Influence of the Convexity of the Upper Central Incisor on the Torque Expression of Preadjusted Brackets

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The Andrews method of preadjusted bracket positioning involves placing the twin tie wings parallel to the long axis of the clinical crown and then moving the bracket up or down until the middle of its slot is at the same height as the center of the clinical crown.[1] Many authors have noted, however, that individual variations in dental anatomy—and particularly in the convexity of the labial crown surface—can produce considerable differences in torque expression.[2-5]

According to Meyer and Nelson, on the mandibular first premolar, which has the greatest occlusogingival curvature of any tooth, a 3mm vertical movement of the bracket results in a 15° change in the applied torque.[6] Miethke found that a 5mm vertical displacement of an anterior bracket can increase torque by 18°,[7] and Germane and colleagues showed that a 1mm vertical placement error can alter torque values by as much as 10°.[8] In a study by Miethke and Melsen, displacements of less than .4mm had only a minor influence on bracket torque, but greater deviations resulted in changes of 2-10°.[9] These authors concluded that a totally preadjusted appliance was unattainable because of individual morphological variation.

The objective of the present study was to evaluate the variability of the labial surface of the maxillary central incisor and to assess its influence on the torque expression of preadjusted brackets.

Materials and Methods

Fifty extracted maxillary central incisors were selected from the Department of Anatomy, Federal University of Paraná, Brazil, according to the following three criteria, as determined by three experienced orthodontists: anatomic characteristics typical of a maxillary central incisor, labial surface integrity, and lack of incisal edge wear.

Three points were marked on each tooth surface with a fine-point pen (Fig. 1):
- Point I: midpoint of the incisal edge.
- Point C: most apical point on the curvature of the cementoenamel junction.
- Point A: most apical point on the labial surface of the root (if there was an apical deviation, the most apical point next to the deviation was selected).

These points were initially marked by one of the orthodontists and then checked by the other two. In case of disagreement, the points were erased and marked again until there was a consensus.

The labial surface contour of each tooth was recorded with a Contracer SV-C500* surface scanner, beginning at point I and continuing on to points C and A (Fig. 2). The following points were then identified by the accompanying Formpack-1000* software (Fig. 3):
- Point I: most incisal point of the labial crown convexity.
- Point C: most apical point of the labial crown convexity, representing the cementoenamel junction.
- Point X': midpoint of line IC.
- Point X: orthogonal projection of point X' on the contour of the labial convexity, representing the midpoint of the anatomic crown.

Three points were marked at 1mm intervals gingival to point X (X+1, X+2, X+3), and three points were marked at 1mm intervals incisal to point X (X–1, X–2, X–3). The normal line—a line perpendicular to the tangent to a curve—was

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determined for each point with the same software, and the following angles were measured (Fig. 4):

• X–1: angle between normal lines at points X and X–1.
• X–2: angle between normal lines at points X and X–2.
• X–3: angle between normal lines at points X and X–3.
• X+1: angle between normal lines at points X and X+1.
• X+2: angle between normal lines at points X and X+2.
• X+3: angle between normal lines at points X and X+3.

A positive value indicated a counterclockwise movement (labial crown torque); a negative value, a clockwise movement (lingual crown torque). Potential errors were estimated by repetition of the measurements on 20 teeth.

Fig. 1 Landmarks marked on surface of extracted maxillary central incisor.

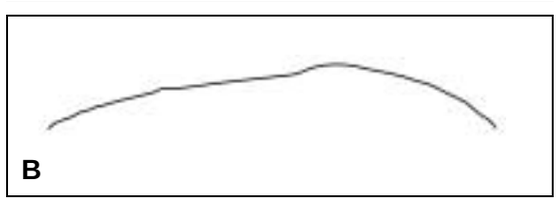


Fig. 2 A. Scanning of labial surface contour. B. Typical labial convexity drawn by scanner.

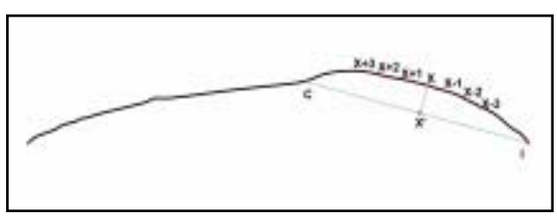


Fig. 3 Points measured at 1mm intervals from midpoint of anatomic crown.

Results

Considerable angular variations were found among the points studied in relation to the central point: 3.07° for X–1, 6.35° for X–2, 10.25° for X–3, –3.77° for X+1, –8.96° for X+2, and –15.97° for X+3 (Table 1). Clinically, these measurements indicate an increase in labial crown torque when brackets are moved incisally and an increase in lingual crown torque when brackets are moved gingivally.

