Selecting custom torque prescriptions for the straight-wire appliance

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Selecting custom torque prescriptions based on the treatment needs of each patient can reduce the amount of routine archwire torque adjustment needed and speed torque correction, thus reducing the total treatment time. Using the appropriate torque prescription prevents iatrogenic torque problems and allows most torque corrections to be done earlier with more resilient nickel-titanium and beta-titanium wires. As a result, fewer time-consuming final torque adjustments are needed with stainless steel finishing wires, resulting in shorter treatment time. (Am J Orthod Dentofacial Orthop 2013;143:S161-7)

With judicious treatment planning, the clinical orthodontist using a straight wire appliance can reduce the need for routine torque adjustments. Molars needing torque can be uprighted early and accurately during treatment, and fewer routine final torquing adjustments will be needed at the end of treatment (Figs 1 and 2).

The straight-wire appliance was developed by Dr Larry Andrews of San Diego, Calif.1 This appliance incorporated slot inclination (torque), slot angulation (mesiodistal root tip), and first-order offsets (varied bracket base thickness) into individual brackets designed for each tooth in the arch. This innovation made it possible not only to level with unadjusted round nickel-titanium wires but also to continue leveling with flat unadjusted rectangular wires. This appliance concept greatly reduced the amount of routine wire bending needed for the average patient. The torque prescription values incorporated were developed from Andrews’ research with 120 untreated normal occlusions (Table I).1

The straight-wire appliance made it possible to use flat, unadjusted rectangular nickel-titanium wires for generalized initial torque correction and control.

Accurate bracket placement is essential for an excellent tooth position outcome. Beyond that, the slot torque prescription in the bracket can be varied according to the direction of buccolingual root movement desired or to be prevented. Attention to torque values permits even more accurate leveling and early torque control than is possible with the basic Andrews’ torque values. By following up leveling with formable beta-titanium or stainless archwires, complete torque correction can be easily completed to the values chosen by the practitioner.

Any bracket can rotate freely about a rectangular archwire until the wire becomes locked against the bracket slot walls (slot lock). The total amount of free rotation for each tooth crown, from lock point to lock point, is twice the amount of nominal slot play (Figs 3 and 4, Table II). Since the bracket can rotate about the archwire in 2 opposite directions, 2 slot lock points are created. Every combination of archwire shape and specified slot size has a slot play for that particular combination. These data are not easily available from manufacturers.

Meling et al2 published a formula for calculating slot play, taking into consideration (1) slot height (manufacturers make them larger than nominal size), (2) wire size (manufacturers make them slightly smaller than nominal size), and (3) edge rounding (corner radius) of the archwires (not usually disclosed by manufacturers).

For all teeth, the desired torque prescription calculations are based on the slot play of the final finishing or detailing archwire.

Ideally, the final finishing archwire will bring each tooth to its desired faciolingual angulation. To achieve this, the clinician must choose a torque prescription and wire size combination that will cancel out the slot play at the crown’s desired final inclination. The
prescription depends on the direction of root movement during treatment. For any torque prescription and archwire combination, the resulting tooth position will be different if the tooth is moved labially than if it is moved lingually. Since the practitioner knows which direction the teeth will be moved, the torque prescription can be custom chosen to stop tooth movement at the desired crown inclination.

A bracket’s torque prescription value is the angle that the occlusal and gingival slot walls make with the plane of the bracket base. Angle’s original prescription was 0° for all teeth. Nominal values are the amount in degrees that the slot inclination deviates from Angle’s 0° orientation. By convention, a positive torque value essentially means that lingual root torque would be created by a large unadjusted rectangular wire; conversely, a negative torque value means that facial root torque would be created.

If a flat, unadjusted rectangular wire is placed in an edgewise slot and does not lock against the slot walls, it will provide no labiolingual forces on the tooth root (torque). If, on the other hand, the wire must be twisted before seating in the slot and remains twisted after ligation (slot locked), it will apply forces to the roots until the wire is no longer twisted (Fig 5).

The 2 lock points create a range of uncontrolled crown torque values 2 slot-plays wide. The 2 lock points form the boundaries of the “torque trap.” If the initial root angulation is within this range, no torque is applied until the root position changes enough to lock the bracket against the wire. These lock points also define the desired final inclinations of any teeth with their root positions initially beyond the lock points. Roots previously outside the trap demonstrating any excessive labial or lingual root positions (eg, Division 2 incisors) will be attracted to the nearest border of the trap (Fig 6).

