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Research Article

COMPARISON OF THE AMOUNT AND RATE OF RETRACTION AND ANCHOR-LOSS BETWEEN MONO-CRYSTALLINE SAPPHIRE BRACKET AND POLY-CRYSTALLINE CERAMIC BRACKET DURING CANINE RETRACTION - AN IN VIVO RANDOMIZED CLINICAL TRIAL

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ABSTRACT

The purpose of this study was to compare the amount and rate of retraction and anchor loss, brought about by Monocrystalline saffire (Radiance) and Polycrystalline alumina (Clarity Advanced) brackets in an in-vivo randomized split mouth design, during individual maxillary canine retraction by sliding mechanics. Study sample comprised of thirteen patients who fulfilled the selection criterion. Individual canine retraction was carried out using superelastic nickel-titanium closed coil springs (150g force) for 4 months on a 0.018-inch SS archwire. Photocopies of casts obtained at start of retraction (T1) and after 4 months (T2), were traced and superimposed to measure the amount of retraction of the canine and anchor loss of the first molar for each side (serial model analysis).It was found that Polycrystalline brackets exhibited increased distal movement of the maxillary canines and lesser amounts of anchor loss when compared to monocrystalline brackets. These differences were found to be statistically significant ($P<0.05$).

INTRODUCTION

With increasing orthodontic awareness, a larger proportion of patients are opting for inconspicuous esthetic treatment. Biomechanical advantage with labial brackets far surpasses other esthetic options such as plastic aligners or lingual brackets. Ceramic brackets have dominated the market in this category, even though they present a higher degree of friction compared to stainless steel alternatives. In the mid-1980s, the first brackets made of monocrystalline sapphire and polycrystalline ceramic materials came into the field of Orthodontics[1-2]. Monocrystalline and polycrystalline varieties of ceramic brackets exhibit phenomenally distinct physical and esthetic properties. In-vitro friction studies comparing the two are not conclusive about the performance of these brackets clinically. Hence, there is lack of unanimous agreement regarding the clinical efficiency of these brackets. This study compares the two brackets in-vivo.

MATERIALS AND METHODS

This study was conducted at the Department of Orthodontics and Dentofacial Orthopaedics, Meenakshi Ammal Dental College and Hospital, Chennai and approved by the Institutional Review Board, Meenakshi Ammal Dental College.

Patient Selection: Thirteen patients with Class I or Class II malocclusion, requiring bilateral extraction of maxillary first premolars were included in the study (7 males and 6 females; aged between 15-22 years). Inclusion criteria comprised of:

1. Minimum of 4mm pre-retraction extraction space available
2. Symmetrically placed, fully-erupted upper canines without any reported or observed dental treatment;
3. No history of prior orthodontic treatment 4) Systemically healthy patients with good oral hygiene

Patients with severe crowding in the maxillary arch were excluded from the study. Consent was acquired from patients participating in the study. Three patients were excluded during the course of the study due to fracture of the canine bracket and

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failure of the two patients to report within the data collection period.

Materials: Ceramic brackets used in study were Clarity Advanced (3M-Unitek, Monrovia, Calif.) and Radiance Plus (American Orthodontics, Sheboygan, Wis). Clarity Advanced brackets (Group A) were made of injection-molded polycrystalline alumina; whereas Radiance Plus ceramic brackets (Group B) were made each from a single crystal of sapphire.

Study design and randomization: Study was performed in a split-mouth design, with both sides being test groups (randomized trial). Ceramic brackets from Group A and Group B were randomly allocated to either the right or the left upper canines for each patient.

Method: Orthodontic treatment was performed with standard SS pre-adjusted edgewise appliance (MBT prescription; 0.022 x 0.028 inch). Ceramic brackets (MBT prescription) were bonded on maxillary canines (Fig 1). Alignment and levelling of the arches were performed using 0.016-inch and 0.016 x 0.022-inch superelastic nickel titanium (NiTi), following which retraction was performed on 0.018-inch SS round archwire (3M-Unitek, Monrovia, Calif; Orthoform-III). For anchorage preparation, maxillary first molars and second premolars were consolidated using steel ligatures on each side. Distal tie wings of canine brackets were tied with Teflon-coated SS 0.012-inch ligatures (Ortho Organizers Inc, San Marcos, Calif). Retraction of canines was done with super-elastic nickel titanium closed-coil spring (3M-Unitek, Monrovia, Calif; 9mm-medium), started 1 month after SS archwire engagement (Fig 2). The force of 150 g was checked with a dynamometer (Dontrix Ortho Gauge 16 OZ, TP Orthodontics, LaPorte, Ind).

