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Evaluation of Canine Retraction Using Double Slot Vs. Single Slot Orthodontic Brackets; CBCT Study

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ABSTRACT

Aim. The duration of orthodontic treatment is the primary concern of almost all the patients. Therefore, this increases the demand to find the best method to increase the rate of tooth movement with the least possible disadvantages. **Subjects and Methods**: This prospective randomized clinical study was conducted on a total sample of 32 orthodontic patients recommended for upper first premolar extraction as part of their orthodontic treatment plan. The patient ages were ranged from (16-26) years. Patients were assigned to (Group I) single slot bracket, (Group II) double slot bracket. **Results:** Regarding the post-treatment value, a significantly higher mean value was recorded for Canine Vertical Tipping Angle in single slot bracket group (12.65±6.15), in comparison to double slot bracket group (7.31±2.71), (p=0.00). Canine Cusp Retraction Distance showed a non-significant higher value in double slot bracket group (p=0.30). **Conclusion:** Double slot bracket is very effective in canine retraction as it showed less canine vertical tipping and more bodily movement during retraction, and more apex retraction value in comparison with single slot bracket.

KEYWORDS

Canine retraction, CBCT, double slot, tooth movement, vertical tipping

INTRODUCTION

The duration of orthodontic treatment is very important point for almost all the patients and also orthodontists. Therefore, there is always several trials for developing more techniques to increase the rate of tooth movement with the least possible disadvantages. [1]

Since Andrew's invented the straight wire appliance and introduced commercially, many bracket prescriptions and techniques have been developed. All these developments are trying to create a force system that can end up efficiently to shorten the orthodontic treatment period. [2]

Extractions are frequently considered one of the most favorable treatments plans especially in crowded cases. Space closure is the most critical and important steps in treatment after extraction. [3]

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As long as canine retraction procedure takes the longest duration of the entire orthodontic treatment, the main goal that every orthodontist is trying to is to achieve a rapid and controlled canine retraction with the least anchorage loss. [4,5]

Reducing the duration of orthodontic treatment is of great interest to orthodontists. Several bracket types and methods have previously been reported to efficiently move teeth. A systematic review aimed to examine, in evidence-based way, which kinds of canine retraction methods/techniques are most effective and which have the least side effects. Most of the studies had serious problems with small sample size, confounding factors, lack of method error analysis, and no blinding in measurements. To obtain reliable scientific evidence, controlled RCT's with sufficient sample sizes are needed to determine which method/technique is the most effective in the respective retraction situation. [6,7]

It is interesting to note that despite the numerous bracket designs, one feature has remained unchanged: there is only one single horizontal slot on the facial facet of the bracket. In some design variations, such as the Tip- Edge Plus, In-Ovation and 'R' brackets, an additional horizontal slot is enclosed within the bracket base and is not open to the labial surface (Parkhouse, 2007), therefore only allowing for engagement of segmental auxiliary arch wires. [8]

Shen reported that the double-slot bracket significantly increased the bracket width without reducing the interbracket span and therefore can generate increased force moments within the bracket, leading to an improved manipulation in tooth repositioning. [9]

Therefore, the following research was done to compare the effectiveness of using double slot bracket versus single slot bracket systems during canine retraction stage.

SUBJECTS AND METHODS

This prospective randomized clinical study was conducted on a total sample of 32 orthodontic patients recommended for upper first premolar extraction as part of their orthodontic treatment plan. The patient ages were ranged from (16-26) years. The sample was selected from patients seeking orthodontic treatment in the orthodontic clinic, Faculty of Dental Medicine (Boys branch), Al-Azhar University, Cairo, Egypt. Sample size calculation was undertaken with G power test version 3.1 statistical software based on the following pre-established parameters: an 80% power, sample size for unpaired t-test, significance level (alpha) = 0.05 (two-tailed). The estimated minimum sample needed to have adequate power to detect a difference was twenty-six. The G power test was based on the result of study of Shpack N.[25] titled "Duration and anchorage management of canine retraction with bodily versus tipping mechanics."

