Anterior Torque: Second and Third Order Problems in Lingual Orthodontics Revisited

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Introduction

For those practicing Lingual Orthodontics, one of the re-occurring problems over the decades has been correct leveling of the upper incisors when there are major torque changes.

Obviously the upper incisors and particularly the central incisors are a major focal point for the patient. These are the most prominent teeth when they look in the mirror every day and with lingual orthodontic treatment they are able to clearly see the changes taking place.

The phenomenon of height vs torque has been studied before with relation to ‘slop effect’, or play between bracket slot and wire, with various articles being published highlighting the effects since 1999.

In this brief lab study done nearly 3 years ago, the ‘Tip and Torque Surveyor’ and the ‘Bracket Positioning Instrument’ were used to clearly show how a standard lingual bracket with a slot to base angle of 55 degrees looks in relation to torque at the same vertical height, also how the base fits to the lingual morphology of an average looking central incisor. These instruments are used every day for our work measuring study models, mal-occlusion models and diagnostic set-up models to find the mesio-distal crown angulation (Tip) and the labio-palatal crown inclination (Torque) of teeth in order to individualize the Lingual Bonding prescription for each case within the “IN-tendo” system started in 2010, so over the years we have measured thousands of different archforms and made the necessary adjustments to minimize the relationship of second and third order problems in our lab work.

Note

Torque is a word which is often misused and for the sake of this article we are keeping with the term commonly used in orthodontics to describe a desired labio-palatal inclination. Torque is actually a torsional force. In orthodontics it is the force exerted between the wire and the slot to achieve a certain tooth inclination between the lingual and the facial aspects of the anatomy.

Paris 2004 I spent 2 weeks at Dr. Fillion’s lab in Paris learning to use the Modified TARG in the B.E.S.T. system for Lingual indirect bonding. He returned again for another 2 weeks in 2005 after completing the BPD and working on the TAD instrument project.
Method

An average shaped central incisor was chosen from a real case stone master model and the long axis of the clinical crown (LACC) marked using a 0.5 mm pencil down the center of the crown from incisal edge to the gingival margin. The crown length was measured using digital calipers and then the midpoint (FA point) also marked. The model was sectioned using a stone cutting disc to remove just the central incisor required; in this case the #21 was chosen. A root was modelled with a tungsten bur just as a means of retention, so that the tooth could be inserted into a block of lab putty for stability and clear visibility during the measurements.

The previous generation of instruments 'Torque Angulation Device' (TAD) and 'Bracket Positioning Device' (BPD) were used in this study but the principle function of both the TAD and the New 'Tip and Torque Surveyor (TTS) are the same/ Also for the BPD and New BPI.

The TAD or TTS are used to either measure or 'set' Tip and Torque, however it must be noted that when doing both it is also critical to get our reference lines as accurate as possible (this goes for all orthodontic techniques involving 'Tip & Torque'). The blade of the TAD has an average curvature and a mid-point marked. It is the operators job to make sure the mid-point of the blade matches the FA point of the tooth for height. Also the vertical aspect of the blade follows parallel to the LACC for Tip. The curvature of the blade should find the best fit to the morphology of the tooth being measured when the mid-point matches the FA point and Tip has been previously established, this will give the best average tangent for the labio-palatal crown inclination (often referred to as 'Torque').

The #21 was inserted into the lab putty to be held securely whilst doing the measurements plus photographs and the process started by setting first the TAD to a 0 degree torque and a 2 degrees positive tip by moving the torque and tip adjustment knobs. Then the adjustable survey base holding the tooth was moved, at the same time using the fine height adjustment of the TAD instrument to align the FA point and LACC of the #21 with the blade of the TAD. Once a good relationship of tooth to instrument blade had been established, then the adjustable base was locked and transferred with model over to the BPD. The BPD instrument being used to set the height of the lingual bracket slot and measure the distance from the vestibular surface to the slot. It has a Mitutoyo digital dial test indicator and digital calipers to do this which are held perpendicular and parallel to the base of the instrument. The calipers are opened wide enough and the reciprocating jaw of the bracket holder lowered down to the incisal edge using the gross and fine height adjustment knobs. Once light contact is made with the edge of the tooth, the DTI is reset to zero. The fine height adjustment knob can then be used to lower the bracket down to the prescribed height. We chose the middle third of the lingual surface on the crown of the tooth for the best bracket position and this corresponded to a vertical height setting of 3.5 mm. The thickness was read from the point the bracket base made contact with the lingual surface. The same procedures were followed with increasing tip and torque settings which are close to common prescriptions used today in labial orthodontics, such as Andrews, Roth and MBT. However the vertical height setting of the BPD was always kept at 3.5 mm, which is a common slot height used in lingual orthodontics.
Above the Torque prescription for Andrews (low torque) and right we can see how the bracket fits to the tooth at 3.5 mm vertical height.
Below and right we can see the same situation, but with Roth prescription. So we have only changed torque by +5 degrees, everything else is the same with bracket height still at a vertical of 3.5mm.
Results