Fig 1 Pre-retraction maxillary arch (of same patient) with Clarity Advanced bracket bonded to right canine and Radiance bracket bonded to left canine (T1)

Fig 2 Maxillary arch of same patient after 4 months of individual canine retraction(T2)

Data Collection: Impressions of the upper arch were made at start (T1) and after 4 months (T2) of canine retraction. Casts at T1 and T2 were obtained and duplicated. Following landmarks were located and highlighted on each duplicated cast using a 0.5mm lead mechanical pencil (Fig 3 & 4):

1. Incisive papilla-midpalatine raphe line;
2. Third palatine rugae bilaterally;
3. Cusp-tip of canines;
4. Mesio-palatal cusp of first permanent molars

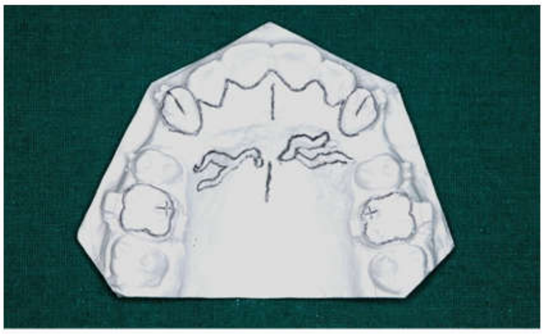

Fig 3 T1 maxillary cast

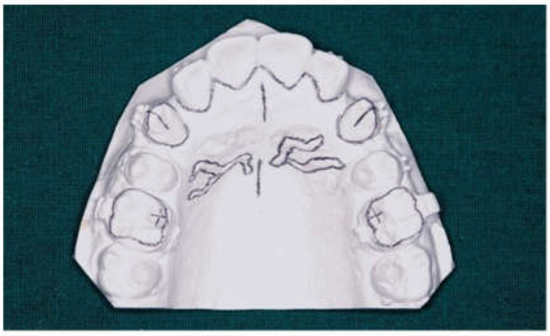

Fig 4 T2 maxillary cast

Occlusal and palatal surfaces of the casts were photocopied (from an occlusal perspective) individually without any magnification, using a photocopying machine, by keeping casts directly on the platen of the photocopier. Highlighted landmarks were traced on acetate tracing paper using the T1 photocopies of each patient as the baseline. T2 photocopies of respective patients were superimposed at the incisive papilla-midpalatine raphe line (transverse reference plane) and the medial points of right and left third palatal rugae (sagittal reference), and traced using different colour markings (serial model analysis). This tracing was labelled S1. A second tracing, S2, was made from S1 for each patient. The following were plotted on S2:

1. Incisive papilla-midpalatine raphe line;
2. Pre-retraction canine cusp tip lines (X1; X2) drawn perpendicular to midpalatine raphe line;
3. Post-retraction canine cusp tip lines bilaterally (Y1; Y2) drawn perpendicular to midpalatine raphe line;
4. Pre-retraction molar mesio-palatal cusp tip lines bilaterally (A1; A2) drawn perpendicular to midpalatine raphe line;

5. Post-retraction molar mesio-palatal cusp tip lines bilaterally (B1; B2) drawn perpendicular to midpalatine raphe line.

S2 tracing of each patient was used for measuring the amount of canine retraction (X1-Y1 and X2-Y2) and also anchorage loss (A1-B1 and A2-B2), on right and left sides individually. The amount of canine retraction (4 months) and anchor loss were measured directly from S2 tracing; whereas, the rate of retraction was calculated by dividing the total amount of canine retraction achieved by the number of months of the study. Measurements were repeated after 7 days to check for reproducibility.

Statistical Analysis: Kolmogorov-Smirnov and Shapiro-Wilk tests were employed to check the distribution pattern of the data. Parametric tests were applied for statistical analyses. Means and standard deviations for the total amount of retraction (4months), rate of retraction (per month) and anchor loss were calculated. Paired t-test was used for comparison of the mean values of the amount of retraction and anchor loss between the two groups. Significance level was set at 5%. Statistical software SPSS, version 20.0 was used to perform data analysis and processing.

