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ORIGINAL RESEARCH

Influence of Preadjusted Bracket Shape and Positioning Reference on Angulation of Upper Central Incisor

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ABSTRACT

Aim: To verify the influence of different bracket shapes and placement references according to Andrews and MBT systems on the expression of angulation in upper central incisors (UCI).

Materials and methods: Bracket positioning and mesiodistal dental movement simulations were performed and the angulations produced in the dental crown were evaluated, based on computed tomography scan images of 30 UCI and AutoCAD software analysis. Rectangular (Andrews) and rhomboid (MBT) brackets were placed according to the references recommended by Andrews and MBT systems – long axis of the clinical crown (LACC) and incisal edge (IE) respectively.

Results: Data showed that the use of LACC as reference for bracket positioning produced 5° and 4° UCI angulations in Andrews and MBT brackets respectively. The use of IE produced a 1.2° mean angulation in UCI for both brackets.

Conclusion: When the LACC was used as reference for bracket positioning, the UCI crown angulation corresponded to the angulation built into the brackets, regardless of shape, while the use of IE resulted in natural crown angulation, regardless of bracket shape.

Clinical significance: This research contributes to guide the orthodontist in relation to the different treatment techniques based on the use of preadjusted brackets.

Keywords: Orthodontic brackets, Orthodontics, Straight wire, Tooth angulation, Tooth movement.

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INTRODUCTION

The Andrews straight wire technique was introduced in the 1970s, consisting of one of the main innovations in orthodontics. This technique is based on the use of preadjusted brackets and treatment with minor need for bending the archwires.[1,2] However, thorough bracket positioning is fundamental to transmit the prescribed angulation, inclination, rotation, and in–out for ideal teeth positioning.[3,4]

The original preadjusted brackets are rectangular and the angulation prescribed for each tooth is built into the slot angulation. Therefore, these accessories have an angled slot in relation to their upper and lower edge base. As for positioning, the author proposed that the long axis of the clinical crown (LACC) should be used as reference. The bracket must be positioned in the center of the clinical crown, the LACC midpoint, while for axial adjustment, the mesial and distal bracket edges must be positioned parallel to the LACC.[1] Following these references, when brackets are placed on the vestibular faces of the incisors, several horizontal lines are projected to different directions, corresponding to slot, incisal edge (IE), and bracket upper and lower edges. The divergence between these lines may cause visual confusion, impairing accurate positioning of the accessories (Fig. 1).[5]

Over the years, both the brackets and the preadjusted appliance treatment technique have suffered changes. Different preadjusted bracket prescriptions and several techniques and treatment philosophies based on their use have emerged, including the MBT system.[2,5,6] The MBT system proposes the use of rhomboidal or trapezoidal shaped brackets. In these brackets, the indicated angulation

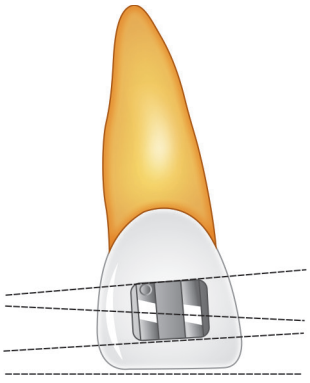


Fig. 1: Andrews brackets. Divergent horizontal lines

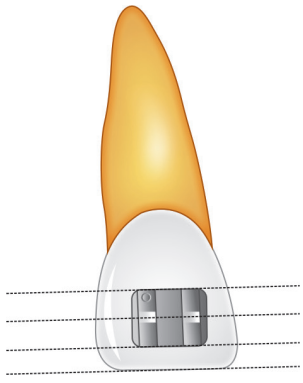


Fig. 2: MBT brackets. Parallel horizontal lines

for each tooth is built in the angle formed between the lateral edges and the upper and lower edges. Thus, the slot is parallel to the upper and lower edges. As for positioning, the MBT system proposes that the IE should be used as reference for bracket positioning in incisors. The bracket must be positioned in the center of the LACC and the slot must be positioned parallel to the IE for axial adjustment. Consequently, when brackets are placed in the vestibular faces of the incisors, the projected horizontal lines exhibit parallelism, which creates greater visual comfort for the operator, facilitating the bracket positioning stage (Fig. 2).[5]