Randomization:

Patients were assigned to (Group I) single slot bracket, (Group II) double slot bracket. The process of randomization and group allocation was undertaken using Random Allocation Software, Version 1.0, May 2004.

Eligibility of criteria:

- ***Inclusion criteria:***

The patients were included in the study if they have the following:

1. An age ranges from 16 to 26 years.
2. Full permanent dentition (3rd molars excluded).
3. Indication for bilateral extraction of maxillary first premolars.
4. Mild form of crowding.

Groups:

The patients enrolled in this study were 26 extraction orthodontic patient. These patients were randomly divided into two equal groups:

- Group I: sixteen orthodontic patients, were treated with Roth brackets 0.022-inch slot.
- Group II: sixteen orthodontic patients, were treated with double slot bracket 0.022-inch slot.

Treatment steps:

A) Leveling and alignment

Initial leveling and alignment was initiated by utilizing 0.012″ nitinol orthodontic arch wire that was followed by ordinary sequence of nitinol orthodontic arch wires (0.014" & 0.016"). This was followed by 0.018 stainless steel orthodontic arch wire for starting canine retraction.

B) The first CBCT was taken for each patient after leveling, alignment and extraction of upper 1st premolars.

C) Canine retraction

Maxillary canine retraction was started in on 0.018 inch stainless steel in group I, while two wires 0.018 inch stainless steel in group II. The maxillary canine retraction was undertaken in both groups (I & II) using NiTi coil spring on both sides according to a standardized protocol. Fig 1,2

Canine retraction was done by applying NiTi coil spring with the force values of approximately 200 g [10,11] in each quadrant. The force was determined using YDM 5N YS-31 tension gauge.

D) The second CBCT was taken when both canines touch the mesial surface of the upper second premolar.

E) The canine retraction rate was measured by CBCT. Measurement was done till closure of the extraction space (the extraction space is considered closed when both canines touch the mesial surface of the upper second premolar). Also canine rotation was measured in relation to the Frankfurt plan. Fig 3,4 [12]

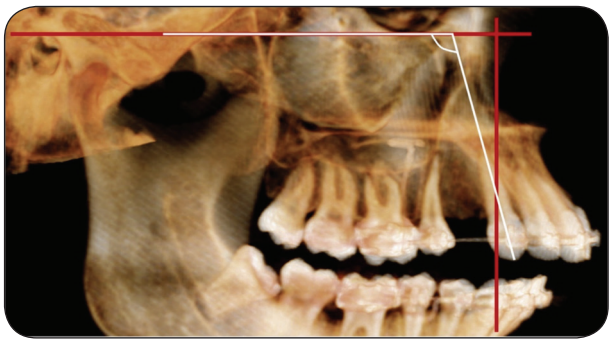

Fig. (1) Maxillary canine angulation as measured to FHP (pre canine retraction).

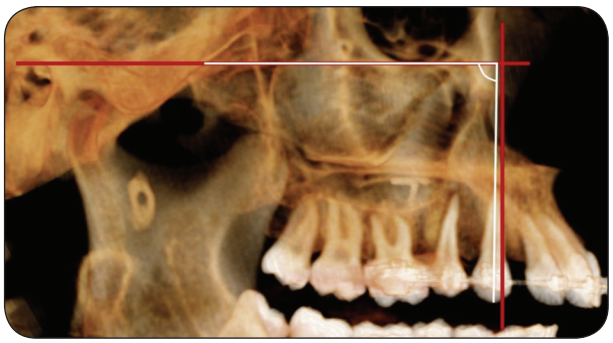

Fig. (2) Maxillary canine angulation as measured to FHP (post canine retraction).

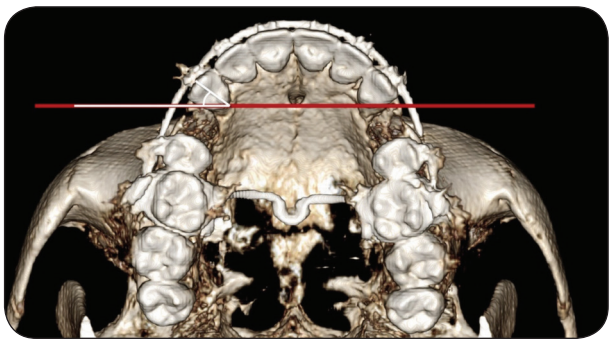

Fig. (3) Measurement of maxillary canines rotation in relation to FP (pre canine retraction).

