspid brackets. Thus, in most situations, one bracket is used for all four upper bicuspids. This simplifies inventory and provides for less confusion during placement.

• Additional 0.5mm of in-out in upper second bicuspid brackets. (Figure 32). Approximately 30% of upper second bicuspids are smaller than upper first bicuspids. This bracket is most beneficial in this situation. If all four bicuspids are the same size, then first bicuspid brackets can be placed on both first and second bicuspids.

• Upper second molar bands and brackets on upper first molars in non-headgear cases. (Figure 33). This adjustment provides greater comfort for the patient, as opposed to the placement of an unnecessary headgear tube.

• Lower second molar bands and brackets on lower first molars. When the buccal cusps of upper first molars impinge on the bracket of the lower first molar, the use of the lower second molar band with a much lower occlusal profile bracket often eliminates this problem.

• Lower second molar brackets on upper first and second molars when finishing in a Class II molar relationship. (Figure 34, 35). The lower second molar bracket has zero rotation and 10° of torque which places the Class II upper first molar in a correct relationship with the lower first molar.

• Inventory identification. This is vastly simplified by the pre-labeled individual blister packs of the APC™ Adhesive Coated brackets used in the operatory.
3. Bracket Placement

Prior to the development of the pre-adjusted appliance, edgewise brackets were placed using gauges which set the bracket a specific number of millimeters from the incisal or occlusal tooth surface. When the pre-adjusted appliance was developed, the center of the clinical crown became the vertical reference for bracket placement, and most orthodontists discontinued the use of gauges. The brackets were therefore placed by visually selecting the center of the clinical crown. Unfortunately, this method resulted in significant errors relative to vertical placement. For example:

- Gingival variations, such as partially erupted teeth, labially and lingually (palatally) displaced roots, and gingival inflammation led to placement errors.
- Large teeth (upper central incisors) and small teeth (upper lateral incisors) within the same patient led to obvious errors when brackets were placed in the center of the clinical crown.
- Incisal or occlusal fractures and wear, as well as teeth with extremely tapered and pointed cusps, led to bracket placement errors. (Figure 36)

"In the past, the best results were achieved by the orthodontists who were the best wire benders. In the future, the best results will come from those orthodontists who are the best bracket positioners."

The use of a bracket placement chart (developed in 1994), as well as pre-adjusted Dougherty gauges, Figures 37 and 38, dramatically reduces bracket placement errors in the vertical dimension. Figures 39 though 44 show placement technique. We have experienced approximately a 50 - 60% reduction in the need to reposition brackets during treatment using this very simple but effective system.

Figure 39, 40, 41 illustrate measuring on the occlusal plane, burnishing the band, and then light curing the band and tube in position.

Figure 42, 43 and 44 show checking bracket height and tip, then curing.
Editor: Arch form and archwire sequencing are a very important part of the McLaughlin-Bennett-Trevisi philosophy of orthodontic treatment. Can you comment in general on this importance?

Dr. McLaughlin: The proper selection of an arch form for each patient as well as the development of a general archwire sequencing system in the orthodontic practice can greatly increase treatment efficiency and also provide greater stability in completed cases.

Editor: Can you offer an historical perspective on the subject of arch form?

Dr. McLaughlin: A review of the orthodontic literature on the subject of arch form reveals that there are three main themes that run throughout this information. The first is the search for the ideal arch form (Bonwill-Hawley, catenary curve, Brader arch form, etc.). Second is the conflicting view that there is a great deal of variation in human arch form. The third is that when arch form is significantly changed in the patient, there is a great tendency toward orthodontic relapse.

Editor: How should this information affect the choices an orthodontist must make when selecting an arch form for each patient?

Dr. McLaughlin: This information, as well as treating patients over a 20 year time period, indicates that the use of a single arch form in all patients is an unsatisfactory method of treatment. Some method of individualization must be carried out.
With the evolution of orthodontic techniques, the sliding biomechanics has shown to be the most effective technique applied for closing spaces in extraction cases when the pre-adjusted appliance is used.

The sliding technique consists of the sliding of the rectangular archwires in the bracket slot of premolar teeth and in the buccal tube of molar teeth, allowing the remaining spaces of the extracted teeth to be closed.

The system to be presented in this article is based on the extensive clinical experience of the three MBT™ System advocates — McLaughlin, Bennett, Trevisi — who have applied this technique over a long period of time, achieving excellent force levels and resulting in tooth movement with excellent control of the biomechanics during the space closure of the extraction sites.

It is very important to emphasize that orthodontic appliances that produce tip overcorrection for anterior teeth (upper tipping using Andrews, Sabata and Watanabe figures) have caused single movement or group movement of teeth without the control of the professional during the aligning and the leveling stage of treatment (deep overbite of anterior teeth, intermediate open bite of premolar teeth, protrusion of anterior teeth). These matters require further anchorage during the space closure stage of treatment.

