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MHM bracket design on the path of Dr Andrews of true straight wire technique, prototype study design

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Abstract

OBJECTIVE: The authors invented an innovation in the bracket design; that targeted to fulfill the aim of Dr. Andrews for a true straight wire technique.

MATERIALS AND METHODS: The use of the ball and socket design together with the ability to relocate the position of the slot in three dimensions enhances the control and precision of individual teeth.

RESULTS: The revolutionary bracket eliminated any wire bending in the initial, intermediate or finishing stages of fixed orthodontic treatment. This was achieved together with complete 3D control on individual teeth positions to achieve the finest occlusion for individual patients.

CONCLUSIONS: That system allowed for a true straight wire mechanics with no wire bending. The design could be used labially or lingually without the need of indirect bonding techniques. Additionally, any adjustments could be performed intraorally with simple pressure.

Keywords:

Andrews, bracket design, prototype, straight wire

Introduction

The introduction of straight wire appliance by Dr. Andrews was a revolutionary step in the era of modern orthodontics; aiming to eliminate wire bending needed in the Edgewise appliance.^[1] His target was to introduce an easier way for treating patients and facilitated achievement of the best finishing results. Unfortunately, that aim was not fulfilled completely; owing to errors in bracket placement in the conventional manual bonding techniques and individual 3D teeth positioning. Rebonding of the fault bracket or adding finishing bends, esthetic bends or segmentation of the archwires with vertical elastics compensated these errors in the finishing stages. Additional major cause that avoided the achievement of true

straight wire treatment was the individual differences between subjects regarding teeth sizes, shapes and crown-root angles.^[2] Even if the brackets were bonded in the correct position in every individual, not all subjects will reach satisfactory results without addition of wire bends and/or vertical elastics.

To solve all these problems, introduction of semi-custom and fully custom-made prescriptions were suggested. Appearance of revolutionary prescriptions as MBT of McLaughlin, Bennett and Trevisi was one of these evolutions.^[3] They aimed to provide the clinician with a new prescription to reach the best goals of treatment. They created even sub-prescriptions for individual variations as the different options regarding the canines' torque. ORMCO Company with the introduction of DAMON system performed the same regarding varieties of sub-prescriptions to meet the individual

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variations.^[4] Although, nevertheless the clinician needs to be optimistic in selection of the proper prescription for the specific patient or else he will face the need for complex finishing mechanics or acceptance of less-than-ideal results.

The latest advances to solve that problem of “complex finishing mechanics” were introduced with fully custom-made brackets. ORMCO Company introduced INSIGNIA system, which was a fully costumed appliance, especially made for a particular individual.^[5] That nearly eliminated the complex finishing procedures, but on the expense of increased fees of the appliance more than three times the standard appliances. Together with the probability of faulty measurements and/or bonding process that still necessitated some finishing adjustment and/or rebonding of certain brackets.^[4]

Currently, the research trials were directed toward a fully machined custom-made bracket with less financial and more accurate properties. From this point, the authors managed to design a revolutionary bracket design to be incorporated into the new fixed orthodontic appliances. That was designed to avoid the prominent faults of prescription design, bracket position and rebonding steps. The concept was to return to the classical design of straight wire concept by designing a standard type of appliance for every patient to decrease the financial load on the clinicians. The MHM bracket was designed to fully accept modifications according to the individual case inside the oral cavity. This in turn will overcome any error occurred into the bonding process and any individual tooth variations. Through these incredible modifications, a true straight wire concept will be introduced with full 3D control on first, second and third-order movements. Furthermore, it will be compensated into this standard bracket within the patient’s mouth that eliminates any need for complex machining and decreased the total cost on the clinician.

Materials and Designing

The slot mechanism

The bracket design consisted of a slot to receive the wire, with a passive sliding door to hold it in place in a passive self-ligation phenomenon [Figure 1]. The slot was designed to present 0.018” by 0.025” measurements. Those measurements allow for full engagement archwire to be used. While in the same time allowed for lower gauge wires use to avoid heavy forces on the periodontium. The slot was manufactured from Stainless-Steel alloy, with the corners flared and rounded to facilitated sliding mechanics. The surface was laser polished to allow for the least possibility for binding or friction with the used wires [Figure 1].^[6,7] The sliding

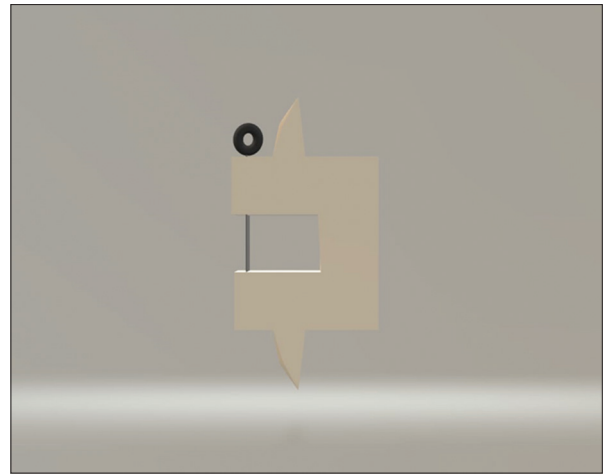


Figure 1: Slot mechanism with the sliding door closed

door has an eyelet on top to facilitate opening and closure by dental explorer [Figure 2].

