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Comparative Study of Two Maxillary Molar Distalization Appliances Using Different Anchorage Systems (An in Vitro Study)

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الخلاصة

الأهداف: ان الهدف من اجراء هذه الدراسة هو مقارنة تاثيرتقنيتين لدفع الضرس العلوي الاول للخلف باستخدام طريقتين مختلفتين لتثبيت الاسنان الامامية. **المواد وطرائق العمل:** عينة الدراسة تتكون من مجموعتين، تضم المجموعة الاولى النابض الحلزوني مع الجهازالتقليدي للتثبيت، بينما تضم المجموعة الثانية النابض الحلزوني مع الزرعة للتثبيت. تم استخدام القوس العلوي لمثيل الاسنان التشابهي من نوع (Cl II div1).تم تحفيز النابض في كلا المجموعتين لتسلط قوة مقدارها(٢٠٠ غرام) ، تم اخذ صور رقمية لمثيل الاسنان التشابهي قبل وبعد عملية دفع الضرس و من ثم تم تحليلها بواسطة برنامجAutodesk AutoCAD تم قياس ومقارنة سبع متغيرات لكل مجموعة وتم تحديد مستوى المعنوية عند ٠.٠٥. **النتائج:** نتائج هذه الدراسة اظهرت وجود فرق معنوي في التغير العمودي ودرجة ميلان الضرس الاول والتغير العمودي والتقدم للامام للضاحك الاول بينما اظهرت وجود فرق غير معنوي في دوران وسرعة دفع الضرس وتغير ميلان الضاحك الاول **الاستنتاجات:**باستخدام الزرعة للتثبيت تم الحصول على دفع للضرس باقل مقدار من خسارة التثبيت للاسنان الامامية.

ABSTRACT

Aims: This study aimed to compare the effects of two different anchorage systems for molar distalization. **Materials and Methods:** The sample consisted of two groups, Buccal Coil spring with Nance button as anchorage and Buccal Coil spring with simulated Screw as anchorage. Upper typodont arch of class II division I was used and the appliances were activated to deliver 200 gram of distalization force. Pre and postoperative digital images were taken and analyzed using Autodesk AutoCAD software™. For each group seven parameters were measured and compared. A significance value of 0.05 was predetermined. **Results:** Significant difference was found between the two groups in the vertical change, tipping change of the first molar, vertical change, mesial movement of the first premolar. Insignificant difference in first molar rotation, molar distalization rate and premolar tipping change. **Conclusions:** Maxillary molar distalization with minimal effects on anchoring teeth, molar tipping and vertical position change could be achieved with Buccal Coil spring with Screw distalization appliance.
Keywords: Distalization appliance, Buccal Coil spring, Nance button, Screw.

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INTRODUCTION

The primary goal of orthodontic treatment is to achieve an 'ideal occlusion' that involves molars placement in class I relationship.(1)

One of the traditional approaches for molar Class II Correction is upper molar distalization, which can be obtained with either extra oral appliance (EOA) using head gear or intraoral appliance (IOA) which can be inter-maxillary or intra-maxillary appliance. For the clinician, the IOA is more favorable method than EOA to create distal molar movement. The biggest advantage of IOA over EOA distalization is being not dependent on patient co-operation.(2,3) Generally, the IOA design includes two elements which is the active components that distalize the maxillary molars and the anchorage unit that compensates for the reciprocally acting force system.(3) Conventional intraoral distal molar movement has relied mainly on a Nance button and the use of anterior teeth to reinforce anchorage when the maxillary first premolars are banded and connected to the acrylic plate with a retaining wire. Although these methods often achieve an acceptable result, anchorage loss is unavoidable and the mechanics are often difficult to control precisely. These problems can be overcome using temporary skeletal

anchorage devices such as endosseous implants, miniplates, onplants, or miniscrews which could be used as direct or indirect anchorage systems.[4] With the help of these absolute anchorage systems, various successful methods of distal molar movement have been reported.[5-8]

The purpose of this study is to compare and contrast the effects of two maxillary molar distalization methods with different anchorage systems (Buccal Coil spring with Nance button and Buccal Coil spring with simulated Screw as indirect anchorage).