There was an even wider individual range of angles between the normal lines at each point, although the differences were not statistically significant, according to the paired Student t-test at a significance level of .05. This variability indicates that when a bracket is positioned 1-3mm above or below the center of the crown, depending on the particular patient's labial convexity, the torque can change by 25° or more.

Discussion

The torque prescription of preadjusted brackets should theoretically not be altered by crown morphology when using a fixed and constant reference such as the center of the clinical crown, as recommended by Andrews[1] and Roth.[10] Our results show that a positioning error of 1mm, for example, would generate an insignificant change in torque of approximately 3°.

Other proposed positioning methods involve more vertical adjustment of the brackets and thus could produce greater changes in the torque expression of preadjusted brackets. In Vigorito's technique, the bracket is positioned in the middle third of the crown, centered in the mesiodistal and occlusogingival directions, but vertical adaptations are made for specific teeth.[11] McLaughlin and Bennett developed a bracket-positioning chart in which the distance of the maxillary central incisor bracket from the incisal edge is between 4mm and 6mm, although individual adjustments can be made based on the operator's experience.[12] The chart would place the bracket somewhere between points X–2 and X+1 as measured in our study, where the torque expression varied by about 10°.

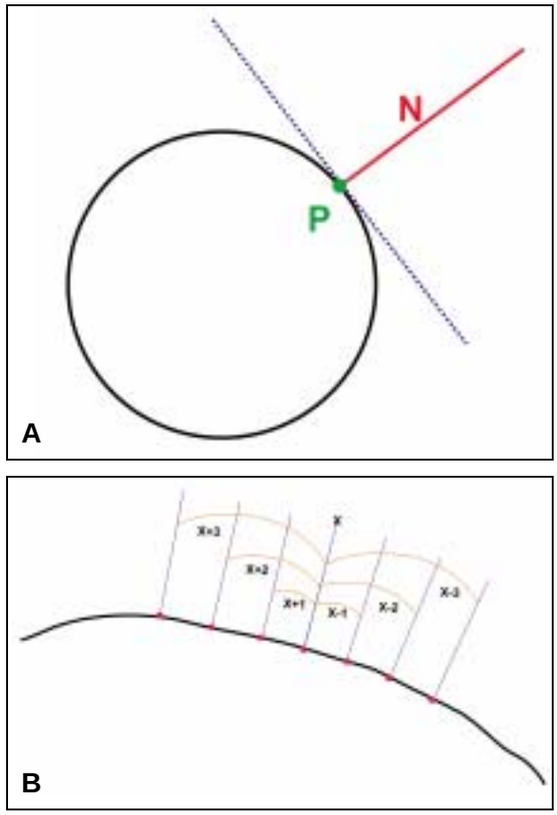


Fig. 4 A. Normal line (N) at point (P) on given curve. B. Angles measured between normal lines in this study.

According to Dellinger, a deviation of 7.88° occurs when an .019" × .025" archwire is inserted in an .022" × .028" slot, but the deviation is only 2.93° when an .021" × .025" archwire is inserted in the same slot.[2] This means that if the smaller rectangular archwire is used, small vertical bracket displacements of 1mm from the center of the clinical crown (between points X–1 and X+1) will not clinically affect the original torque prescription of the maxillary central incisor.

Other factors that can influence torque must also be controlled. If the bracket base does not closely conform to the tooth surface, or if excess adhesive is left beneath the base, the position may be inaccurate and torque may not be proper-