The slot mechanism has posteriorly-located tie wings to allow for precise wire tying at the finishing stages for optimum tooth control. If the clinician was trying to force a heavy archwire into the slot, the elastic ties will demonstrate tension. That protected the bracket from frequent debonding and in the same time avoided unnecessary heavy forces. Heavy forces are unfavorable and lead to massive biological and mechanical drawbacks. An example of biological deleterious effect of heavy forces was root resorption.^[8] For the mechanical disadvantages, heavy forces lead to Roller-Coaster Effect and bowing of arch wires together with bite deepening anteriorly and bite opening in the premolars area [Figure 3].^[9]

The ball mechanism

The metallurgy of the balls was of Stainless-Steel alloy. If we examined the types of joints in the engineering fields, we easily figured that the ball and socket joint was the only design to allow almost 360° movements in all three planes of space X-Y-Z.^[10] The body of the bracket was designed to exhibit ball and socket joint phenomena. The internal ball was attached to the slot mechanism. Together with the external socket attached to the base mechanism [Figure 4]. The internal ball is able to rotate 3D within the confinements of the external socket to allow for tipping, torqueing, rotational and combined effects of the previous movements. The ball and socket are fixed together by locking pins. Those pins could be removed to allow the ball to rotate freely within the confinements of the socket, and then the pins were to be attached again. Both the ball and the socket had graded marks vertically and horizontally. Each mark presented 5 degrees change in position on the X and the Y axes. That allowed for precise knowledge of the changes happened before reattaching the locking pins again to secure the mechanism [Figure 5].

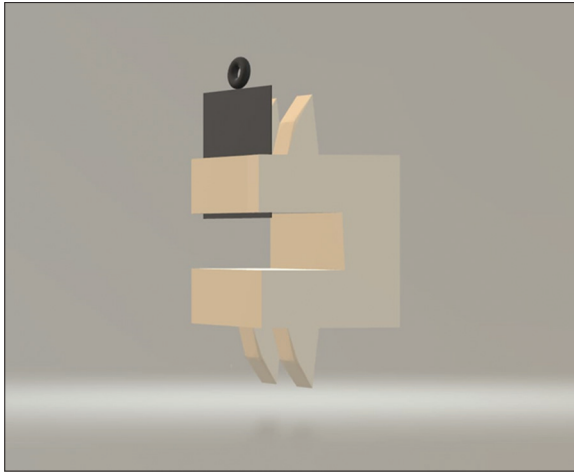


Figure 2: Slot mechanism with the sliding door open

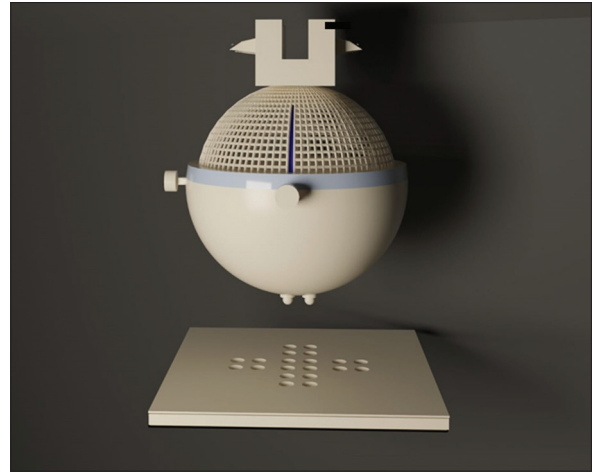


Figure 3: The slot mechanism with accessory wings to hold O-ties

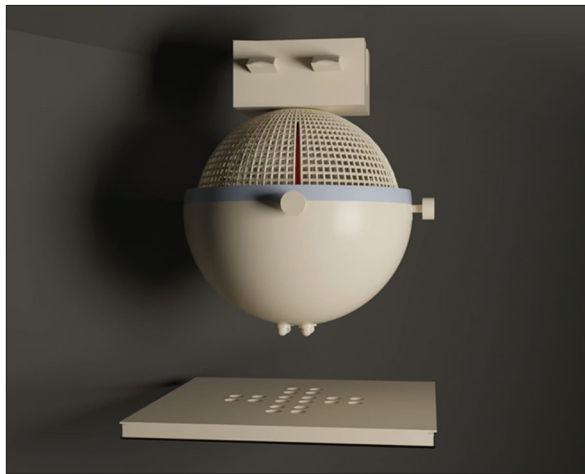


Figure 4: The way of attachment between the slot mechanism, the ball-and-socket mechanism and the base mechanism