MATERIALS AND METHODS

The sample of this study was composed of 2 groups (Fig.1), Buccal Coil spring with Nance button for anchorage (BCN) and Buccal Coil spring with simulated Screw as indirect anchorage (BCS).

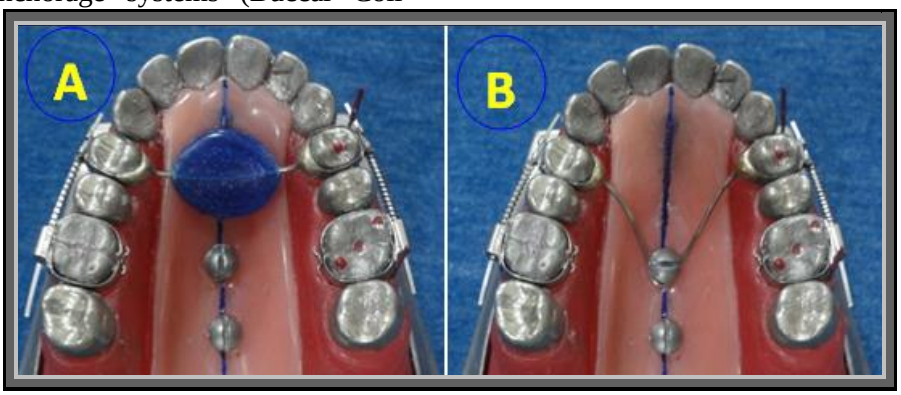

Figure (1): Experimental Groups: (A) Buccal Coil spring with Nance button. (B) Buccal Coil spring with simulated Screw

A. Preparation of Typodont models

Two typodont models were prepared; one for each type of the distalization appliances. Typodont wax and teeth setup according to manufacturer's instructions (Ormco). Remove the top and bottom metal plate and insert the wax forms then replace the metal plates. Note the palmer tooth number identification on the root which will assist us in properly identifying the teeth. Insert the teeth into their socket in the wax form and press the teeth firmly into the wax. Once the teeth have been tried in the wax forms, remove the teeth one at a time for application of sticky wax. Palatal acrylic with metallic bar in the middle was constructed to give the support required for the distalization appliances by taking impression to the typodont model then made stone cast for this model and fabrication of palatal acrylic using cold cure acrylic then it was finished and polished. Made two perforations in the midline of palatal acrylic for the fixation screws with the metal base of typodont.

B. Distalization Appliances Construction

Upper right and left first premolar bands with (0.22×0.30") bracket and upper right and left first molar bands with (0.22×0.30") tubes are fitted to the teeth on the typodont so that the bracket of the premolar bands at (4mm) from the premolar cusp tip and the molar bands parallel with the buccal cusps[9]. Impression was taken using alginate with molars and premolars bands on their respective teeth. Stone model was made with bands in their position in the impression. Using 0.9mm wire, the trans-palatal anchorage bar was modeled, joining the first premolars at the center of their lingual cleats; the wire was secured with wax then was fixed with plaster. The metallic parts were soldered then were refined and polished. The Nance button was made using cold cure acrylic with the soldered Transpalatal bar for the Nance button supported buccal coil distalizer, finally the Nance button was finished.[10,11]

For the screw supported distalizer, the same previously mentioned steps were followed but there is no need for cold cure acrylic. Only made solder of the transpalatal bar with U-shape bending around the palatal screw.[12-14] The appliance was transferred to the typodont model then the bands were cemented to their respective

teeth. Molar and premolar tipping bars were fixed to their respective teeth with epoxy steel adhesive at (90°) to the base of typodont. They were (20mm) in length, with (10mm) red painting. These bars were used as a guide for determining the change in tipping of the first molar and premolar after distalization and for repositioning of these teeth after each trial.

C. Appliances Activation and Force Magnitude:

Using tension gauge to measure (200gm) distalization force of Nickel titanium open coil spring (0.012 ×0.036") that was compressed between the molar tube and premolar bracket through (0.018 × 0.025") stainless steel wire[10,11].