Because the MBT appliance system has less tipping for anterior, upper and lower teeth, the aligning and the leveling biomechanics are much more effective, as they avoid these problems. Furthermore, the sliding technique is much more sensitive when compared to appliances that have a very strong anterior tipping.

During the sliding biomechanics, the MBT system advocates recommend using a preadjusted appliance with a .022” x .028” slot, .019” x .025” rectangular steel archwires and .07mm or .08mm hooks welded or prewelded to the archwire to the mesial of the cuspid teeth (Fig. 5). In addition, .009” or .010” steel ligatures associated with Alastik™ Modules should be used for the retraction system.

Therefore, three retraction systems will be presented in this article. These systems have been developed from the experience of the MBT system advocates who have over 25 years of experience with the preadjusted appliance and the sliding technique.

**Retraction System 1**

It consists of applying the Alastik module to the hook of first molar teeth and steel ligatures laced to the hooks prewelded to the rectangular archwire to the mesial of cuspid teeth. This was the first retraction system proposed by the MBT system advocates (Figs. 1 and 2).

**Figure 1:** The Alastik™ Module is applied to the hook of molars, and the steel ligature is laced to the prewelded hook to the archwire to the mesial of the cuspid teeth.

**Figure 2:** Resources of retraction system 1. In order to avoid the Alastik™ Module to be in contact with the gum, it is recommended to involve the steel ligature on the Alastik module of second premolar teeth.
**Retraction System 2**

It consists of lacing the steel ligature to the molars and applying the AlastiK™ Module to the hook prewelded to the archwire to the mesial of cuspid teeth. This was the second retraction system proposed by the MBT™ System advocates (Fig. 3).

Retraction system 2 allows the force to be applied over the bracket slot, enhancing the sliding mechanics and providing comfort to the patient.

**Retraction System 3**

It consists of lacing molar and premolar teeth with steel ligatures and applying the AlastiK module to the hook prewelded to the archwire to the mesial of cuspid teeth. This retraction system is similar to retraction system 2, and it has been developed to decrease friction caused by the sliding mechanics. In this system, it is not necessary to apply the AlastiK module to premolar teeth during the space closure stage of treatment (Fig. 4).

**Prewelding to the Mesial of Cuspid Teeth**

Professionals should precisely establish the contact point between cusps and the lateral incisors and use .07mm brass wire when prewelding the hooks. The fixation of the wire to the rectangular archwire is performed using a Mathieu plier. This is a very comfortable system, allowing good prewelding and not distempering the rectangular steel archwire (Fig. 5). In the MBT system technique, rectangular archwires with prewelded hooks are available with three inter-cuspid distance.

**Engagement of the Retraction Systems**

**Retraction System 1:** Firstly, place the steel ligature to the AlastiK module (Fig. 6). Then, apply the AlastiK module to the hook of the first molar and the steel ligature to the mesial of the cuspid hook, applying the recommended activation (Fig. 7).

**Retraction Systems 2 and 3:** Firstly, place the steel ligature to the posterior teeth (Fig. 8). Then, apply the AlastiK module to the steel ligature, and place the AlastiK module to the mesial of the cuspid hook, applying the recommended activation (Fig. 9).
**Activation and Force Level**

For the three systems, the MBT™ System advocates recommend activating the module to twice the size of the AlastiK™ Module (Figs. 1, 3 and 4), leaving it on the patient for twenty-one days. The force level achieved in each quadrant is approximately 150g. After twenty-one days, the system can be redone or reactivated (Fig. 10).

The second activation should be twice the size of the AlastiK module or, it should be carried out until the professional feels some resistance during the activation. The system should remain set on the patient for another 21 days.

It is recommended using retraction system 3 when the force level needs to be increased, mainly when the second molar is part of the space closure biomechanics (Fig. 11).

**When to apply the sliding mechanics**

In order to achieve perfect performance of the sliding biomechanics, the professional should follow some recommendations given by the MBT system advocates:

- Using .022” x .028” slot with .019” x .025” steel archwires.
- Leveling should be well performed. The slot plane should be well leveled, mainly in deep overbite cases.
- Using passive steel ligatures at least for 30 days in order to allow torque settlement during the initial use of .019” x .025” rectangular archwire. Then, progress to the sliding mechanics.
- Checking if there is a damaged bracket, as it causes friction during biomechanics.
- Checking if the archwire end (1mm) is at the distal of first or second molar teeth. If it does not occur, the archwire won’t slide in the bracket slot.

**MBT System Innovations:**

**Second premolar tubes and the MBT System technique**

The use of second premolar tubes has been incorporated into the MBT system technique, and it serves to improve the resources used in orthodontic treatment. The use of these tubes brings advantages to both the professional and the patient.

