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Evaluation of effect of bracket slot size on the rate of the tooth movement during leveling and alignment stage

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Abstract:

Objective: The purpose of this study was to evaluate the effect bracket slot size on the rate of the tooth movement during leveling and alignment stage in the mandibular dental arch.

Patients and methods: 20 patients (15 females, 5 males with a mean age of 16.93 ± 2.22 years in group 1 and 17.31 ± 2.65 years) in group 2 who needed fixed orthodontic treatment and extractions of their maxillary and mandibular first premolars were allocated equally into two groups randomly as follows: Group 1, who had bracket slot 0.022, while Group 2 who had bracket slot 0.018.

Eligibility criteria included: Age range of 14 to 18 years, cases of malocclusion requiring extraction of the maxillary and mandibular first premolars, good general and oral health, no systemic disease, and no previous orthodontic treatment. The leveling and alignment was done in the mandibular arch after extraction of bilateral first premolars.

Results: Clinical assessments showed that there was not statistically significant difference in the rate of tooth movement during leveling and alignment at T0–T6 between two groups ($P \geq 0.05$).

Conclusions: It was concluded that both types of brackets can be used, and both are effective in the leveling and alignment stage of orthodontic treatment, however bracket slot 0.018 showed non-significant faster rate of tooth movement than bracket slot 0.022.

Keywords:Leveling and alignment, rate of tooth movement, bracket slot size.

1. Introduction

Anterior crowding is one of the most popular orthodontic problems that affect the patient's oral health, appearance, and psychology. To treat crowding or any other type of malocclusions, clinicians need to apply mechanotherapy. This mechanical intervention can be delivered to the teeth through either fixed or removable orthodontic appliance (1, 2).

In 1925, Edward Angle introduced the edgewise bracket system and proposed slot size 0.022 X 0.028-inch, which was suitable for use with gold archwires available at that time. Later, stainless steel wires have been introduced in thinner dimensions, but with the same stiffness as that of gold archwires. This permitted reducing bracket slot size to 0.018-inch. However, this did not preclude the continued use of 0.022-inch bracket slots in clinical practice (3).

A lot of research were published to state the advantage and disadvantages of every slot system, management of deep overbite and space closure after extraction were supposed to be one the advantage of the 0.022-inch slot system (4, 5).

In opposing point, the use of wire 0.018 × 0.022 was quite enough to provide the torque required to finish the orthodontic case early without the need for more wire bending and leads to less treatment time. (6).

When comparing the incidence of root resorption with the two-bracket system, the results haven't been yielding any significant difference between the two slot systems (7, 8).

Treatment time is important and critical for each orthodontic case, orthodontic research always seeking the ways to achieve an ideal treatment in a shorter time, it was reported that aligning the mandibular anterior teeth was faster with 0.022 than with 0.018-inch slot, however the total treatment time was shorter with 0.018-inch slot system (4).

Friction is a critical point that affected by different factors as wire material, slot size, bracket design, and the type of ligation. As much as the friction could be reduced the treatment time could be accordingly reduced, in addition, the damaging effect on teeth roots could be prohibited (9).

Therefore, this study will be directed to evaluate and compare the effects of the two slot systems on the quantity of orthodontic teeth movements during leveling and alignment stage of orthodontic treatment.

Specific objectives:

The primary outcome was the rate of tooth movement during leveling and alignment from scanned study models from the baseline till complete leveling and alignment.

Patients and methods:

Study design, sample, and eligibility criteria:

The current randomized clinical study was done on a total sample of 24 patients. They were selected from the outpatient clinic of the Department of Orthodontics, Faculty of Dental Medicine (Boys), Al-Azhar University, Cairo, Egypt. Institutional Review Board and Ethical Committee of Al-Azhar University reviewed and approved the study protocol (Approval number 735/1246) and registered on ClinicalTrials.gov (ID: NCT05537506).

Based on Kim et al (2017) (10) Using G power statistical power Analysis program (version 3.1.9.4) for sample size determination (11), A total sample size (n=24; subdivided to 12 in each group) will be sufficient to detect a large effect size (f) = 0.69, with an actual power (1-β error) of 0.8 (80%) and a significance level (α error) 0.05 (5%) for two-sided hypothesis test.