D. Preparation of laboratorial Environments

Wood table (250x150mm), in addition to (Two) special metallic bases to receive the typodont (one was fixed horizontally and the other was fixed vertically to the wood table for lateral and occlusal views of typodont model respectively) (Fig.2). The camera(14.1 mega pixels, Sony, Japan) was at a standard distance (80mm) to the metallic bases for both views. A metallic ruler of 130 millimeter in length was attached to the posterior aspect of the wood table perpendicular to the wood table and in the same level with the occlusal plane of the teeth when the typodont was positioned vertically for the occlusal view. It aids in repositioning of maxillary teeth in sagittal plane after each trial and for measuring the amount of molar distalization and premolar mesial movement pre and postoperatively. It also helped in scaling (standardization) of preoperative and postoperative images of the experiments processed by Autodesk AutoCAD© software.

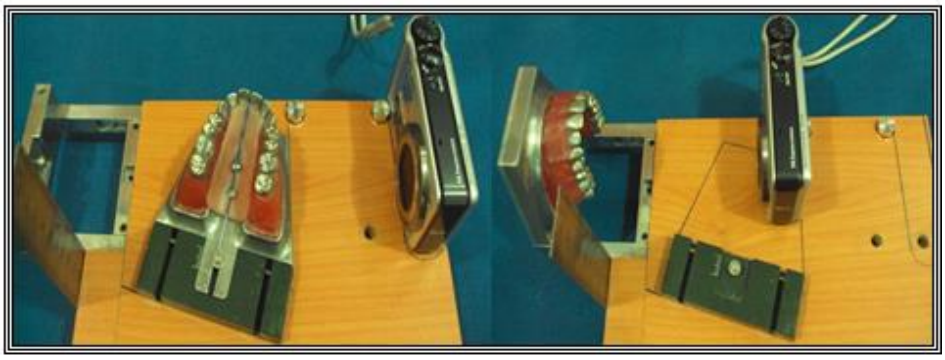

Figure (2): Wood table with two metallic bases to receive the typodont and digital camera

E. Standardization of the tools

For teeth repositioning before each trial, acrylic guide plate was constructed from cold cure acrylic resin with three points of contact with three fixed points in the design for optimal positioning of the acrylic guide plate. A standered distance between the buccal groove of molar to the typodont base was (51.5mm), between premolar cusp tip to the typodont base was (52mm), measured by digital vernia. Molar and premolar tipping guides at (90°) to the typodont base, molar rotation was (48°) measured by protractor. Sagittal position of molar at ruler reading of (61mm) and of premolar at (46mm).Finally, all the measurements were checked and recorded using AutoCAD program analysis for digital pictures before each trial.

Water baths had controlled temperature of about (50±2°C).[15] Typodont was immersed in the digital water bath for (5) minutes. Then the Typodont was immersed in a cool water of about (5±2°C) for (5) minutes [16].

Pre and Postoperative Image Processing:

Pre and postoperative images for all samples was processed by Autodesk AutoCAD© software. All images were standardized (scaled) in such a way that the distance of (10 mm) on the image was equal to a distance of (10 mm) on the ruler for occlusal view and on the (10mm) painting of the molar and premolar tipping guide for lateral view. So the linear measurements on the image were equal to the

real measurements in the same plane. Also this software application was used for the angular variables measurement. All the measurements were calculated by subtracting the postoperative reading from the preoperative reading. Digital images analyses were made on occlusal view (Fig.3) and lateral view (Fig.4).

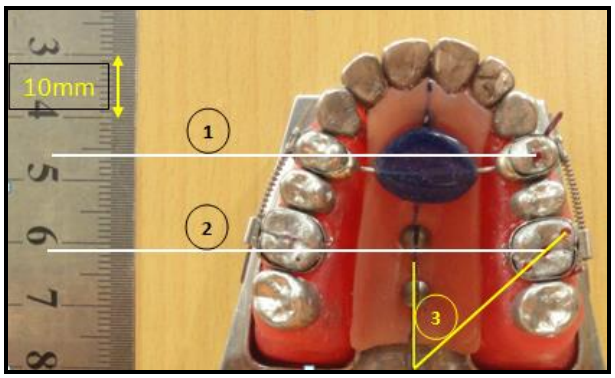

Figure (3): Preoperative occlusal view measurements by Autodesk AutoCAD© software: (1) sagittal position of the 1st premolar (the ruler reading of the perpendicular line from the central point of the occlusal groove of the 1s premolar to the ruler. (2) sagittal position of the 1st molar (the ruler reading of the perpendicular line from central fossa of the 1st molar to the ruler. (3)1st molar rotation (The angle between the palatal midline and the line that connect the mesiobuccal and distopalatal cusp tips of the 1st molar tooth)