Although these changes have facilitated bracket positioning, studies on the impact of the transfer of angulation built into the brackets to the teeth were not found. Therefore, the purpose of this study was to verify the influence of different bracket shapes and placement references according to Andrews and MBT systems on the expression of angulation in upper central incisors (UCI). For this, computed tomography (CT) scan images from UCI were analyzed using AutoCAD software.

MATERIALS AND METHODS

The study was approved by the Research Ethics Committee of the Health Sciences Division of the Federal University of Paraná (UFPR) (CEP/SD: 763.098.09.07, CAAE: 0036.0.091.000-09). Thirty UCI belonging to the Department of Anatomy of the UFPR were used.

Teeth were submitted to CT scanning (i-CAT – Imaging Sciences International, Hatfield, PA, USA), and all subsequent stages of the study were carried out using AutoCAD 2011 software (Autodesk, San Rafael, CA, USA). Drawing of the external outline of the crown vestibular face and teeth root was performed. Subsequently, the mesial and distal face lowest points were delineated and a line connecting these two points was defined, representing the IE. The amelocemental junction and IE midpoints were also delineated. The LACC was then obtained by connecting these two points.

Additionally, schematic representations of the UCI brackets according to Andrews and MBT systems were created, respecting the real Andrews (A Company Orthodontics, San Diego, CA, USA) and MBT Dyna-Lock (3M Unitek, Monrovia, CA, USA) bracket measurements, obtained by using a digital pachymeter (Mitutoyo, Kawasaki, Kanagawa, Japan).

Four analyses were performed to measure the angulation expressed in the teeth using different bracket types and placement references:

Analysis 1: Andrews brackets placed according to reference proposed by Andrews system.

Analysis 2: MBT brackets placed according to MBT system.

Analysis 3: MBT brackets placed according to Andrews system.

Analysis 4: Andrews brackets placed according to MBT system.

The analyses were carried out in all teeth, according to the following stages:

Stage I: Bracket bonding simulation. Schematic representation of bracket was placed on top of tooth image, bracket central point coinciding with LACC midpoint.

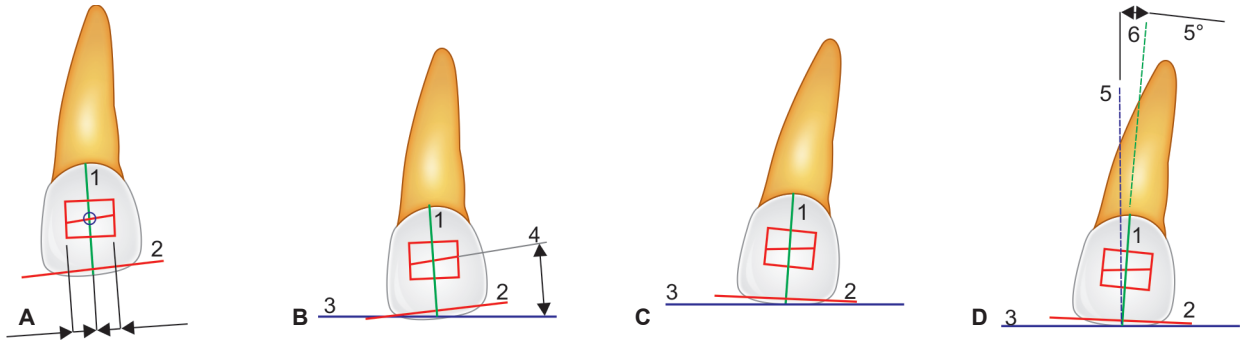
Stage II: Axial positioning adjustment. Analyses 1 and 3, bracket positioning was adjusted so that side edges were parallel to LACC. Analyses 2 and 4, bracket positioning was adjusted so that slot was parallel to IE.