Randomization and group allocation:

All patients were randomly divided and allocated into two groups as follows: group 1: included 12 patients which were treated by 0.022-inch bracket system. group 2: included 12 patients which were treated by 0.018-inch bracket system. The process of randomization and group allocation was undertaken via a computerized simple online generated randomization plan using online software found at the website:Web capture_20-11-2023_2187_www.graphpad.com.jpeg

Inclusion criteria:

All patients included in this study had the following criteria:

a) The age ranged from 14 to 18 years.

b) Angle class I malocclusion with normal facial proportions.

c) Moderate to severe crowding in the lower arch as assessed by little Irregularity Index that required treatment with extraction approach.

d) No systemic diseases or medications that could interfere with orthodontic treatment especially NSAIDS.

e) No previous orthodontic treatment.

f) No previous history of trauma or endodontic treatment of mandibular anterior teeth.

g) All permanent teeth have erupted (3rd molars were excluded).

Orthodontic appliance:

All patients received fixed orthodontic appliances. Direct bonded pre-adjusted metal brackets utilizing 0.022-inch slot in group 1 and 0.018-inch slot in group 2 (IOS, Capricorn St. Stafford) from right to left 2nd maxillary premolars, except the maxillary 1st premolars, using light-cured orthodontic adhesive (Grengloo Two-Way Color Change Adhesive, Ormco Corp, Glendora, USA). In addition, the maxillary 1st molars were also directly bonded using single buccal molar tubes with a 0.022-in slot (IOS, Capricorn St. Stafford).

After bracket and tube bonding, each patient was referred to make minimal traumatic extraction of the lower first premolars. Leveling and alignment were done in lower arches using a sequence of round Niti wiresas the following 0.012. 0.014, 0.016 and 0.018 IOS Super Elastic Titanium Archwires, USA.), till reaching a final working round 0.018 Niti archwire (IOS Niti Archwires, USA.).

Study measurements:

An alginate impression of the lower arch was taken and poured immediately after 10 minutes with extra hard dental stone. To create digital models, the final study models were scanned using Shining 3D laser scanner. Maestro 3D Dental Studio, Pisa, Italy. software was then used to upload the scanned models and perform all Little's Irregularity Index measurements (12). In the same way, 3D digital model of the lower arch was obtained every 3 weeks from the start of treatment to the end of observation period. The scoring method of LII involves calculation of the linear displacement of the anatomic contact points of each mandibular