Expected advantages presented by the use of second premolar tubes:

- Decreased occlusal interference of the opposing teeth, mainly in overbite and Class II cases.
- More comfort to the patient.
- Decreased bracket failure.
- Decreased friction during the sliding mechanics.

Second premolar tubes result in excellent performance during the sliding mechanics for closing remaining spaces in first premolar extraction cases and in non-extraction cases. There is no need to use AlastiK modules. Tubes are expected to decrease friction between the wire and the bracket slot and allow the spaces to be closed quickly.
Lower second premolar brackets present debonding failure because they are set in a very difficult area, in which the incidence of masticatory forces, deep overbite and Class II malocclusion are high (Figs. 12A and 12B). Then, lower second premolar tubes have been designed in order to overcome this matter. These tubes have a larger base, enhancing bonding strength, and a 1.0mm debasing. They also have a special design, allowing the biomechanics to be performed during the aligning, leveling and space closure stage of treatment.

**Figure 12A:** Occlusal interference of upper premolar with a lower second premolar bracket.

**Figure 12B:** Tube replacing a second premolar bracket.

**Figure 13A:** Second premolar tube replacing a bracket due to bonding failure.

**Figure 13B:** Occlusal view. .014" Nitinol archwire during re-leveling.

**Figure 13C:** Maximum intercuspation. The patient presents overbite and a slight Class II malocclusion.

**Figure 14A, 14B, 14C:** Space closure stage of treatment applying the sliding biomechanics and using a bonded lower second premolar tube with .019" x .025" steel archwire.

**Figure 15:** Occlusal view of a lower second premolar tube and .019" x .025" steel archwire during the finishing stage of space closure.

### Lower Second Molar Mini Tubes

For the great majority of patients, there has always been a difficulty in including lower second molars in the orthodontic treatment. The interocclusal space and the gingival tissue do not allow setting a band with a tube or a bonded tube of regular size on teeth. The biomechanics resources are favored when it becomes possible to include these teeth in the orthodontic treatment, mainly in deep overbite cases.
For extraction or non-extraction treatments presenting space matters, second molar impaction is a barrier to the whole course of treatment. Therefore, it is necessary to have an appliance with a design that allows the inclusion of second molars in the treatment.

Lower second molar mini tubes have been developed, aiming at providing a good bonding strength to second molar devices, placing second molars to the level of the occlusal plane of first molar teeth. Its base has been designed to be well adapted to the contour of second molar mesial cusp. And, its design has a good debase, allowing it to be set in deep overbite cases (Figs. 16A and 16B).

Figure 16A: Mini tubes bonded on lower second molars. In this case, it would be difficult to use a regular tube.

Figure 16B: Engagement of the initial aligning and leveling archwire.

Figure 17: Lower second molar mini tube bonded to the distal on an impacted lower second molar.

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5 Andrew L F 1989. Straight-Wire – the concept and the appliance. Wells Co, LA
6 Ouchi, K et al. The effects of retraction forces applied to the anterior segment on orthodontic archwire: changes in the wire deflection with the wire size. California: Edward H. Angle Society, 2001
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 bicuspid 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 bicuspid 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 bicuspid, 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 cuspipid 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).

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>T2</th>
<th>difference</th>
<th>P</th>
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<tr>
<td>C6-S</td>
<td>13.88</td>
<td>13.35</td>
<td>-0.53</td>
<td>2.496*</td>
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<td>R6-S</td>
<td>13.94</td>
<td>13.03</td>
<td>-0.91</td>
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<td>C-R6.GoMe</td>
<td>90.35</td>
<td>89.15</td>
<td>-1.21</td>
<td>1.768</td>
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<tr>
<td>C1-S</td>
<td>7.91</td>
<td>6.24</td>
<td>-1.68</td>
<td>5.228***</td>
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<tr>
<td>R1-S</td>
<td>4.91</td>
<td>4.97</td>
<td>0.06</td>
<td>-0.293</td>
</tr>
<tr>
<td>C-R1.GoMe</td>
<td>97.41</td>
<td>93.41</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>
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<th>T1</th>
<th>T2</th>
<th>difference</th>
<th>P</th>
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</thead>
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<tr>
<td>C6-S</td>
<td>14.21</td>
<td>13.78</td>
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<td>0.29</td>
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<td>R6-S</td>
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<td>15.16</td>
<td>-0.4</td>
<td>0.44</td>
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<td>C-R6.GoMe</td>
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<td>94.5</td>
<td>0.46</td>
<td>-0.21</td>
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<tr>
<td>C1-S</td>
<td>10.14</td>
<td>8.3</td>
<td>-0.6</td>
<td>0.26</td>
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<tr>
<td>R1-S</td>
<td>6.99</td>
<td>7.1</td>
<td>0.11</td>
<td>-0.14</td>
</tr>
<tr>
<td>C-R1.GoMe</td>
<td>97.94</td>
<td>95.84</td>
<td>-2.1</td>
<td>0.54</td>
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</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>T2</th>
<th>difference</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6-S</td>
<td>15.6</td>
<td>15.5</td>
<td>-0.10</td>
<td>0.101</td>
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<tr>
<td>R6-S</td>
<td>17.46</td>
<td>17.6</td>
<td>0.14</td>
<td>-0.80</td>
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<td>C-R6.GoMe</td>
<td>94.7</td>
<td>95.4</td>
<td>0.70</td>
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<td>C1-S</td>
<td>3.6</td>
<td>3.94</td>
<td>0.34</td>
<td>-0.141</td>
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<td>R1-S</td>
<td>100.9</td>
<td>100.8</td>
<td>-0.10</td>
<td>0.537</td>
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*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>II vs. III</th>
<th>I vs. III</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6-S</td>
<td>-0.53</td>
<td>-0.44</td>
<td>-0.19</td>
</tr>
<tr>
<td>R6-S</td>
<td>-0.91</td>
<td>-1.115</td>
<td>-0.40</td>
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<tr>
<td>C-R6.GoMe</td>
<td>-1.21</td>
<td>-0.7</td>
<td>-0.161</td>
</tr>
<tr>
<td>C1-S</td>
<td>-1.68</td>
<td>-2.496*</td>
<td>-0.60</td>
</tr>
<tr>
<td>R1-S</td>
<td>0.06</td>
<td>0.11</td>
<td>0.34</td>
</tr>
<tr>
<td>C-R1.GoMe</td>
<td>-4</td>
<td>-2.10</td>
<td>-1.368</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 CR6.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 anterior 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 aid, 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