For example, if a bracket’s torque prescription is 0° and the slot play of the edgewise wire in the slot of this same bracket is ±9°, any excessive labial root position farther labially than −9° will be corrected back to −9°.

By the same token, any excess lingual root position more palatal than +9° will be corrected back to +9°. The net effect is that any excessive torque inclinations will be corrected to the closer slot-play border of the torque trap.

With this example, if the preexisting torque of a central incisor was +5° (within the ±9° borders) and traction was causing the tooth to tip toward the lingual aspect, the incisor would tip until it reached the −9° border. Obviously, a −9° inclination is way too lingual and unacceptable. However, if the clinician chose a +15° bracket instead of a 0° bracket, the incisor facial inclination would be held at +6° (+15° − 9° = +6°); this is much closer to Andrews’ ideal of +7°.

The key point is that, before treatment starts, the clinician, knowing the slot play of the final wire, can pick an optimal prescription that will set the borders of the torque trap that either will move the tooth to the desired inclination or prevent it from escaping it. A small selection of off-the-shelf bracket prescriptions will usually provide torque values that are close enough. The end point is to minimize repeated routine torque adjustments.

Andrews’ torque norms are my final torque goals. His seminal research in tooth anatomy, normal occlusions, and treatment goals has produced excellent norms for the labiolingual inclination of facial surfaces of clinical crowns. These norms reflect normal crown inclinations and their corresponding normal labiolingual root positions (Table I). All of his torque values are measured in relation to the occlusal plane. They do not consider the actual inclination of the patient’s occlusal plane and

Fig 1. Second molar with a residual hanging lingual cusp late in treatment because of poor automatic torque control.

Fig 2. Second molar in need of buccal uprighting and automatic torque correction.
therefore should only be used as an approximate guide and not an immutable goal in all instances. In this discussion, Andrews’ norms will be called target torques.

Does 1 prescription fit all? Most practitioners pick 1 constellation of bracket prescriptions that have been developed by a prominent clinician: eg, Andrews, Roth, Ricketts, and Alexander. These prescriptions were developed by the clinician using his own wire sequences and wire-modification techniques. Look in any orthodontic catalog and see the many techniques and related torque values available for any tooth. If you know the slot play allowed by your finishing archwire, you can choose brackets off the shelf that will torque the teeth much closer to your goals.

In extraction patients, both the maxillary and mandibular anterior teeth are usually retracted to some degree. Retraction forces tend to tip the crowns lingually, whereas excessive slot play can lead to insufficient lingual root torque at the end of movement. Class II mechanics often produces a similar effect. To prevent excessive maxillary incisor lingual tipping, select a bracket prescription that equals the target torque plus the slot play. Retraction will just tip the incisor lingually until the slot play is used up, then the archwire will lock in the slot at the proper inclination and resist any further lingual tipping.

Table I. Average crown inclinations

<table>
<thead>
<tr>
<th>Tooth</th>
<th>Central incisor</th>
<th>Lateral incisor</th>
<th>Canine</th>
<th>First premolar</th>
<th>Second premolar</th>
<th>First molar</th>
<th>Second molar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxilla</td>
<td>+7</td>
<td>+3</td>
<td>−7</td>
<td>−7</td>
<td>−7</td>
<td>−9</td>
<td>−9</td>
</tr>
<tr>
<td>Mandible</td>
<td>−1</td>
<td>−1</td>
<td>−11</td>
<td>−17</td>
<td>−22</td>
<td>−30</td>
<td>−35</td>
</tr>
</tbody>
</table>

Fig 3. Slot play. A bracket can rotate in either direction around the flat archwire until the slot play is used up and the wire locks between the slot walls (slot lock). The amount of slot play is specific to each individual wire-slot combination.

Fig 4. Formula for calculating slot play of any archwire and slot combination (see Table II).

\[
\gamma = \arcsin \frac{H - 2r}{d} - \arcsin \frac{h - 2r}{d}
\]

Calculation assumptions: wires undersized by 0.0002 in; slots oversized by 0.0005 in; wire corner radius = .0004 in.