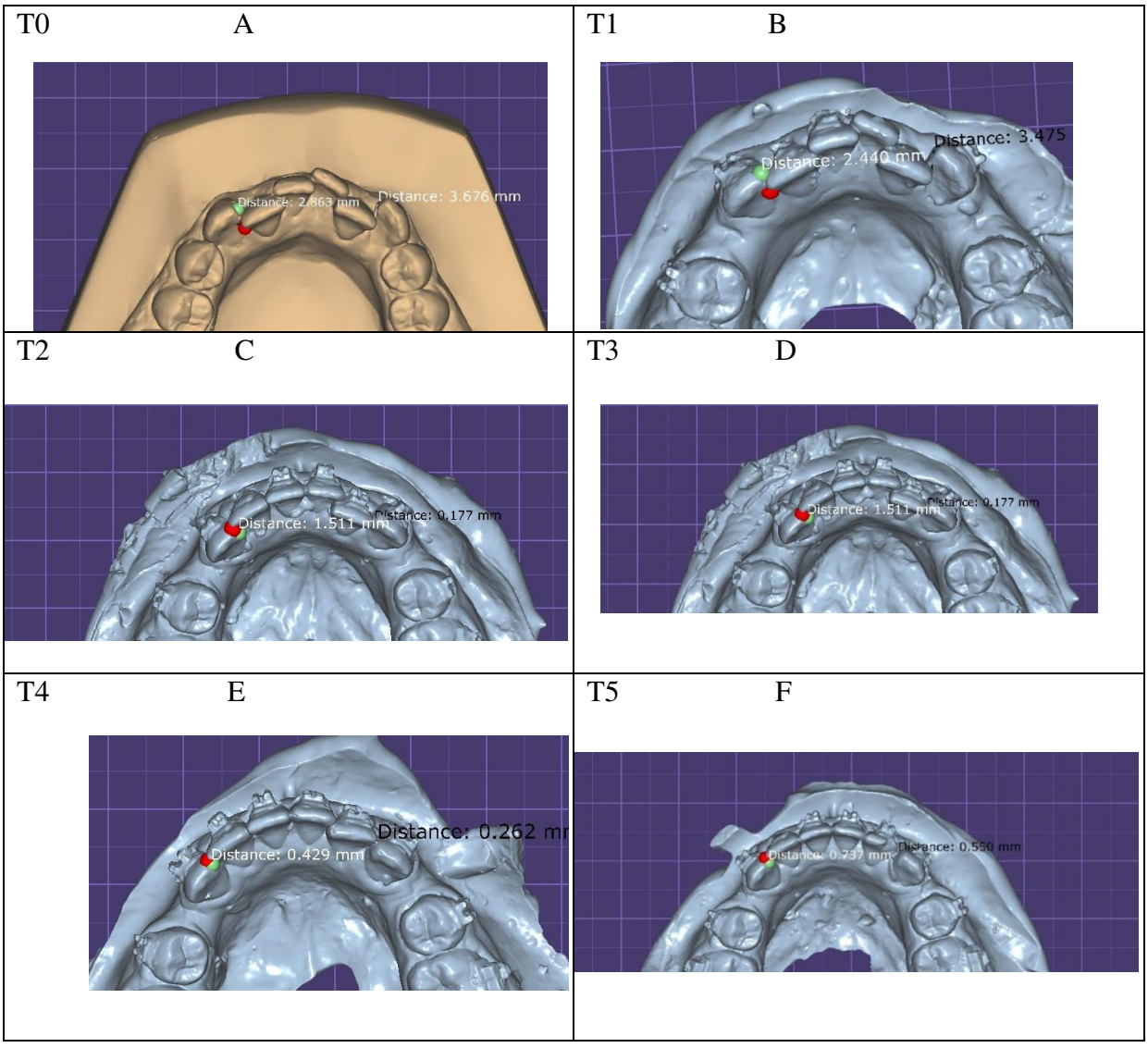
incisor from the adjacent tooth anatomic contact point, the sum of these five displacements representing the relative degree of anterior irregularity.

Perfect alignment from the mesial aspect of the left canine to the mesial aspect of the right canine would theoretically have a score of 0 while increased crowding was represented by greater displacement and subsequently higher index score.

Scoring of LII scores (mm) was determined on a scale ranging from 0 to 10 as the following:

0	Perfect alignment.
1 - 3	Minimal irregularity
4 - 6	Moderate irregularity.
7 - 9	Severe irregularity.
10	Very severe irregularity.

The LII scores were measured by the software for each patient in the two groups at T0 (pre-alignment) and every three weeks until the end of observation period. (Fig. 1)



T6 G

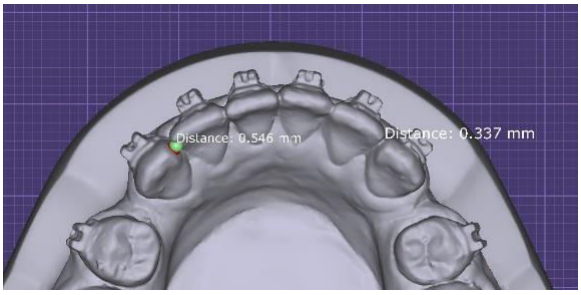


Figure (1): Measurement of Little 's irregularity index on 3D scanned digital model using Maestro 3D software at: A: T0 (before treatment), B: T1 (after 3 weeks), C: T2 (after 6weeks), D: T3 (after 9 weeks), E: T4 (after 12 weeks), F: T5 (after 15 weeks), G: T6 (after 18 weeks).