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Accuracy of bracket positioning is essential, so that the built-in features of the bracket system can be fully and efficiently expressed. This helps treatment mechanics and improves the consistency of the results. The authors use the following techniques, and recommend them.

**Bonding and Banding Technique**

The use of light-cured systems for bonding brackets and cementing bands is helpful. Light-cured systems avoid time pressure on the orthodontist when setting up cases. The bonding materials should be carefully used exactly to the maker’s recommendations, with plenty of good quality light. This will reduce breakages. Errors can be introduced when replacing loose brackets. The bonding agent should be thick enough to prevent floating of the brackets during positioning.

Bracketing and banding should always be performed by the orthodontist. Setting up of the case is the most important aspect of the treatment, after correct diagnosis and treatment planning. Banding and bonding should therefore not be delegated. When bonding brackets, if possible it is helpful to avoid viewing the incisor teeth from the side, or from above or below. This will require the patient to turn the head, and the orthodontist to change seating position from time to time (Fig. 1).

![Figure 1](image_url)

When placing brackets it is important to view the teeth from the correct aspect.

**The Use of Gauges**

Vertical accuracy can be greatly improved by the use of gauges and a bracket positioning chart (Fig. 2a,b). This will deal with difficulties such as tooth length discrepancies, labially and lingually displaced roots, partly erupted teeth, and gingival hyperplasia. The technique has previously been reported (ref. 1, 2).
The bracket placement gauges are used in slightly different ways in different areas of the mouth. In the incisor regions the gauge is placed at 90° to the labial surface (Fig. 3). In the canine and premolar regions the gauge is placed parallel with the occlusal plane (Fig. 4a, 4b, 4c). In the molar region the gauge is placed parallel with the occlusal surface of each individual molar (Fig. 5a, 5b, 5c).

**Figure 3:**
In the incisor region, the gauge is placed at 90° to the labial surface.

**Figure 4a:**
In the canine and premolar regions the gauge is placed parallel with the occlusal plane.

**Figure 4b:**
Parallel placement on UL Cuspid.

**Figure 4c:**
Lower bicuspid placement.

**Figure 5a:**
In the molar region the gauge is placed parallel with the occlusal surface of each individual molar.

**Figure 5b:**
Molar attachment positioned parallel to occlusal surface.

**Figure 5c:**
Parallel gauge placement to molar’s occlusal surface.
Modified Bracket Placement Charts

If the treatment plan involves extraction of four first or second premolars, a modified bracket positioning chart may be used (Fig. 6). This will ensure good vertical relationships between the marginal ridges of canines and second premolars.

**MBT™ Bracket Placement Guide (Bicuspid Extraction)**

<table>
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<th>U7</th>
<th>U6</th>
<th>U4.5</th>
<th>U3</th>
<th>U2</th>
<th>U1</th>
<th>Upper Arch</th>
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</thead>
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<tr>
<td>A</td>
<td>2.0</td>
<td>4.5</td>
<td>5.5</td>
<td>6.0</td>
<td>5.5</td>
<td>6.0</td>
<td>+1.0 mm</td>
</tr>
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**Figure 6**

If the treatment plan involves extraction of four first molars, a modified bracket positioning chart may be used as shown in figure 7. This will help to achieve good vertical relationships between the marginal ridges of second premolars and second molars. Second molar bands and tubes are used for the second molars, even though they will occupy the first molar positions.