From the images provided, the results clearly show the effect of torque on bracket positioning when using the same vertical height of the bracket slot in lingual orthodontics, thus a direct relationship between Second and Third order problems in lingual orthodontics. As the tooth is proclined the vertical surface of the lingual morphology shortens, thus the bracket moves more gingival at higher torque settings on incisor shaped teeth. The “Triangle Effect,” (as I call it) due to the morphology will determine the varying lingual height for changing morphologies. We can see from the results in the charts below, that the change in distance down the lingual surface (the hypotenuse of the triangle) is not equal for the change in torque. As that triangle form changes so does the effect of torque. The base of the bracket fitted best in the mid torque settings.

<table>
<thead>
<tr>
<th>Torque</th>
<th>Thickness</th>
<th>HL2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degrees</td>
<td>mm</td>
<td>mm</td>
</tr>
<tr>
<td>Lab test Zero</td>
<td>0</td>
<td>4.74</td>
</tr>
<tr>
<td>Andrews (Low)</td>
<td>7</td>
<td>5.25</td>
</tr>
<tr>
<td>Roth (Medium)</td>
<td>12</td>
<td>6.22</td>
</tr>
<tr>
<td>MBT (High)</td>
<td>17</td>
<td>7.73</td>
</tr>
</tbody>
</table>

HL1 being the fixed vertical height from the incisal edge and HL2 being the distance from the incisal edge to the bracket slot down the lingual surface or ‘hypotenuse’ of the ‘tooth triangle’.

Right: The red lines represent the slot at 3.5mm of pure vertical height for all 4 different torque settings. We can see the distance moved is not the same for each torque change, with the smallest change coming in the mid torque range between 7 and 12 degrees. The change between 12 and 17 degrees was around 50% more than the 7-12 range. So from 0 to 7 degrees we had approximately 0.15mm movement per degree, 7-12 had 0.1 mm per degree and between 12-17 degrees of change, we had 0.16 mm change per degree of torque.
I also did a test to see how much the incisal edge moved in relation to degrees of torque, by setting 0, 10 and 20 degrees into the TAD, moving the tooth to match the blade as previously, then using the BPD to measure the drop of the incisal edge. This related almost exactly to the amount found in previous studies, such as the one by Thomas Stamm and Dirk Weichmann in the year 2000 for the Journal of Lingual Orthodontics.

**Left:** At zero degrees the BPD is set to 0.00 mm to touch the incisal edge.

Below we then increase to 10 degrees and measure the distance moved, here it was 1.2 mm, which exactly fits the research mentioned above in 2000.

Then at 20 degrees we found the incisal edge had dropped a further 1.4 mm. We could factor in human error, although we did check it several times. But this would give an average of 1.3 mm per 10 degrees.

**Below: The working parts**

Diagram of the BPI which has replaced the BPD

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**Conclusions**

In lingual orthodontics the ideal wires are flat. Some prefer them ‘straight’ without 1st order bends using offset bracket positioning to compensate, others prefer good close fitting brackets and wires which have some or many 1st order bends. We see this different philosophy between many of the masters in Lingual Orthodontics, but one thing in common is that they can all reach fantastic results. Some Dr’s prefer to bend wires following their traditional Orthodontic training and others like to use computerized systems and robots to help them. One thing is constant though and they all agree, that precise bracket placement in lingual orthodontics is a must. The problems in systems such as the ‘Hiro technique’ using a ‘flat wire’ to bond the brackets to the set-up (and some CAD CAM systems imitate this in their software), is that when the extra ‘torque’ (inclination) is put into the set-up then the brackets will be more gingival on the anterior teeth.
following the wire/slot plane. This is fine if full torque is expressed, which we know from experience and scientific research it rarely is. So everyone is 'Talking about Torque' and what to do?