Statistical analysis:

All measurements were collected and statistically analyzed by Statistical Package for Social Science software for Windows (SPSS, version 25, Inc., IBM Company, Chicago, III, USA). The mean and standard deviation used to define quantitative variables were determined for all variables in both groups, and descriptive statistics such as mean differences, standard deviations, standard errors, and percentage changes in all measures were also calculated using independent sample t test. The outcome shows that the data were normally distributed using Shapiro-Wilk (S-W).

Results:

A total of 24 patients were recruited into the study, 12 in the 0.022-inch slot bracket, and 12 in 0.018-inch slot bracket groups. Descriptive statistics showed no difference between the groups in crowding pre-treatment as shown in Table 1. Comparison of the difference in the rate of tooth alignment (LII scores) changes during treatment for the two bracket groups are shown in Table 2. There was not statistically significant difference in the rate of tooth movement during leveling and alignment at T0–T6 between the two groups ($P < 0.05$; Table 2).

Table 1: Comparison of before treatment/baseline (T0) LII scores (mm) among the two investigated groups.

Groups		Minimum	Maximum	Mean	SD	Sig
Group 1	T0	10.85	14.62	13.25	1.22	P= .647 NS
Group 2	T0	11.21	14.51	13.48	.965	

T0=before treatment Little's irregularity index, SD= standard deviation, NS= non-significant.

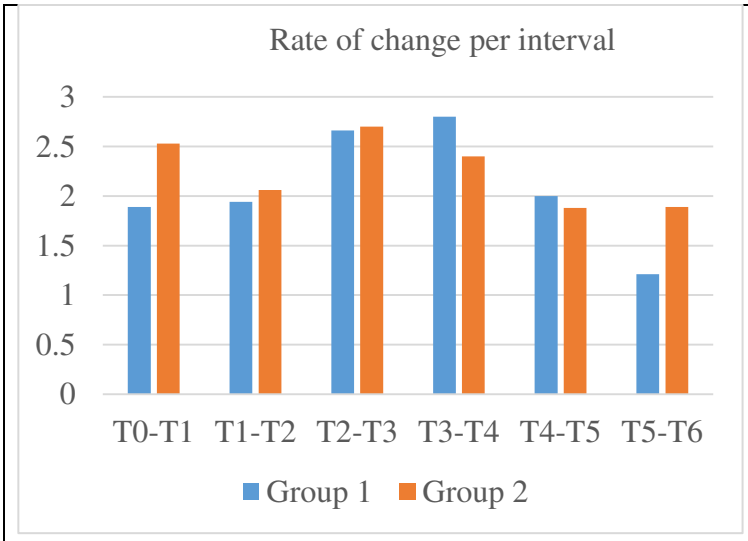
Table (2): Comparison of alignment rate (mm) at different observation intervals of the study (3 weeks) between the two investigated groups:

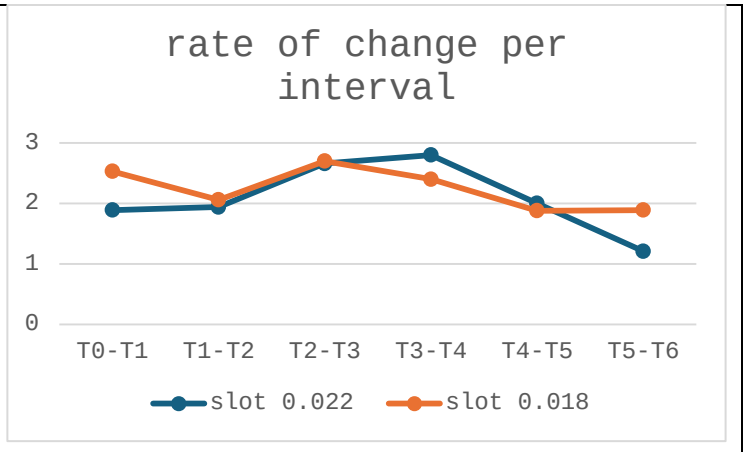
Rate of change	Groups	N	Mean	SD	SE	%	Mean Difference	Independent Samples Test		
								t	df	Sig.
T0_T1	Group 1	10	1.89	.912	.288	14.26	.640	1.069	18	.299 NS
	Group 2	10	2.53	1.65	.524	18.77				
T1_T2	Group 1	10	1.94	1.67	.530	14.64	.124	.209	18	.837 NS
	Group 2	10	2.06	.836	.264	15.55				
T1_T2	Group 1	10	2.66	1.44	.456	20.07	.039	.061	18	.952 NS
	Group 2	10	2.70	1.42	.449	20				