Stage III: Simulation of mesiodistal dental movement through action of a 0.019″ × 0.025″ rectangular wire. A line representing the rectangular wire was placed on top of slot and moved parallel to the occlusal plane. Using the program tools, the tooth image followed the line movement.

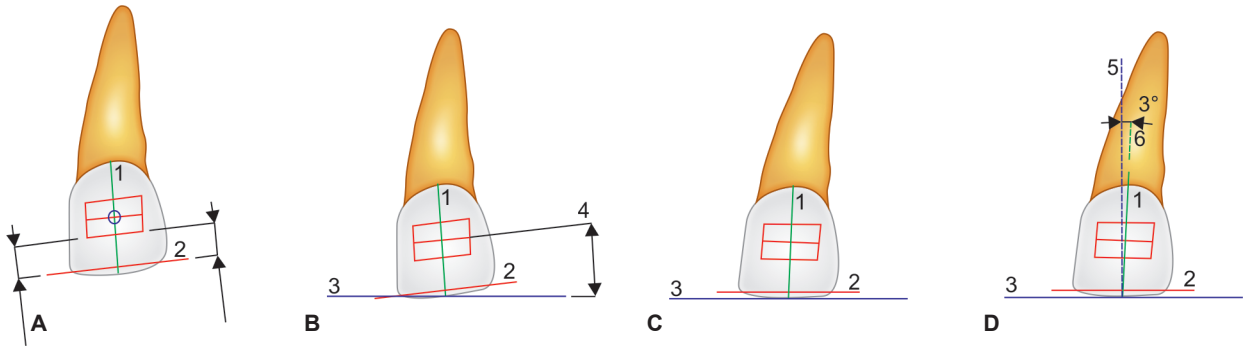
Stage IV: Dental crown angulation measurement after movement. Measurement of angle formed between LACC and line perpendicular to the occlusal plane[1] (Figs 3 to 6).

Additionally, the natural angulation of the crowns was verified, without any dental movement, considering the angle formed between the LACC and line perpendicular to the IE (Fig. 7).

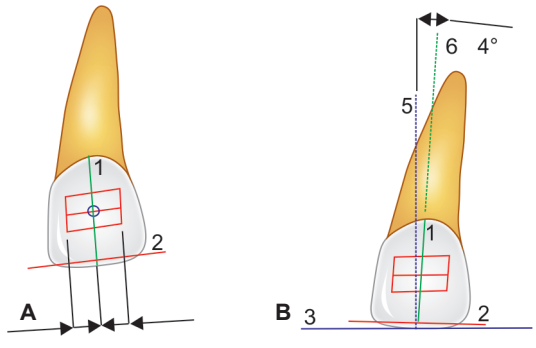
Data were organized into a Microsoft Office Excel spreadsheet (Microsoftware Corporation, Redmond, WA, USA) and analyzed using the Statistica v.8.0 program



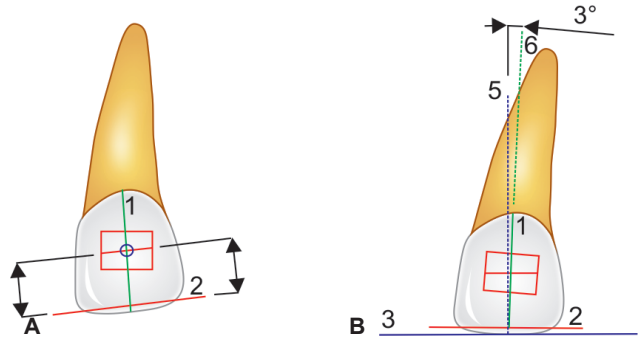
Figs 3A to D: Analysis 1: Andrews bracket placed according to reference proposed by Andrews system: (A) Axial positioning adjustment, lateral edges parallel to LACC; (B) simulation of dental movement, line representing rectangular archwire placed on top of slot; (C) tooth after movement; and (D) crown angulation after movement. LACC, green line (1); IE, red line (2); occlusal plane, blue line (3); rectangular archwire, gray line (4); line perpendicular to the occlusal plane, dotted blue line (5); projection of LACC, dotted green line (6)