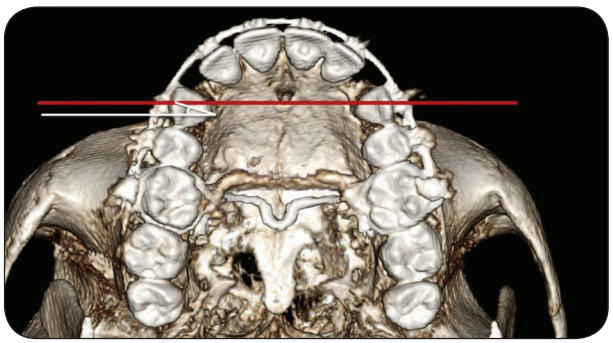

Fig. (4) Measurement of maxillary canines rotation in relation to FP (post canine retraction).

Statistical analysis

Data management and statistical analysis were performed using the Statistical Package for Social Sciences (SPSS) version 18. Numerical data were summarized using median, means, standard deviations and confidence intervals. Data were explored for normality by checking the data distribution and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Comparisons between groups with respect to normally distributed numeric variables were performed using independent t test. Comparison between groups with respect to non-parametric numeric data (percent change) was performed using Mann Whitney U test.

The percent change was calculated by the formula:

(value after-value before) / value before X100

All p-values are two-sided. P-values ≤0.05 were considered significant.

RESULTS

Regarding the pre-treatment value, there no significant difference in mean value of Canine Vertical Tipping Angle (p=0.85), Canine Cusp Retraction Distance (p=0.780), Molar Cusp Anchorage Loss (p=0.88). Canine Rotation Angle showed a barely significant difference (p=0.05); whereas Canine Apex Retraction Distance showed a significantly higher value in double slot group (p=0.00).

Regarding the post-treatment value, a significantly higher mean value was recorded for *Canine Vertical Tipping Angle* in single slot bracket group (12.65±6.15), in comparison to double slot bracket group (7.31±2.71), (p=0.00). *Canine Cusp Retraction Distance* showed a non-significant higher value in double slot bracket group (p=0.30). *Canine Apex Retraction Distance* showed a significantly higher value in double slot bracket group (3.78±.52), in comparison to single slot bracket group (0.1±2.82), (p=0.00). *Molar Cusp Anchorage Loss* showed a non-significant higher value in double slot bracket group (p=0.12). *Canine Rotation Angle* showed a significantly higher value in single slot bracket group (30.95±16.71), in comparison to double slot bracket group (14.36±2.02), (p=0.00), (Table 1, Fig. 6).

Table (1) *Descriptive statistics and comparison between Single and double slot bracket (independent t test)*

	Variable	Group	Mean	Std. Dev	Difference		95% Confidence Interval of the Difference		t	P
					Mean	Std. Error	Lower	Upper		
pre	Canine Vertical Tipping Angle	Single slot	19.30	6.47						
		Double slot	19.66	3.69	-.36	1.86	-4.20	3.49	-.19	.85 ns
	Canine Cusp Retraction Distance	Single slot	7.56	2.11						
		Double slot	7.40	.54	.16	.54	-.99	1.31	.29	.78 ns
	Canine Apex Retraction Distance	Single slot	.20	2.54						
		Double slot	6.74	.38	-6.55	.64	-7.91	-5.18	-10.2	.00*
	Molar .Cusp Anchorage Loss	Single slot	12.66	2.98						
		Double slot	12.80	2.19	-.14	.92	-2.04	1.75	-.15	.88 ns
	Canine Rotation Angle	Single slot	43.43	5.80						
		Double slot	39.95	3.63	3.48	1.71	-.04	7.00	2.03	.05*