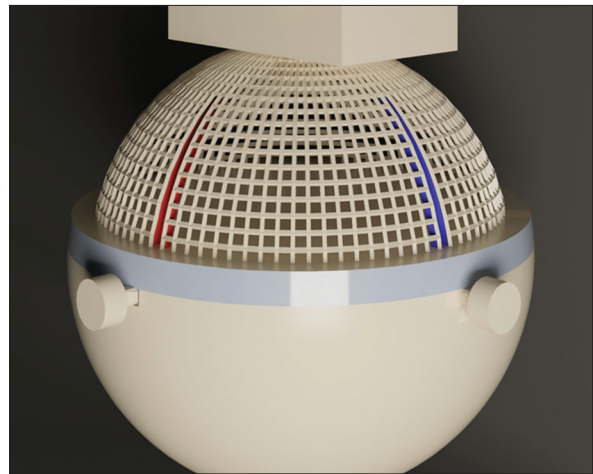


Figure 5: The ball-socket mechanism showing red and blue grading marks together with the two locking pins

The base mechanism

The base system was produced from Stainless-Steel alloy. The base mechanism was composed basically of two sheets. The first sheet was attached the socket with 4 anchor pins projecting from the socket base. Those anchor pins have design of Press-Snap-Button to allow for secure holding [Figure 6]. The second sheet was attached to the tooth structure by the meshwork and has vertical and horizontal hole-rows to receive the anchor pins [Figure 7]. Other sheets of 0.05 mm thickness each could be added between the two basic sheets to allow for in-out movements [Figure 8]. The basal sheet that was attached to the tooth had an open box configuration to receive the added sheets within and avoid any dislodgement of the ball mechanism by sheer or masticatory forces.

Bracket adjustments

1. The bracket has been provided with a prescription as any other system according to the clinician

- preferences. If any further adjustments were to be included, the following steps should be followed.
2. First order movements:
 - a. **Alignment (in-out) movements: Using the base mechanism:** If the clinician was to adjust the alignment of a particular tooth, all he had to do was to detach the bracket basal sheet from the tooth basal sheet and add another sheet in-between. Each added sheet was 0.5 mm in thickness and this pushed that particular tooth inward by 0.05 mm.
 - b. **Rotational movements: Using the ball mechanism:** When a change in rotational movement was required, the clinician had to remove the horizontal locking pin and rotate the inner ball around the vertical pin as required, then reattach the horizontal locking pin again.
 3. Second order movements:
 - a. **Levelling (up-down) movements: Using the base mechanism:** When levelling was needed, the orthodontist was to detach the base system

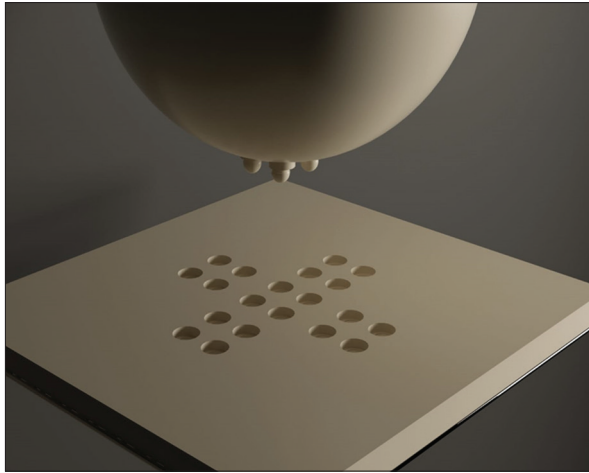


Figure 6: The anchor pins with Press-Snap-Button design fitting four crossing rows of receiver holes