Figs 4A to D: Analysis 2: MBT bracket placed according to reference proposed by MBT system: (A) Axial positioning adjustment, slot parallel to IE; (B) simulation of dental movement, line representing rectangular archwire placed on top of slot; (C) tooth after movement; and (D) crown angulation after movement. LACC, green line (1); IE, red line (2); occlusal plane, blue line (3); rectangular archwire, gray line (4); line perpendicular to the occlusal plane, dotted blue line (5); projection of LACC, dotted green line (6)



Figs 5A and B: Analysis 3: MBT bracket placed according to reference proposed by Andrews system: (A) Axial positioning adjustment, lateral edges parallel to LACC; and (B) crown angulation after movement. LACC, green line (1); IE, red line (2); occlusal plane, blue line (3); line perpendicular to the occlusal plane, dotted blue line (5); projection of LACC, dotted green line (6)



Figs 6A and B: Analysis 4: Andrews bracket placed according to reference proposed by MBT system: (A) Axial positioning adjustment, slot parallel to IE; and (B) crown angulation after movement. LACC, green line (1); IE, red line (2); occlusal plane, blue line (3); line perpendicular to the occlusal plane, dotted blue line (5); projection of LACC, dotted green line (6)

(StatSoft, Tulsa, OK, USA). Statistical hypotheses tests were carried out for mean values and estimation of Pearson correlation coefficient.

RESULTS

The angulation values obtained for the 30 UCI used in the study based on the four performed analyses, as well as the natural crown angulation values are shown in Table 1.

Andrews brackets placed according to the reference proposed by Andrews system (Analysis 1) produced 5° angulation in all teeth (Table 1). On the contrary, MBT brackets placed following the reference proposed by Andrews system (Analysis 3) produced 4° angulation for all teeth (Table 1). The results of analyses 1 and 3 presented no correlation with the natural crown angulation (estimated correlation equal to 0: absent).

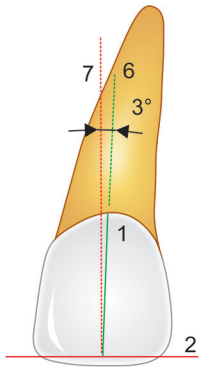


Fig. 7: Natural angulation of crowns. LACC, green line (1); IE, red line (2); projection of LACC, dotted green line (6); line perpendicular to IE, dotted red line (7)

Table 1: Crown angulation results (°)

Tooth	*Analysis 1*	*Analysis 2*	*Analysis 3*	*Analysis 4*	*Natural angulation*
1	5	3	4	3	3
2	5	1	4	1	1
3	5	2	4	2	2
4	5	–2	4	–2	–2
5	5	1	4	1	1
6	5	2	4	2	2
7	5	0	4	0	0
8	5	0	4	0	0
9	5	2	4	2	2
10	5	3	4	3	3
11	5	1	4	1	1
12	5	7	4	7	7
13	5	4	4	4	4
14	5	2	4	2	2
15	5	1	4	1	1
16	5	3	4	3	3
17	5	1	4	1	1
18	5	0	4	0	0
19	5	0	4	0	0
20	5	0	4	0	0
21	5	0	4	0	0
22	5	3	4	3	3
23	5	4	4	4	4
24	5	0	4	0	0
25	5	–1	4	–1	–1
26	5	–1	4	–1	–1
27	5	2	4	2	2
28	5	–1	4	–1	–1
29	5	0	4	0	0
30	5	–1	4	–1	–1

Brackets placed following the reference proposed by the MBT system (Analyses 2 and 4) produced the same angulation, regardless of bracket type used (Table 1). Besides being identical, the angulation values obtained in these two analyses were the same as the natural crown angulation values (estimated correlation equal to 1: perfect). The descriptive statistics of the results of analyses 2 and 4 are shown in Table 2.