Table II. Calculated wire slot play in edgewise brackets

<table>
<thead>
<tr>
<th>Nominal wire size</th>
<th>0.018 slot</th>
<th>0.022 slot</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.014 × 0.025</td>
<td>12.0</td>
<td>24.4</td>
</tr>
<tr>
<td>0.016 × 0.016</td>
<td>11.6</td>
<td>Spin</td>
</tr>
<tr>
<td>0.016 × 0.022</td>
<td>7.8</td>
<td>21.7</td>
</tr>
<tr>
<td>0.016 × 0.025</td>
<td>6.7</td>
<td>18.1</td>
</tr>
<tr>
<td>0.017 × 0.017</td>
<td>6.5</td>
<td>28.5</td>
</tr>
<tr>
<td>0.017 × 0.022</td>
<td>4.8</td>
<td>18.0</td>
</tr>
<tr>
<td>0.017 × 0.025</td>
<td>4.2</td>
<td>15.1</td>
</tr>
<tr>
<td>0.0175 × 0.0175</td>
<td>4.3</td>
<td>23.4</td>
</tr>
<tr>
<td>0.018 × 0.018</td>
<td>2.4</td>
<td>19.5</td>
</tr>
<tr>
<td>0.018 × 0.025</td>
<td>1.7</td>
<td>12.5</td>
</tr>
<tr>
<td>0.019 × 0.025</td>
<td>X</td>
<td>9.5</td>
</tr>
<tr>
<td>0.020 × 0.020</td>
<td>X</td>
<td>8.9</td>
</tr>
<tr>
<td>0.021 × 0.016</td>
<td>X</td>
<td>7.1</td>
</tr>
<tr>
<td>0.021 × 0.021</td>
<td>X</td>
<td>5.1</td>
</tr>
<tr>
<td>0.021 × 0.025</td>
<td>X</td>
<td>4.2</td>
</tr>
<tr>
<td>0.022 × 0.018</td>
<td>X</td>
<td>2.4</td>
</tr>
<tr>
<td>0.022 × 0.025</td>
<td>X</td>
<td>1.7</td>
</tr>
</tbody>
</table>

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Take, for example, the retraction of maxillary central incisors in a Class II case. Andrews’ target torque for
a maxillary incisor is $+7^\circ$. In our example, the wire’s slot play is $\pm 9^\circ$ [Table II, 0.020 × 0.020 in a 0.022-in slot]. Our target is $+7^\circ$. Since we want to prevent excess lingual crown tipping, we would add the slot play to the target for a prescription of $+16^\circ$; $9 + 7 = +16^\circ$, which would be the minimum preventive prescription.

Available on the market are $15^\circ$ and $17^\circ$; either is much closer for the creation of proper tooth angulation than the standard $7^\circ$ bracket.

Or take the example of retracting maxillary lateral incisors. The maxillary lateral incisor target torque is $+3^\circ$ and, in this example, the slot play is $\pm 10$. 

**Fig 5.** Root torque generated by a flat wire twisted, as needed, and inserted in brackets with various slot inclinations. Corrective torque is developed by bracket inclinations past the slot lock points. Note the lack of any torque control between the lock points in the torque trap section.

**Fig 6.** Torque generated by root position. Any root position outside the slot lock points will be torqued toward the closer slot lock point. Any root position between the slot lock points is not controlled by wire torque, but it cannot escape past either slot lock point because of resistant torque buildup.
Since we want to prevent excessive facial root positioning, we add the 10° slot play to the +3° target to equal a +13° prescription that will resist excessive lingual crown tipping during retraction (+3 + 10 = 13) (Fig 7).

The retraction of mandibular incisors in extraction patients presents a similar scenario. The mandibular incisor’s target torque is −1°; in our example, slot play is ±9°. Since we want to resist lingual crown tipping, we add the 9° slot play to the −1° target torque for a preventative prescription of +8°. So, [+9° −1° = +8°]. Currently, on the market, there is a +6° bracket and a −10° bracket that can be inverted to make a slightly hyperactive and preventative +10° torque prescription.

Often, while recovering an impacted canine, the crown tips nicely to the labial aspect, leaving the root tip too far palatally. Andrews’ target for maxillary canines is −7°. In our example, slot play is ±9°. Since the root needs to be moved labially, the 9° slot play must be subtracted from the target torque. So, [−7°] −9° = −16°. There is no −16° prescription available for a maxillary canine, but a −17° mandibular first premolar bracket could be used. If more torque activation is desired, a −22° mandibular second premolar bracket could also be used. Since mandibular premolar bracket bases are thicker, some compensating first-order wire bends might be needed during final detailing.