	Variable	Group	Mean	Std. Dev	Difference		95% Confidence Interval of the Difference		t	P
					Mean	Std. Error	Lower	Upper		
Post	Canine Vertical Tipping Angle	Single slot	12.65	6.15						
		Double slot	7.31	2.71	5.34	1.68	1.84	8.84	3.18	.00*
	Canine Cusp Retraction Distance	Single slot	3.49	2.90						
		Double slot	4.28	.65	-.79	.74	-2.36	.78	-1.06	.30ns
	Canine Apex Retraction Distance	Single slot	.10	2.82						
		Double slot	3.78	.52	-3.68	.72	-5.20	-2.16	-5.14	.00*
	Molar .Cusp Anchorage Loss	Single slot	10.61	2.70						
		Double slot	12.00	2.23	-1.39	.88	-3.18	.40	-1.59	.12 ns
	Canine Rotation Angle	Single slot	30.95	16.71						
		Double slot	14.36	2.02	16.59	4.21	7.65	25.54	3.94	.00*

Significance level p≤0.05, *significant, ns=non-significant

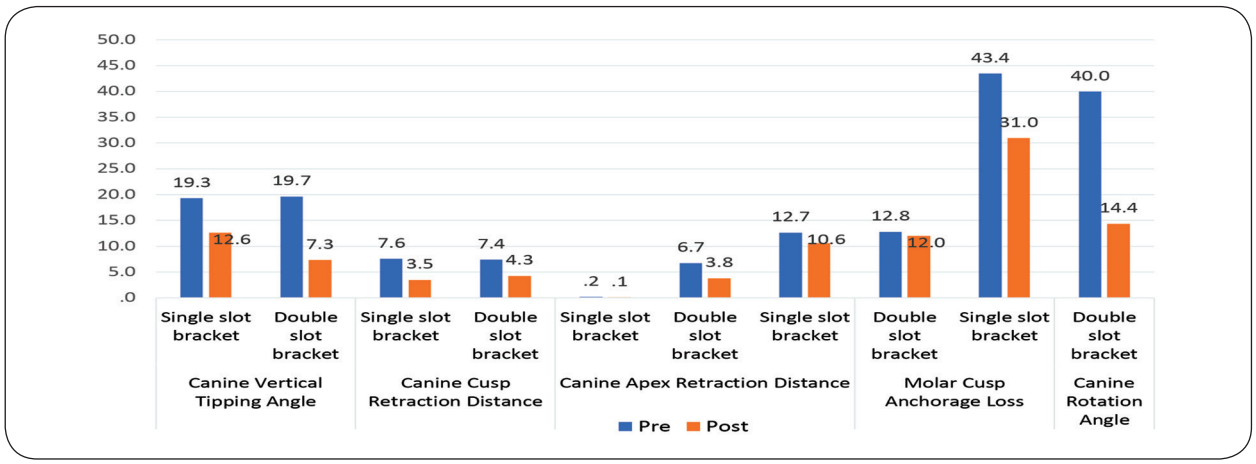

Fig. (5) Bar chart illustrating mean value recorded in Single and double slot bracket groups before and after treatment

Percent change in recorded values

A significantly greater percent decrease was recorded for *Canine Vertical Tipping Angle* in double slot bracket group (median= -63.35), in comparison to single slot bracket group (median= -34.41), (p=0.00). *Canine Cusp Retraction Distance* showed a non-significant greater percent decrease in single slot bracket group (p=0.67). *Canine Apex Retraction Distance* showed a significantly higher percent decrease in double slot bracket group (median= -45.64), in comparison to single slot bracket group (median = -9.4), (p=0.011). *Molar Cusp Anchorage Loss* showed a significant higher percent decrease in single slot (median =-13.82), in comparison to double slot bracket group (median = -5.72), (p=0.00). *Canine Rotation Angle* showed a significantly higher percent decrease in double slot bracket group (median = -63.88), in comparison to single slot bracket group (median = -29.13), (p=0.005), (Table 2, Fig. 5).