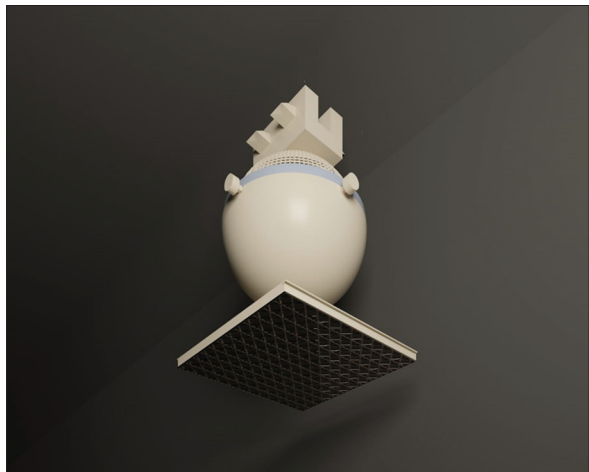


Figure 7: The meshwork of the tooth-sided basal sheet to be bonded onto enamel

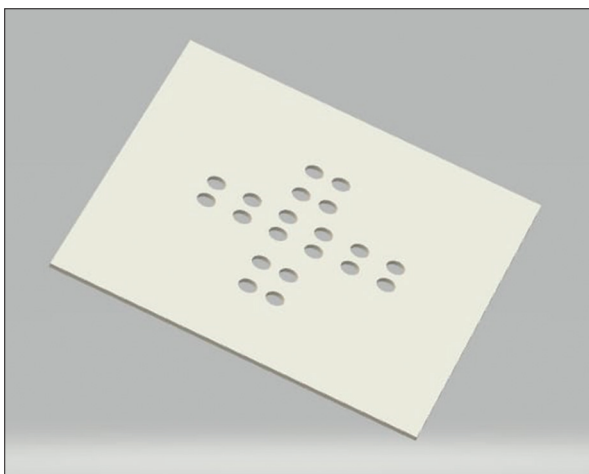


Figure 8: Added sheets of 0.5 mm could be included between the two main basal sheets to facilitate inward-outward movements

and move one from the other vertically using the anchor pins as a guide. Each pin slide in a new hole is 0.5 mm vertical adjustment.

- b. **Tipping (root M-D angulation) movements: Using the ball mechanism:** Detaching the two locking pins from the ball system, allowed the operator to rotate the slot to adjust the root angulation mesio-distally before reattaching the pins again. The ball has grades that indicated 5 degrees change of tipping for each mark.
4. **Third order movements: Torquing (root B-L inclination): Using the ball mechanism:** Rotating the ball system vertically after removing the locking pins allowed for inclination adjustments. Each mark on the ball indicates a 5 degree change in that direction.
5. **Combination of movements:**
 - a. If a particular tooth was required for a complex 3D adjustment, the professional personnel was to combine the use of ball system adjustments vertically, horizontally and torsionally, together with sliding the basal sheet system sagittally and coronally to have 100% control over the required 3D movement.
 - b. For example, moving the ball vertically changed the torque but also changed the levelling of the tooth. Hence to cancel that effect, the downward sliding of the base system cancelled any unwanted levelling changes.

Suggested sequence of arch wires

This revolutionary system was designed to resolve most of the conventional problems in the previous bracket designs. The authors recommended a light force technique, with only NiTi (Nickle-Titanium) wires to keep all the forces below the level of the deleterious effects; starting by 12 NiTi arch wires and increasing sequentially. With addition of any recommended corrections of the slots 3D every visit, the range of pressure remained within biological limit.

In the opinion of the authors, a non-extraction case could be finished with only 0.016×0.022 NiTi arch wires. And all the extra movements compensated by simple brackets adjustments. For the extraction cases, the clinician could reach $0.018 \times 0.025''$ arch wires to gain maximum control.

Discussion

Since the era of straight wire appliance introduced by Dr. Andrews,^[1] many systems of brackets introduced to facilitate easier treatment with maintenance of quality of the results. Variations in the prescriptions consumed many efforts in the research fields.

Besides, indirect bonding techniques were introduced to allow for precise bracket positioning.^[10,11] Also, Kesling wax setups performed for indirect bonding allowed for changes in the default prescriptions to meet individual variations.^[12] The introduction of semi and fully

costumed brackets was a further step toward precise finishing and easy treatment of the cases.^[13,14]

The previous trials had common problems; such as the increased cost of manufacturing for semi or fully customized brackets and lab steps with an additional factor of technician qualification to provide a perfect set for the indirect bonding techniques.^[15-17] Together with the ordinary inaccuracies performed in bracket placement even by the cleverest clinicians.^[18-20]

Rebonding is one of the furious steps during treatment as it wastes the clinician and the assistants' time. Moreover, the strength of bonding decreases every time than the previous session.^[21-23] With the need to return to a smaller wire and repeat steps already performed that is frustrating to the clinician and the patient.

By applying this new design, the bracket could be accustomed by the clinician directly according to the case. That was performed with minimal expenses in the machining price and no rebonding needed except in extreme errors in bonding. Moreover, the design could be used labially or lingually without any need for indirect bonding process. The use of only-NiTi wires guard against any misuse of heavy arch wires, which avoided any heavy forces together with associated deleterious effects such as force induced root resorption.

The authors anticipated throughout that design would make the treatment easier, faster and more stable for the clinician and the patients.

Conclusion

- The current design targeted to introduce a revolutionary bracket system that allowed for a true straight wire mechanics with no wire bending.
- It can be used with NiTi-only wires.
- The design could be used labially or lingually without the need of indirect bonding techniques.
- Any adjustments could be performed intraorally with simple finger pressure (i.e., the bracket could be accustomed by the clinician directly according to the case).

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Ethical policy and Institutional Review board statement

Not needed in this study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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