**MBT™ Bracket Placement Guide (1st Molar Extraction)**

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**Figure 7**

If the patient demonstrates a deep anterior overbite, the brackets on the upper and lower centrals, laterals and cuspids can be placed 0.5mm more occlusal to assist in bite opening. Conversely, if the patient demonstrates an anterior open bite, these brackets can be placed 0.5mm more gingivally to assist in bite closure.

**Chipped or Worn Teeth**

It is advisable to make adjustments for chipped or worn teeth, or those with unusual anatomy, at the time of bonding and banding. The use of gauges and a bracket positioning chart will not deal with chipped or worn teeth, or teeth of abnormal anatomy, such as pointed canines.

For example, if a central incisor has a 0.5mm chip at the start of treatment, the bracket may be placed 0.5mm more gingivally than shown on the bracket positioning chart. Enamel shaping can then be carried out later in the treatment, leaving good coordination of incisal edges (Fig. 8).

**Figure 8:**
If a central incisor has a 0.5mm chip at the start of treatment, the bracket may be placed 0.5mm more gingivally than shown on the bracket positioning chart.

If upper canines are very pointed, and it is planned to re-shape the teeth later by 1mm, it is correct to anticipate this, and position the brackets 1mm more gingivally than shown on the bracket positioning chart (Fig. 9).

**Rotations**

Slight roto bonding is helpful when bracketing rotated incisors. On a rotated tooth the bracket can be bonded slightly more mesially or distally, sometimes with a very small amount of excess composite under the mesial or distal of the bracket base (Fig. 10, 11a, 11b). In this way full correction of the rotation can be achieved with no special measures. Also, viewing canines, premolars, molars, and rotated incisors occlusally or incisally with a mouth mirror helps bracket positioning relative to the vertical long axis of the crown.

**Figure 10:**
On a rotated tooth the bracket can be bonded slightly more mesially or distally, and in this way full correction of the rotation can be achieved.

**Figure 11a:**
A clinical example of roto bonding. Full correction of rotations can be achieved during the early stages of treatment, without any other special measures. Also see Figure 11b.
Special Care With Molars

Special attention is needed in the relationship between the lower first molar and the lower second premolar. This is the most difficult relationship in orthodontics. Special attention is needed to carefully place the lower second bicuspid bracket, because it is well back, and prone to contamination with saliva. A common mistake is to seat the mesial of the molar band too low, and this should be avoided (Fig. 12a, 12b).

Care is needed to avoid positioning the lower first molar band with the bracket too mesially. It should straddle the buccal groove (Fig. 13).

If there is a close bite on the lower first molars, the molar bracket should be at the correct height, as recommended in the bracket placement chart. It should not be positioned more gingivally. A lower second molar band and tube can be used in this situation, as part of the versatility of the MBT™ Appliance System (Fig. 14).

Temporary bonding material on the occlusal of the molars, or an acrylic bite plate can be used to avoid bracket interferences.

Re-positioning

Any positioning errors should be corrected before moving into wires heavier than .014 steel or .019 x .025 Nitinol Heat-Activated Wire. Re-aligning can then be done, before going into heavier wires.

When working with small clinical crowns, either due to partial eruption, or gingival hyperplasia, stepping of .014 round wires is helpful. The tooth can be bracketed with the bracket too incisal. At the .014 round steel stage the crown length can be increased by stepping the wires. At the next visit the tooth can be bracketed correctly and a larger wire inserted. In this way, treatment time can be reduced (Fig. 16).

There is also an opportunity to replace any wrongly positioned brackets when banding or bracketing newly erupted teeth, because normally it will be necessary to go back to light aligning wires. Also, if a patient comes in with a loose bracket which needs rebonding, it is worth checking the position of all other brackets. This is an opportunity to correct errors elsewhere.

The authors take time and care to try to achieve accurate bracket positioning at the set-up appointment. During treatment bracket positions are monitored and reviewed at adjustment visits. Using the techniques described and recommended in this article it is possible, in most cases, to avoid the need to change bracket positions in the later stages of treatment. This improves the efficiency of the treatment and the quality of the results.

REFERENCES
One of the most enjoyable aspects of practicing orthodontics is the diversity of the malocclusions we see. Our patients are all different, and these differences provide opportunities for thought-provoking treatment planning sessions.

As I reflect on my orthodontic residency training, many of us (if not all) were taught to have some level of respect for the existing mandibular arch form. There were many reasons given to keep the integrity of the mandibular arch, including long-term stability and periodontal health. As we treatment-plan our cases two challenges become evident: when should we maintain the integrity of the lower arch, and when should we deviate from it to achieve the results we want; and how to maintain the mandibular arch form in an efficient manner during the operation of a busy orthodontic practice.