Table (2) *Descriptive statistics and comparison between Single and double slot bracket regarding percent change in recorded values after treatment (Mann Whitney U test test)*

Variable	Group	Mean	Std. Dev	Median	Difference		95% Confidence Interval of the Difference		P
					Mean	Std. Error	Lower	Upper	
Canine Vertical Tipping Angle	Single slot	-36.05	21.02	-34.41					
	Double slot	-63.35	10.55	-63.75	27.30	5.88	15.11	39.49	.00*
Canine Cusp Retraction Distance	Single slot	-59.51	29.55	-52.81					
	Double slot	-42.30	6.53	-41.42	-17.21	7.57	-33.22	-1.21	.67 ns
Canine Apex Retraction Distance	Single slot	-19.31	53.79	-9.40					
	Double slot	-44.12	6.17	-45.64	24.81	13.54	-3.98	53.59	.011*
Molar .Cusp Anchorage Loss	Single slot	-16.19	9.75	-13.82					
	Double slot	-6.53	2.96	-5.72	-9.67	2.55	-15.02	-4.31	.00*
Canine Rotation Angle	Single slot	-31.04	32.36	-29.13					
	Double slot	-64.00	4.41	-63.88	32.97	8.16	15.62	50.32	.005*

Significance level p≤0.05, *significant, ns=non-significant

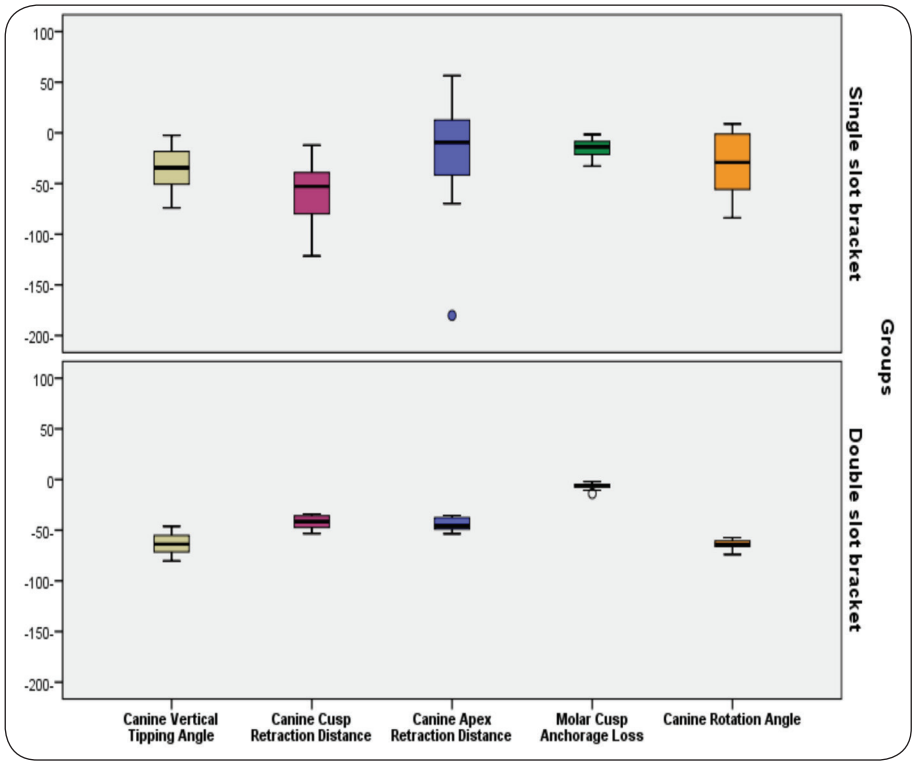

Fig. (6) Box plot illustrating median value of percent change in Single and double slot bracket groups before and after treatment

DISCUSSION

In orthodontic therapy, extractions are frequently indicated to correct various malocclusions. Space closure is one of the most important steps in orthodontic treatment after extraction. Orthodontic appliances are activated by the clinicians to produce forces required for space closure. Hence, the strategy of space closure should be individually tailored based on the diagnosis and treatment plan. Now a days many methods are available to accelerate tooth movement. Key factor in the success of orthodontic treatment is anchorage control. From approximately 1930 onward, there has been concern among authors about posterior tooth anchorage control. [1,13,14]