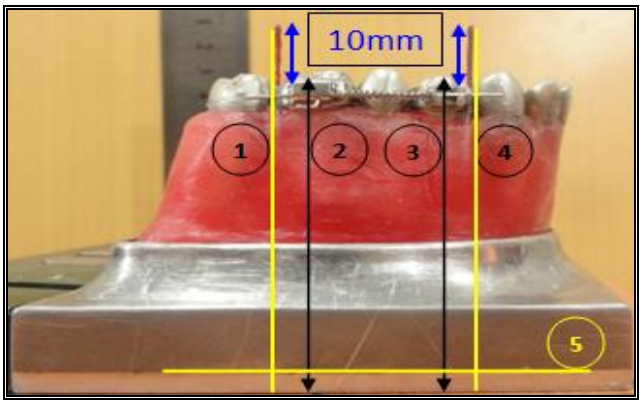

Figure (4): Preoperative lateral view measurements by Autodesk AutoCAD© software: (1) 1st molar tipping (the angle between the molar tipping guide and the base of typodont). (2) vertical position of the 1st molar (the vertical distance from the buccal groove of the 1st molar to the base of typodont).(3) vertical position of the 1st premolar (the vertical distance from the buccal cusp tip of the 1st premolar to the base of typodont). (4) 1st premolar tipping (the angle between the premolar tipping guide and the base of typodont). (5) Typodont base

Statistical Analysis

Statistical analysis was performed using the SPSS (SPSS Inc., Chicago, Ill. USA) statistical program. To check reliability of the method, Intra-examiner and inter-examiner calibration were carried out and there were no significant differences between intra-examiner and inter-examiner calibration at the level of $p < 0.05$. The data were tested for their normal distribution by using the Shapiro-Wilks test. According to the results of this test, an independent t- test was used for the evaluation of changes between the two groups. A significance value of 0.05 was predetermined.

RESULTS

Table (1) shows the descriptive statistic of the parameters measured for (BCN) and (BCS) groups. Comparison between the two groups (table 2) revealed that (BCN) method gave rise to significant difference from (BCS) method at ($p<0.05$), when (BCN) method produced molar distalization with highest mean of molar

vertical change (intrusion), distal molar tipping, first premolar vertical change (extrusion) and first premolar mesial movement. On other hand there is no significant difference between the two groups in distalization rate, first molar rotation and first premolar tipping.

Table (1): Descriptive statistic of the parameters measured in the study

Group	Variable	N.	Mean	# Sign meaning	±SD	Min.	Max.
Buccal Coil +Nance distalizer	First Molar Vertical Change (mm)	10	0.08	Molar intrusion	0.03	0.04	0.15
	First Molar Rotation (°)	10	-1.80	Distopalatal rotation	1.54	-4.00	0.00
	First Molar Tipping Change (°)	10	-8.20	Distal tipping	2.25	-11.00	-5.00
	Molar Distalization Rate(mm/activation)	10	-2.40	Movement distally	0.65	-3.50	-1.50
	First Premolar Vertical Change (mm)	10	-0.75	Premolar extrusion	0.06	-0.85	-0.65
	First Premolar Tipping Change (°)	10	2.10	Mesial tipping	1.44	0.00	4.00
	First Premolar Mesial Movement (mm)	10	1.00	Mesial movement	0.11	0.75	1.25
Buccal Coil +Screw Distalizer	First Molar Vertical Change (mm)	10	0.02	Molar intrusion	0.01	0.00	0.04
	First Molar Rotation (°)	10	-1.90	Distopalatal rotation	1.59	-4.00	0.00
	First Molar Tipping Change (°)	10	-3.70	Distal tipping	1.05	-6.00	-3.00
	Molar Distalization Rate(mm/activation)	10	-3.00	Movement distally	1.15	-4.05	-1.50
	First Premolar Vertical Change (mm)	10	-0.07	Premolar extrusion	0.01	-0.10	-0.05
	First Premolar Tipping Change (°)	10	1.00	Mesial tipping	0.81	0.00	2.00
	First Premolar Mesial Movement (mm)	10	0.12	Mesial movement	0.13	0.00	0.25