Well if we know through the research before and what I am showing now that the problem exists and why, then surely we can learn to compensate bracket positioning with torque or height changes? For example we often see cases where two upper central incisors are at two very different labio-palatal inclinations. To set both brackets at the same height would probably lead to one tooth appearing longer during the treatment and the Dr. having to use his wire bending skills to solve it. A certain amount of 'Rabbiting' or 'Dumping' can be expected when the round wires are being used, but as soon as the torque wires are engaged, we should be able to estimate the amount with regards to the play between wire and slot…."The Torque Trap" as described by Prof Earl Johnson in 2013.

So for example I have two central incisors and one is in a good position with a nice inclination for the case profile and occlusion, but the other is retroclined at 10 degrees. If both are bonded at the same height then the tooth which is retroclined will have the most torque to move it to match the good inclination of the adjacent tooth. In doing so it will be the tooth with the most torque loss and therefore with a 016 x 022 wire in an 018 slot, 10 degrees of play will be exhibited. This we know from this study and others will relate to 1.2-1.4 mm of height difference, thus a leveling/finishing problem.

Below are a couple of diagrams from one of my PPT’s which shows the second and third order problems due to bracket positioning. In labial orthodontics the side effects are minimized but all too often seen in everyday treatments. From the book Systemized Orthodontics Treatment Mechanics: “Torque control is the weakness of the pre-adjusted system and any system which is based on the edgewise bracket. There are three factors, and because of these, there does not seem to be a single set of torque values that will serve the needs of all patients” McLaughlin, Bennet and Trevisi 2001 However in Lingual the problems are exaggerated due to the distance between pint of rotation and the incisal edge as the diagram below shows.

Left: Small errors in Torque between the labial bracket positioning and the lingual, with lingual side effects of either bad bracket positioning or torque loss between bracket slot and wire, leading to dumping of the incisal edges.

In the lingual system the customization for Tip & Torque has to be done via the laboratory process due to the varying lingual morphologies. This can be by using set-up models and wires to position the brackets, instruments such as the ones I use or others on the market developed for this, or via CAD CAM techniques. Whether it is a customized metal casting or just a small composite pad, the results are the same.

Its fine to use the pure mechanics and physics to calculate the amounts of torque compensation. \( r = \sqrt{h^2 + d^2} \) plus all the other mathematical formulas in the various books, however it can only be estimations due to the fact we have “Bio-Mechanics” and those three letters at the beginning of this term can make all the difference, hence the experience and data retrieved by orthodontists over successive cases is paramount to the success of any lingual treatment planning.

As supporting technicians we need to learn as much about the way the Dr's work as possible. Fixed orthodontics is not normally the realm of the Dental technician, so maybe a specialized unit needs to be set-up to prepare them for this type of work. I use a word a lot that I found in a very old technical manual for ‘Swinglocks’ …”Imagineering” can help a lot when we need to visualize a case with all of the elements in front of us.

Comments

By doing thousands of cases in our lab for Lingual Orthodontics, measuring the large part of them for both master model values and set-up values for tip and torque, it helps me visualize the movements and requirements when doing the diagnostic set-up models. By bonding with these instruments for the past 12 years I have had massive data feedback that without them would not be possible. When I travel around the world and meet other people, famous Dr's and see what they are now doing; I am pleased to see that similar principles are being used from Barcelona to Tokyo.
There's always more questions to be answered and we only get the answers by searching. There is a lot of good literature out now with regards to Lingual Orthodontics and informative courses available. We know that for example in the books from Dr. Scuzzo and Dr. Takemoto that the point of rotation with regards to torque is around the wire in the slot and that the distance from the slot to either the vestibular face / incisal edge in anteriors or the buccal cusp in posteriors influences the effect of torque error.

From the study done in 2000 mentioned earlier T. Stamm et al, showed a simulated study for the teeth around the arch and how much in mm per degree can be expected for each tooth. They said “The results of this study show that the degree of vertical alignment discrepancies attributable to torque problems is surprisingly high, at 1.2 mm / 10 degrees in the incisor region and increasing to 2 mm/10 degrees in the buccal segments owing to increase in positioning thickness…” There is much more that was very important in their conclusions, so I recommend reading this article Volume 1 Number 3 JLO.

I wanted to revisit this 17 years later as it looks as though the problems are still there for many Dr’s, maybe through a lack of understanding of lab techniques or a lab that doesn’t apply compensations, due to the complexity of calculating them Peter D. Sheffield Innovator of TAD and BPD, TTS and BPI and inventor of the IN-tendo lab system.

References