The trans-palatal arch (TPA) has many functions in orthodontic treatment. [63,69] When a passive TPA is placed, it prevents both rotation and buccolingual tipping of the molars, and also maintains the transverse distance of the molars. These functions are expected because of the mechanical rigidity of the TPA. On the other hand, a function that the TPA preserves anchorage for mesial movement is not obvious, because molars can move or tip mesially together with the TPA. [17,18]

The patient's age was ranged from 16-26 years old, since it had been documented that younger age group of patients (below 14 years) is mostly associated with increased anchorage loss and rate of tooth movement. That might be due to the different characters of the bone through which the teeth are being moved, like bone density, metabolism and turnover which may be related to younger age than adults. [19,20]

Canine retraction was started in both groups on 0.018-inch stainless steel as a working wire using sliding mechanics; maxillary canine retraction was undertaken using NiTi coil spring on both groups according to a standardized protocol.

Trans palatal arch was used in this study in order to maintain transverse distance to resist the common transverse bowing effect which proved to happen during lingual retraction as a result of molars rotation. [21-24]

Angular changes of maxillary canine:

Regarding canine rotation, in the current study, in group I, there was statistically significant rotation of canine after its retraction, while group II showed statistically non-significant disto-palatal rotation of canine, with statistically significant difference between the two studied groups. The difference in direction of rotation between group I and group II could be because the effect of using double wires that prevent the canine rotation in group II and this in agree with Shen results. [9]

Canine retraction rate:

In the present study, the canine retraction rate showed a statistically non-significant difference between the two studied groups, with increased rate of double slot group. Also, canine apex retraction distance showed a significant value in group II in comparison with group I which means more bodily movement with the double slot bracket.

CONCLUSION

1. Double slot bracket is very effective in canine retraction as it showed less canine vertical tipping and more bodily movement during retraction, and more apex retraction value in comparison with single slot bracket.
2. With the double slot bracket due to presence of double wire it results in less anchorage loss during retraction.

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النشر الرسمي لكلية طب الأسنان
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مجلة أسيوط لطب الأسنان

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تقييم ارجاع الناب باستخدام الحواصر التقويمية ذات الفتحتين مقارنة بالحواصر ذات الفتحة الواحده، دراسة بالاشعه المخروطية بالحاسوب

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الملخص:

الهدف: مدة علاج تقويم الأسنان هي الشغل الشاغل لجميع المرضى تقريبًا. لذلك ، فإن هذا يزيد من الطلب على إيجاد أفضل طريقة لزيادة معدل حركة الأسنان بأقل قدر ممكن من العيوب.

المواد والاساليب: أجريت هذه الدراسة السريرية العشوائية المرتقبة على عينة إجمالية من 32 مريضًا لتقويم الأسنان موصى بها لاستخراج الضاحك العلوي الأول كجزء من خطة علاج تقويم الأسنان الخاصة بهم. تراوحت أعمار المريض بين (16-26) سنة. تم تعيين المرضى إلى (المجموعة الأولى) شريحة فتحة واحدة ، (المجموعة الثانية) شريحة مزدوجة الفتحة النتائج: فيما يتعلق بقيمة ما بعد المعالجة ، تم تسجيل قيمة متوسطة أعلى بكثير لزاوية الميل العمودي للانياب في مجموعة شريحة الفتحة المفردة (12.65 ± 6.15) ، مقارنة بمجموعة الفتحة المزدوجة (7.31 ± 2.71)، (P = 0.00) . أظهرت مسافة سحب نتوء الانياب قيمة أعلى غير معنوية في مجموعة قوس الفتحة المزدوجة (ع = 0.30

الخلاصة: تعتبر شريحة الفتحة المزدوجة فعالة للغاية في سحب الانياب حيث أظهرت انخفاضًا في الانقلاب الرأسي للانياب وحركة جسدية أكثر أثناء التراجع ، وقيمة أكبر لسحب القمة مقارنةً بقوس الفتحة المفردة

الكلمات المفتاحية: ارجاع الناب، الاشعه المقطعيه المخروطيه ، الحواصر التقويمية ذات الفتحتين ، حركه الاسنان, الميل العمودى .