(mm)= millimeter, (°) = degree, N=number, Min.=minimum, Max.=maximum
 # Variable reading= preoperative reading- postoperative reading for all variables= positive or negative sign

DISCUSION

(BCS) method showed significant reduce in molar intrusion, this slight intrusion (0.021mm) may be attributed to the type of anchorage used (indirect screw anchorage) which gave rise to more control on the teeth movements. This is in agreement with[12-14]. Increased Molar intrusion using (BCN) method could be explained by the increased degree of distal molar tipping by distalization leading to increased intrusion reading.

(BCS) method gave rise to less distal molar tipping, this may be attributed to the difference in anchorage device when (BCS) used absolute anchorage system with better control on the force direction by controlling on the mesial reciprocal force. The point of force application is the crucial issue because most distalization devices push the first molar occlusally to their (CR) so leading to its distal tipping. Our result is in agreement with many authors.[10-14]

A significant difference was shown between (BCN) method that gave rise to the highest mean of first premolar extrusion and (BCS). Premolar extrusion could be explained by the fact that the transpalatal bar of the Nance button or of the palatal screw is supported by the first premolar, and activation of the appliance produce a vertical force component that leads to its extrusion.(BCN) method produced less control on the vertical force component produced from appliance activation on first premolar so produce more extrusion. This is in agreement with[17,18].

A significant difference was shown between (BCN) method that gave rise to the highest mean of first premolar mesial movement with (BCS) method. This is because of the type of anchorage used for (BCN) method which was the (Nance button) .Although (Nance button) is an effective traditional way for anchorage, it produced less control on the mesial reciprocal force resulting from the compression coil spring in (BCN) method compared with (BCS) method. This is in agreement with.[19,20]

Table (2): Comparison of the differences between groups.

Variable	Group	Mean	# Sign meaning	±SD	T - value	*P* - value
First Molar Vertical Change (mm)	Buccal Coil +Nance distalizer	0.08	Positive sign= Molar intrusion	0.03	5.180	0.000*
	Buccal Coil +Screw Distalizer	0.02		0.01		
First Molar Rotation (°)	Buccal Coil +Nance distalizer	-1.80	Negative sign= Distopalatal rotation	1.54	0.142	0.888
	Buccal Coil +Screw Distalizer	-1.90		1.59		
First Molar Tipping Change (°)	Buccal Coil +Nance distalizer	-8.20	Negative sign= Distal tipping	2.25	-5.720	0.000*
	Buccal Coil +Screw Distalizer	-3.70		1.05		
Molar Distalization Rate (mm/activation)	Buccal Coil +Nance distalizer	-2.40	Negative sign= Movement distally	0.65	1.427	0.175
	Buccal Coil +Screw Distalizer	-3.00		1.15		
First Premolar Vertical Change (mm)	Buccal Coil +Nance distalizer	-0.75	Negative sign= Premolar extrusion	0.06	-30.49	0.000*
	Buccal Coil +Screw Distalizer	-0.07		0.01		
First Premolar Tipping Change (°)	Buccal Coil +Nance distalizer	2.10	Positive sign= Mesial tipping	1.44	2.091	0.055
	Buccal Coil +Screw Distalizer	1.00		0.81		
First Premolar Mesial Movement (mm)	Buccal Coil +Nance distalizer	1.00	Positive sign= Mesial movement	0.11	15.652	0.000*
	Buccal Coil +Screw Distalizer	0.12		0.131		

*$P<0.05$, (mm)= millimeter, (°) = degree, # Variable reading= preoperative reading- postoperative reading for all variables= positive or negative sign

CONCLUSIONS

The results of the present study indicated that the two distalization methods are effective in molar distalization with insignificant difference in molar distalization rate but (BCS) method is the superior method when it produced distalization with reduced distal tipping and intrusion of molar, also with minimal extrusion and mesial displacement of first premolar.

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