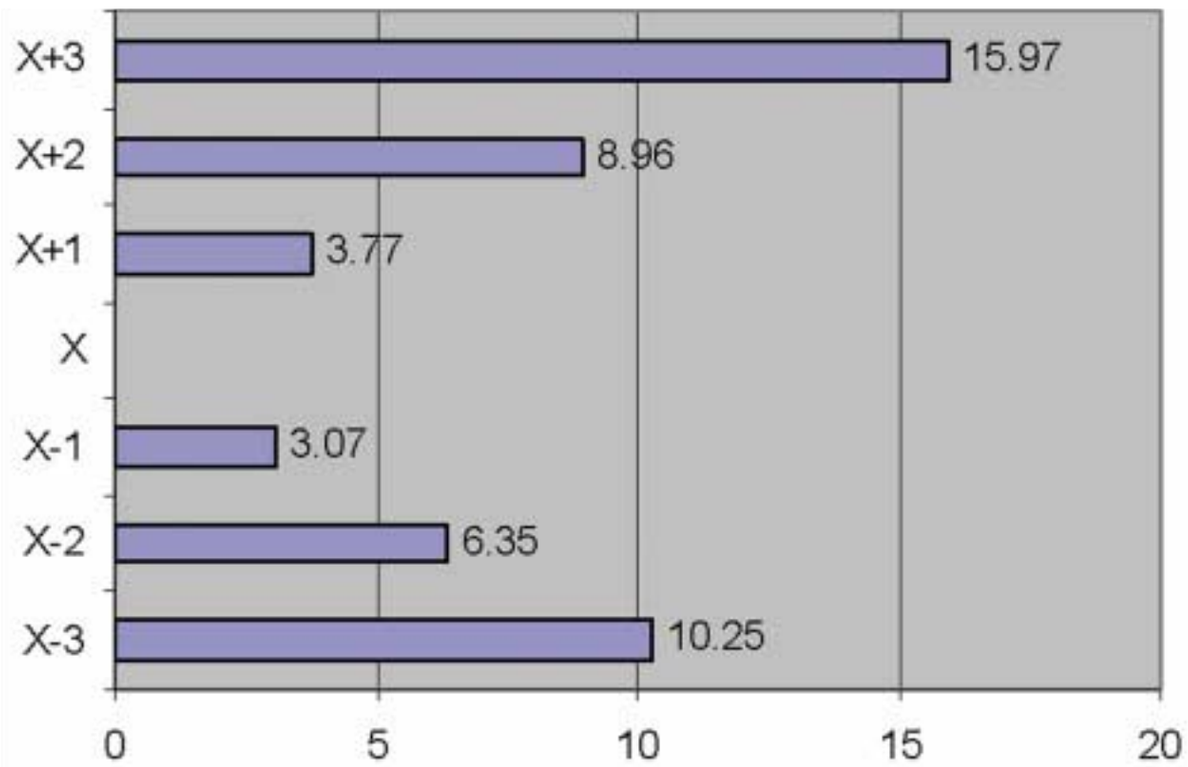
ly expressed.

Sondhi stated that because the maxillary central incisor has a mild degree of convexity, when the bracket level is modified for a severe open bite or overbite, the vertical position of the tooth will change relative to the archwire, but there will be only a slight change in the expressed torque.[13] The wide dispersion of data found in the present study (Table 1), however, indicates that individual variations in labial convexity must be

TABLE 1
DESCRIPTIVE STATISTICS OF STUDIED ANGLES (°)

Angles:	X–3	X–2	X–1	X	X+1	X+2	X+3
Mean	10.25	6.35	3.07	0	–3.77	–8.96	–15.97
Standard error	0.45	0.38	0.33	0	0.34	0.48	0.65
Median	10.63	5.86	2.84	0	–3.29	–8.66	–16.08
Standard deviation	3.19	2.66	2.31	0	2.42	3.37	4.57
Variance	10.19	7.07	5.33	0	5.86	11.34	20.86
Minimum	3.60	1.86	0.18	0	–0.18	–3.30	–7.90
Maximum	17.60	15.00	10.55	0	–14.00	–20.35	–27.74

X = Midpoint of anatomic crown.



taken into consideration (Fig. 5).

Our results indicate that in situations where we need to move the bracket away from the center of the crown, some torque adjustment should be made in the archwire to maintain the original prescription. About 3° of lingual crown torque should be introduced in the wire for every millimeter that the bracket is displaced incisally, and about 5° of labial crown torque for every millimeter that the bracket is moved gingivally. In cases of accentuated labial convexity, further individual adjustments may be required.

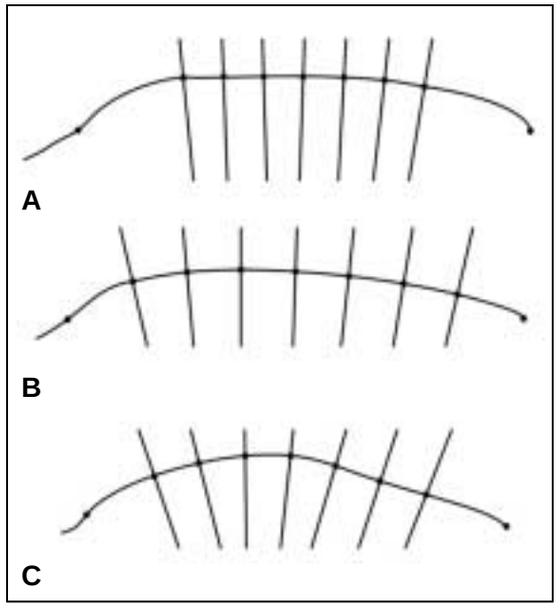


Fig. 5 Examples of individual maxillary central incisor labial surface contours. A. Flat. B. Mild degree of convexity. C. High degree of convexity.

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