RESULTS

Since the study was carried out in a split mouth design, each subject was divided into two homogenous within-patient experimental units, the right and the left sides. Sides were randomly allocated to the two groups in the study, Group A-polycrystalline brackets, and Group B-monocrystalline brackets. The amount of retraction and anchor loss were measured using tracing superimpositions of the maxillary casts parallel to the incisive papilla- midpalatine raphe line, with a digital caliper. A detailed description of the study sample measurements is provided in Table 1.

Table 1 Amount and average rates of distal movement of maxillary canines, and anchorage loss of maxillary first molars in 4 Months

S.No	Group A (Clarity Advanced)			Group B (Radiance)		
	Amount of ret. (in mm)	Rate of retrac. (in mm)	Anchor loss (in mm)	Amount of ret. (in mm)	Rate of retrac. (in mm)	Anchor loss (in mm)
1.	2.83	0.71	0.38	2.89	0.72	0.80
2.	4.03	1.01	0.70	3.43	0.86	2.11
3.	4.10	1.03	0.31	3.31	0.83	0.76
4.	2.95	0.74	0.90	2.73	0.68	1.98
5.	3.48	0.87	0.94	2.58	0.65	1.33
6.	4.57	1.14	0.84	3.89	0.97	0.45
7.	4.47	1.12	0.43	4.53	1.13	0.85
8.	2.92	0.73	0.34	3.19	0.80	0.47
9.	4.41	1.10	1.27	3.80	0.95	0.95
10.	2.96	0.74	0.51	2.26	0.57	1.45

The results showed that the data followed normal distribution. Therefore parametric tests were applied for statistical analyses. Means and standard deviations for the total amount of retraction (4months), rate of retraction (per month) and anchor loss were calculated. Paired t-test was used for comparison of the mean values of the amount of retraction and anchor loss between the two groups (Table 2).

Table 2 Means, standard deviations, and significance values comparing amount of retraction, and anchor loss with polycrystalline (Group A) and monocrystalline (Group B) brackets in 4 months

Variables	Group	N	Mean (mm)	Std. Dev	t-value	p-value
Amount of ret.	A	10	3.67	0.718	3.124	0.012
	B	10	3.26	0.685		
Anchor loss	A	10	0.66	0.320	2.496	0.034
	B	10	1.12	0.585		

The amount of retraction in 4 months with polycrystalline ceramic brackets (Group A) was more than that with monocrystalline saffire brackets (Group B) by 0.41mm, which was statistically significant (t=3.124; p=0.012). Anchor loss in 4 months with polycrystalline ceramic brackets (Group A) was less than that with monocrystalline saffire brackets (Group B) by 0.46mm, which was also statistically significant (t=2.496; p=0.034). Average rate of retraction per month with polycrystalline ceramic brackets (Group A) was more than that with monocrystalline saffire brackets (Group B) by 0.10mm.

DISCUSSION

Observations made can be explained based on differences observed in the slot ends of these two categories of brackets. Although monocrystalline saffire brackets show smoother surface topography compared to polycrystalline brackets under scanning electron microscopes (Omana et al[3] 1992; Saunders and Kusy 1994[4]), they present rougher slot ends (sliding edges) due to the machining process during manufacturing. Although Guerrero et al[5]. (2010) did not find a significant difference between the frictional values obtained with injection-molded and metal-lined polycrystalline brackets, the polycrystalline brackets were found to have lower friction when compared to monocrystalline saffire brackets. Russell[6] (2005), on the other hand, states that the frictional resistance offered by the monocrystalline ceramic bracket is comparable to that of stainless steel bracket. The present study was conducted in a split mouth design with paired observations for each individual similar to that done with split mouth design studies earlier (Lotzof et al[7] 1996; Yee et al[8] 2009) so that inter-subject variability was removed; resulting in increased power of the study (Pandis et al[9] 2013).It is further stated by Mezomo et al[10] (2011) that precision in bracket positioning could vary according to the patient's side. Such bias, if not randomized, could influence results.Ceramic brackets on both sides were tied by the same operator to keep the ligature force levels more constant and minimize interoperator error (Deguchi et al[11] 2007).

CONCLUSION

The monocrystalline saffire brackets offered higher resistance to sliding when compared to polycrystalline injection-molded alumina brackets. Although, the difference in average rate of retraction between the two brackets was found to be very minimal; when associated with the amount of anchor loss, clinical efficiency for sliding mechanics was found to be higher with polycrystalline alumina brackets. Thereby, authenticating that polycrystalline brackets are better suited for sliding (friction) mechanics in a clinical study.

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