Once space has been created, a palatally blocked lateral incisor crown can be easily tipped out to its proper position in the arch, usually leaving its root too far toward the palate. Andrews’ target torque for maxillary lateral incisors is +3°. Since we need labial root movement, we subtract our example’s slot play of +10. From the target torque of +3° to equal a custom torque prescription of −7° (Fig 8). A −7° maxillary lateral bracket does not currently exist. One could invert a +3°, a +8°, or even a +14° bracket to effectively produce a −3°, a −8°, or a −14° lateral incisor bracket. I have found that a −8° bracket or even a −14° works quite efficiently with “full-fit” square nickel-titanium wires. However, if it is left in place too long, the resulting movement would exceed the goal, so one must replace these hyperactive brackets once torque correction has been achieved.

A hyperactive prescription can be the best choice to fully upright some lingually inclined Division 2 central incisors. Our maxillary central incisor calculation above indicated a +16° prescription for a 9° slot-play bracket. Using the Ricketts +22° prescription will give an additional +6° of activation over the +16° bracket.
You can replace the hyperactive bracket when good position is obtained, if necessary.

Maxillary second molars typically erupt tipped buccally. Often, after buccolingual round-wire leveling, the roots are still too far toward the palate, resulting in an extruded “hanging lingual cusp.” Andrews’ target torque for the maxillary second molar is $-9^\circ$. If you subtract (need labial root movement) our examples’ $9^\circ$ slot play from the $-9^\circ$ target torque, you would find a theoretical corrective torque prescription of $-18^\circ$. Second molars, however, present a different clinical situation, since their interbracket distance from the first molar is quite large. Also, second molars have only 1 neighbor, the first molar to the mesial aspect, to influence their position through wire mechanics. Because of these 2 factors, I have found that a $-30^\circ$ mandibular second molar tube works quite well on a maxillary second molar.

Mandibular second molars often erupt tipped lingually. After leveling, their crowns can still be inclined toward the lingual aspect, with the roots remaining too far toward the buccal aspect. Andrews’ target torque for mandibular second molars is $-35^\circ$. Since you want the roots to move toward the lingual aspect, you would add the $9^\circ$ slot play to the target torque, resulting in a theoretical $-26^\circ$ torque prescription. For the same reasons outlined for the maxillary second molars, I have found that we need even less negative torque in the prescription. I have found that using a $-10^\circ$ maxillary molar tube on the mandibular second molar works quite well.

**CONCLUSIONS**

1. Choose which edge of the torque trap will be active: high torque or low torque position on the torque trap.
2. To correct or prevent excessive facial root positions, add the slot play to the target torque.
3. To correct or prevent an excessive lingual root position, subtract the slot play from the target torque.
4. Many off-the-shelf prescriptions can be used.
5. Realistically, very few different prescriptions are needed for any given tooth. I use only 1 prescription for the mandibular canines, all premolars, and all molars (Table III).
6. Minor torquing adjustments are usually made only in my final finishing arch.

By selecting the torque prescription needed on a patient-to-patient basis, the practitioner can use thick unadjusted nickel-titanium and beta-titanium archwires to efficiently correct existing aberrant torque situations. Proper selection also enables a practitioner to avoid creating poor iatrogenic torque situations that will then need to be corrected later. Final torque detailing adjustments can still be made by adjusting either
formable beta-titanium wires or the more traditional, but stiffer, stainless steel archwires. Overall, fewer routine torque adjustments will need to be made with formable wires. Total treatment time and clinical effort can be reduced by proper torque prescription selection for each patient during treatment planning.

The entire thought process described above was done without the benefit of all the computerized enhancements that are now available to the practitioner. Now, a computer can select the appropriate torque prescription to be created in the slot of a custom fabricated bracket for every tooth in the arch. Other computerized systems calculate how much torque needs to be bent, on a tooth-to-tooth basis, into a custom prefabricated archwire. To be effective, the computerized “black box” must know the slot play, the diagnosis of each tooth position, and the net direction of tooth movement to the final position.

Currently, the practitioner can quickly do all of the above already. Rapid consistent excellence is still possible with yesterday’s technology.

**REFERENCES**