Evidence for maintaining the lower arch integrity is abundant in our literature. As with most subjects in the practice of orthodontics we can find articles to support just about any position we want to take. However, there is definitely a preponderance of evidence pointing us in a certain direction on this subject. The typical result of deviating from a patient’s existing arch form is a relapse to pre-treatment arch width dimensions. The most often quoted studies come from those conducted at the University of Washington, although there are numerous other studies showing even greater links between arch form preservation and long-term stability in our treatment results\textsuperscript{1,2,3,4}.

Our evidence regarding periodontal effects of arch expansion is admittedly much thinner. We have all seen the effects on the periodontium of teeth that have been moved out of the alveolar bone. Yared, et al, in 2006 provided some hints at the periodontal effects of excessive proclination of lower incisors in orthodontically treated individuals when they reported significant recession associated with proclination in excess of 95 degrees to the mandibular plane. They also point out that tissue type plays a bigger role in whether recession occurs. This information can help us in determining which patients may tolerate some proclination and which can’t. A patient who has upright incisors and thick keratinized tissue will tolerate a treatment involving arch expansion better than a patient with proclined incisors and thin keratinized tissue.

I hope that as cone beam technology is advanced we will be able to look closer at what our treatment does to the underlying bone. This will advance our ability to provide the best treatment for the long-term health of the supporting structures of the teeth. It is unwise to forget about treatment planning for the functionality of the teeth. We can have the best functioning occlusion and fail in this goal of treatment if the teeth are compromised due to breakdown of the periodontal structures.
It undoubtedly takes more time to customize archwires for each of our cases. It is much easier to grab an archwire from a box and throw it in. This allows a shorter appointment time, however, we are compromising the stability of our final result. Multiple studies have shown that mandibular canines that have been expanded will relapse to their pre-treatment positions\textsuperscript{1,2,3}. If we ignore that fact then our treatment goal to provide long-term stability to our final results will fail. Whenever possible we should devise treatment plans that allow that width to be maintained. In those cases that require deviation from the pre-treatment width we should inform the patient that lifetime retention is necessary to maintain the alignment and bite.

3M Unitek offers many archwires in various arch forms. Our initial wires (.012 and .014 NiTi) are of insufficient stiffness to drive teeth to a different arch form. However, as we increase wire dimensions we must start to shape our wires to avoid distorting the arches. This is where keeping an inventory of at least three different arch forms can save time and still allows maintenance of lower arch integrity. In my practice I use a tapered, ovoid, and square arch form for any wire larger/stiffer than a .016 NiTi. When the original treatment plan is made, the pretreatment models and 3M Unitek’s archwire templates are used to determine whether a patient is tapered, ovoid, or square.

Prior to forming the final wire, the templates assist in determining how much distance is needed between the posts on the finishing archwire.

Having three arch forms means less time for me chairside, adjusting the wire to fit the patient’s original models. We now have a wire that is customized to the patient’s original arch form, yet took very little of my time chairside to create. Much of this process can even be delegated to properly trained staff members.

There are times when a deviation from the original lower arch form is indicated, such as an increased Curve of Wilson or retroclined lower incisors; however this deviation should be justifiable. Most of our cases should be treated to conform to the patient’s original lower arch form, and 3M Unitek has provided a simple way to achieve that.

In those cases where expansion or narrowing of one or both arches is necessary, care should be taken to do this without distorting the original arch form. Take, for example, the case that has been expanded with an RPE and needs an expanded archwire to hold it while treatment is completed. This wire should have some progressive palatal crown torque (or buccal root torque) and be expanded so that as it is activated it conforms to the lower arch form.

If this step is not taken, the practitioner risks distorting the arches by, for example, narrowing or expanding the canine region too much. Sometimes it is necessary to constrict the lower arch, and care should be taken so that when the lower arch is activated it conforms to the original shape of the lower model.
If we have taken care to maintain arch integrity during treatment, then settling at the end of treatment can take place. The archwire can be cut distal to the maxillary 2’s or 3’s and vertical elastics worn at night for approximately 2-3 weeks. When this is done the maxillary arch is laced 7-7 and the 6 bands removed to allow band space to close (unless the patient is bonded 7-7). Vertical 3/16” 6.5 oz triangle elastics are worn starting with the apex on the maxillary canine and the base on the mandibular canine and first premolar.

Figure 9: Finishing elastics. If the 7’s are not included in the appliance, the 6 bands are left in place so the rotational effects of the lacing are not left on a premolar.

Figure 10: Finished case maintaining lower arch integrity.

Three are worn per side at night for 2-3 weeks to allow final settling of the occlusion. If arch forms have been grossly violated then this may not be a good idea.