T3_T4	Group 1	10	2.80	.741	.234	21.13	.399	1.053	18	.306 NS
	Group 2	10	2.40	.940	.297	17.08				
T4_T5	Group 1	10	2.00	.908	.287	15.09	-.117	-.251	18	.804 NS
	Group 2	10	1.88	1.15	.365	13.95				
T5_T6	Group 1	10	1.21	.642	.203	9.13	.677	1.476	18	.157 NS
	Group 2	10	1.89	1.30	.411	14.02				

T0=before treatment Little's irregularity index, T1= Little's irregularity index at first interval, T2= Little's irregularity index at second interval, T3= Little's irregularity index at third interval, T4= Little's irregularity index at fourth interval, T5= Little's irregularity index at fifth interval, T6= Little's irregularity index at six interval, N= number, SD= standard deviation, SE standard error, df= degree of freedom,

Figure (2): A bar and line charts showing comparison of amount (mm) of changes in LII scores at different observation intervals of the study among the two studied groups:





Discussion:

The main aim of the current study was to compare 0.018-inch and 0.022-inch bracket slot systems in terms of the effects of bracket's slot system on the quantity of teeth movements during orthodontic leveling and alignment stage. While other previous studies aimed to compare clinical outcomes of cases treated with 0.018-inch brackets vs 0.022-inch brackets or aimed to compare the duration of fixed orthodontic treatment with different bracket slot size (4,5).

The mean age of participants in the study was 17.12 ± 1.96 years. This is in accordance with several studies that have reported a gradual increase in the age of orthodontic patients (13).

Angle class I malocclusion with normal facial proportions were recruited in the current study sample to simplify the comparison and this is different to other study that was included all types of malocclusions in the study, or other that with a relatively increased proportion of subjects with Class III malocclusion in the sample (13,14).

The severity of malocclusion was evaluated in this study by little Irregularity Index in six anterior and this was with agree to many previous studies. Most of these studies that have evaluated the severity of irregularity have only included the six anterior teeth. This method can be misleading because it ignores the irregularity in the posterior segments. Evans et al. assessed irregularity in both the anterior and posterior segment (15,16).

In this study, we selected the cases needed to extraction with moderate and severe crowding to effectively compare the difference of the time taken to alignment in both group and this is difference to other studies that selected both cases that needed to extraction or not. Extraction vs. non extraction of the literature review there is controversy about the influence of extraction on the full duration of orthodontic treatment, there is no evidence to suggest any effect of extraction on the duration of the levelling and alignment phase. (13,14).

Comparison of the descriptive baseline variables between the two groups indicated that there is no statistically significant difference. This ensured that the randomization process of the recruited sample was effective in producing study groups with similar pre-treatment characteristics. This reduced the influence of confounding factors when comparing between the two study groups and indicate that the results are valid and unlikely to be caused by any factor other than the intervention being investigated.

On comparing the difference of LII changes between each appointment and the previous one between the two groups, it was found that there were no significant differences in the alignment scores (mm) and percentage (%) of changes between the two groups at all observation periods of the study.

This finding agrees with previous study of Elangbawi et al. 13 which has found that there were no significant differences between the two groups in alignment rate.

This finding disagreed with the study of Cobb et al. 19 which the results have revealed that the rate of alignment was significantly faster in the lower arch for cases that were treated with the 22-slot appliance. This difference may be due to different types of archwires or may be due to difference in the recall interval where in this study, the participants were recalled every 4 weeks, while in the present study the participants were recalled every 3 weeks.

Conclusion:

It was concluded that both types of brackets can be used, and both are effective in the leveling and alignment stage of orthodontic treatment, however bracket slot 0.018 have showed non-significant faster rate of tooth movement than bracket slot 0.022.

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