Table 2: Descriptive statistics of analysis 2 and 4 results (°)

n	*Mean*	*Medium*	*Minimum*	*Maximum*	*Standard deviation*
30	1.2	1	–2	7	1.9

DISCUSSION

The present study aimed at verifying whether different bracket shapes and placement references using Andrews and MBT systems influence the expression of UCI angulation. For this, a simulation of bracket positioning and mesiodistal dental movement was carried out using AutoCAD software analysis.

The data from the present study showed that when using the reference proposed by Andrews system, the angulation results expressed in the UCI corresponded to the angulation built into the brackets for all sample elements, regardless of the bracket shape used. In other words, the angulation obtained for Andrews brackets was 5°, whereas for MBT brackets it was 4°. On the contrary, the reference proposed by the MBT system expressed quite varied angulation results in the UCI; in general, it was different from the angulation value built into the brackets, regardless of the bracket shape used. Additionally, it was noticed that the reference proposed by the MBT system showed identical angulation results for each tooth, even when varying the bracket shape, besides being similar to the natural crown angulation.

These results show that the bracket placement method proposed by Andrews, which prioritizes the LACC as reference, is a precise and reliable method as regards angulation expression built into the brackets. In contrast, when the IE is used as a reference, as proposed by the MBT system, the angulation produced in the dental crowns by the orthodontic movement will simply be the natural angulation of the crowns, considering the angle formed between the LACC and a line perpendicular to the IE.

It is important to consider, however, that the ideal characteristics of each tooth in a normal occlusion, recommended by Andrews and based on his study with 120 patient models with normal occlusion, are mean results. In addition, that study was performed in North American individuals.[7] Therefore, if these measures are applied to all patients, individual and racial/ethnic variations should be disregarded.[8] In this sense, the use of the IE as reference for bracket placement allows each tooth to maintain its natural angulation, which is favorable within an individualized orthodontic treatment concept.[5]

Furthermore, it is important to mention that when the IE is used as reference for bracket placement in incisors, the IE of upper incisors will be parallel to each other and in relation to the occlusal plane and to the lower incisors

at the end of the orthodontic movement. Therefore, the contact area between the IE of upper and lower incisor will increase, maximizing the role of anterior guidance in mandibular protrusive movement.[5] When using Andrews system for positioning, the angulation built into the bracket will be transferred to the crowns, which will be mesially angled, just like their IE, at the end of the orthodontic movement. This angulation results in a lower distoincisal angle in these teeth, which can impair achieving proper anterior guidance.

Besides the functional aspect, the IE parallelism must be emphasized from an esthetic point of view.[9] Additionally, the angulation of the UCI produced by the Andrews system can predispose the appearance of black spots in the interproximal region, which can be avoided with the use of the MBT system.[10]

The use of rhomboid brackets, associated with IE as positioning reference, also allows the use of a bracket placement system that facilitates this treatment stage.[11-13]

Thus, it is possible to consider that the bracket placement method proposed by Andrews, despite accurate as for UCI angulation expression, presents standardization of the orthodontic treatment as a consequence. On the contrary, the method proposed by the MBT system results in treatment customization and can deliver better aesthetic and functional results. In addition, the correct bracket positioning, fundamental for treatment success with the preadjusted appliance, is also facilitated in this system.

CONCLUSION

The use of the LACC as reference for bracket placement resulted in UCI crown angulation similar to the angulation in the bracket (5° for Andrews brackets and 4° for MBT brackets), regardless of shape. On the contrary, when the IE was used as reference, the natural angulation of the crown (mean of 1.2°) was reproduced, regardless of bracket shape.

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