We all desire the best treatment possible for those trusting us with their care. We need to be conscious of what information our research as a specialty has given us. We also need to find ways to implement that knowledge in our everyday practice. Clearly there is a strong relationship between arch form distortion and post treatment relapse. There is a more tenuous relationship between arch expansion and loss of periodontal support. The three different arch forms available to us as part of the MBT™ Versatile+ Appliance System philosophy allows us to preserve our patients’ original arch forms through a clinically efficient means. Combine this with accurate bracket placement through indirect bonding and meticulous finishing, and we can finish each of our cases to the highest standard possible in as short a time as possible. It does require more inventory, however the savings in time chairside and the reassurance we are doing the best for our patients are well worth it.

Case photos provided by Dr. Ryan Moses.

References
Other references available upon request.

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Orthodontic Treatment Using The Dental VTO And MBT™ System

by Dr. Hideyuki Iyano

Dr. Hideyuki Iyano, Department of Orthodontics, Ohu University School of Dentistry, Japan. He is also a member of the Japan MBT™ System Study Group.

Having many cases with severe crowding in Japan, we tend to level the dental arches after premolar extraction. This often results in tipping of the adjacent teeth into the extraction site, slowing the leveling process and causing the anterior teeth to elongate due to the angulation built into the canine bracket in a preadjusted appliance system. In principle, .016 and .019 X .025 HANT wires with the anterior form of the arch wire matching the patient’s arch form should be sequentially used to level the buccal segments and canine bracket slots before proceeding to premolar extraction and bracketing of the anterior teeth.

In the MBT™ System, .019 X .025 stainless steel wires are used as final arch wires to correct the upper and lower dental midlines and close remaining spaces by sliding mechanics. This necessitates the analysis of the direction and amount of tooth movements in each quadrant to make an extraction/non-extraction decision and select appropriate anchorage.

The Dental VTO devised by McLaughlin, et al., is a useful diagnostic tool that enables clinicians to plan treatment and manage tooth movements during treatment. Two cases treated with the MBT system based on the Dental VTO will be presented.

Charting of the Dental VTO

This analysis consists of three charts:

Chart 1 (Initial Midline and Molar Position) records initial midline and first molar positions. These must be recorded with the mandible in centric relation.

Chart 2 (Lower Arch Discrepancy) records the lower arch discrepancy. Six primary lower arch factors, ① through ⑥, are estimated and recorded separately from canine to midline and from second molar to midline on each side. These values are then added to obtain the initial discrepancies a1, a2, A1 and A2. Four secondary factors (⑦ through ⑩), which are sometimes used to gain additional space, are then recorded from canine to midline and from second molar to midline on each side and added up to derive the remaining discrepancies b1, b2, B1 and B2 for the respective segments.

Chart 3 (Anticipated Treatment Change, VTO) records anticipated direction and amount of movements relative to first molars, canines and midline correction.
Initial crowding/spacing in the lower arch
1. Crowding/spacing from canine to midline on each side
2. Crowding/spacing in the premolar area
3. Crowding/spacing in the molar area
4. Space required for Curve of Spee leveling
5. Space required for midline correction
6. Space required for desired correction of protrusion or retrusion of the lower incisors

Initial discrepancies
a1: Crowding/spacing from right canine to midline
a2: Crowding/spacing from left canine to midline
A1: Crowding/spacing from right second molar to midline
A2: Crowding/spacing from left second molar to midline

Spaces expected to be gained with treatment
7. Additional space from interproximal enamel stripping
8. Additional space from expansion
9. Additional space from uprighting or distal movement of lower first molars
10. Additional space from extraction

Remaining discrepancies
b1: Crowding/remaining space from right canine to midline
b2: Crowding/remaining space from left canine to midline
B1: Crowding/remaining space from right second molar to midline
B2: Crowding/remaining space from left second molar to midline

Case 1: A crowding case with mesial displacement of the upper left first molar
Hideyuki Iyano, Department of Orthodontics, Ohu University School of Dentistry

Diagnosis and treatment plan
An 11 year 6 month old male presented with crooked anterior teeth (Fig. 1). The upper left lateral incisor was palatally displaced. His molar relationship was Angle Class II on the left side. There was 1.0mm of crowding in the lower left anterior area. The lateral cephalogram showed ANB of 2°, Wits of –4.0mm and no abnormality of A-P jaw relationship (Fig. 2). The inclination of the upper incisor was within a normal range, while the lower incisor was inclined labially. The upper left first molar was displaced 3mm mesially (Fig. 3). The upper midline was deviated 2mm to the left.

The above lower arch information was recorded on chart 2 (Fig. 4). From the primary factors for the lower anterior segment such as crowding, Curve of Spee and midline deviation, the initial discrepancy from canine to midline was calculated to be –2.0mm on the right side and –1.0mm on the left side. The initial discrepancy for the entire lower arch thus totaled –2.0mm on the right side and –1.0mm on the left side.

Diagnosis: Crowding with mesial displacement of the upper left first molar.

Dental VTO: Additional space from expansion of the lower arch with a full appliance was estimated to be 2.0mm for the right anterior area, 1.0mm for the left anterior area, 2.0mm for the right side of the whole arch, and 1.0mm for the left side of the whole arch.

A decision was made to distalize the upper left first molar 3.0mm and move the upper dental midline 2mm to the right in order to create space for the palatally displaced upper left lateral incisor (Fig. 5).
Course of treatment and results

A unilateral headgear was used for 4 months, resulting in 4mm distal movement of the upper left first molar. As Class I molar relationship was established on the left side, full appliance treatment was initiated. Three types of arch wires were used during treatment: .016 HANT wires, .019 X .025 HANT wires and .019 X .025 SS wires, all in OrthoForm™ III (ovoid type).

Upper and lower .016 HANT wires were placed to level the lower canines with lacebacks (Fig. 6). With the placement of upper and lower .019 X .025 HANT wires, the buccal segments were leveled and the overbite was closed (Fig. 7, 1 mo.). The upper and lower anterior teeth except the upper left lateral incisor were bracketed (Fig. 8, 2 mo.). Upper and lower .019 X .025 SS wires were inserted, and an open coil spring was used to gain space for the upper left lateral incisor (Fig. 9, 4 mo.). The upper left lateral incisor bracket was placed upside down (Fig. 10, 5 mo.). The palatally displaced upper lateral incisor was moved labially into the arch by under-laying the .016 HANT wire. In the upper arch, a .019 X .025 HANT wire was placed (Fig. 11, 6 mo.), followed by a .019 X .025 SS wire (Fig. 12, 12 mo.). After the upper lateral incisor was torqued adequately, the settling process was initiated (Fig. 13, 13 mo.). Active treatment time was 14 months (Fig. 14, 15, 16). The post-treatment panoramic X-ray shows that root paralleling has been accomplished.

The torque of the palatally displaced upper left lateral incisor was effectively controlled with the inverted bracket.
Case 2: A functional anterior crossbite case
Hideyuki Iyano, Hideki Ogawa, Department of Orthodontics, Ohu University School of Dentistry

Diagnosis and treatment plan
A 13 year 3 month old female presented with a crossbite. The anterior teeth were in crossbite (Fig. 17). Her molar relationship was Angle Class I. The lateral cephalogram showed that the mandible was in front of the maxilla with ANB of –2.0° and Wits of –8.0mm (Fig. 18). The inclinations of the upper and lower incisors were 124.0° and 94.0°, respectively, both being labially inclined. The upper dental midline was deviated 2.0mm to the left (Fig. 19). The Curve of Spee was 2.0mm. Her arch showed 1.0mm of crowding in the lower premolar area on each side.

These numbers were entered into chart 2 (Fig. 20). The initial discrepancy for the lower anterior segment consisting of incisor position, crowding, Curve of Spee and midline deviation amounted to –3.0mm on the right side and –3.0mm on the left side. The initial discrepancy for the entire lower arch totaled –4.0mm on the right side and –4.0mm on the left side.

Diagnosis: Functional anterior crossbite

Dental VTO: Extraction of four first premolars was required due to the amount of discrepancy. The lower central incisors needed to be retracted 3.0mm. The analysis also called for 3.0mm of lower canine retraction on each side and 3.3mm of mesial movement of the lower first molar on each side. The upper first molars needed to be moved forward 3.3mm per side in order to maintain Angle Class I molar relationship.

It was decided to shift the upper midline 2mm to the right (Fig. 21).
Course of treatment and results

Three types of arch wires were used during treatment: .016 HANT wires, .019 X .025 HANT wires and .019 X .025 SS wires, all in OrthoForm™ III (ovoid type). A Nance holding arch was placed in the upper, while the lower arch was started with a .016 HANT wire (Fig. 22). Considering the need to intrude the lower incisors, the lower buccal segments were leveled first, followed by leveling of the lower canines with lacebacks. An upper .016 HANT wire and a lower .019 X .025 HANT wire were then placed (Fig. 23, 2 mo.). These wires were replaced with an upper 019 X .025 HANT wire and a lower 019 X .025 SS wire (Fig. 24, 8 mo.). Following the intrusion of the lower incisors, which was accomplished in 2 months, the upper incisors were bracketed (Fig. 25). Midline correction was initiated after overbite improvement (Fig. 26, 16 mo.). After one month of settling, active treatment was completed in 23 months (Fig. 28, 29, 30). The post-treatment panoramic X-ray shows that root paralleling has been achieved. The use of lacebacks for lower canine retraction minimized anchorage loss of the molars.

Summary

The Dental VTO was found to be a useful aid in diagnosis, treatment planning and management of three-dimensional tooth movements at chairside.