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Canine Retraction: A Randomised Clinical Trial Comparing Damon™ 3 Self-Ligating with Conventional Ligating Brackets

(Penarikan Gigi Taring: Satu Percubaan Klinikal Rawak untuk Membandingkan Braket Swa-Ikatan Damon™ 3 dengan Braket Ikatan Konvensional)

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ABSTRACT

*The clinical efficacy was investigated between Damon™ 3 self-ligating (SLB) and Mini Diamond conventional-ligating brackets (CLB) of the straight-wire fixed orthodontic therapy on the tooth movement during canine retraction stage. Twenty patients, age between 14 and 30 years old were randomized into 2 groups: ten patients received Damon™ 3 SLB and another ten patients received Mini Diamond CLB. A transpalatal arch soldered to both maxillary first molar bands was constructed for each patient and cemented before the extraction of the maxillary first premolars. The canine retraction was commenced on a 0.018" stainless steel archwire by attaching a Nickel-Titanium close coil spring from the canine bracket to the molar band for three consecutive visits of 4 weeks interval (T_0, T_1, T_2 and T_3). Tooth movements were determined by subtracting the present measurement from the previous ones using a digital caliper on a study model. Statistical analysis showed that there was no difference (*p>*0.05) in canine retraction between Damon™ 3 and Mini Diamond brackets. The Damon™ 3 and Mini Diamond brackets have same efficacy in tooth movement.*

Keywords: Canine retraction; conventional ligating bracket; Damon™ 3 self-ligating bracket; orthodontics

ABSTRAK

*Keberkesanan klinikal dikaji antara braket Swa-ikatan Damon™ 3 dan ikatan konvensional Mini Diamond (CLB) daripada terapi ortodontik menggunakan wayar lurus pada pergerakan gigi semasa tahap penarikan gigi taring. Dua puluh pesakit, berumur antara 14 dan 30 tahun dirawak menjadi dua kumpulan, sepuluh pesakit menerima braket Swa-ikatan Damon™ 3 dan sepuluh pesakit lainnya ikatan konvensional Mini Diamond (CLB). Satu lengkung transpalatal dipateri ke atas kedua-dua gegelang besi geraham pertama maksilari, dibina untuk setiap pesakit dan disimen sebelum penarikan geraham pertama maksilari. Penarikan gigi taring menggunakan wayar lengkung keluli nirkarat 0.018" dengan melekatkan spring Nikel-Titanium pada gigi taring ke gegelang besi geraham selama tiga temu janji berterusan dalam masa 4 minggu (T_0, T_1, T_2 dan T_3). Pergerakan gigi ditentukan dengan menghitung perbezaan dari pembacaan jarak sekarang dengan sebelumnya menggunakan kaliper digital pada model gigi. Analisis statistik menunjukkan bahawa tidak ada perbezaan signifikan (*p>*0.05) dalam penarikan gigi taring antara braket Damon™ 3 dan Mini Diamond. Braket Damon™ 3 and Mini Diamond mempunyai keberkesanan yang sama dalam pergerakan gigi.*

Kata kunci: Braket ikatan konvensional; braket Swa-ikatan Damon™ 3; ortodontik; penarikan gigi taring

INTRODUCTION

Treatment efficacy is prudence in the management of all orthodontics cases to ensure optimal treatment results with lesser clinical time and shorter treatment duration. Studies on the different efficacy of self-ligating brackets (SLB) and conventional ligating brackets (CLB) have been made to prove that SLB is superior in tooth movement (Miles 2007; Rohaya et al. 2011; Sirinivas 2003; Stivaros et al. 2010).

Sliding mechanics in modern appliance system has made an impact by considerably reducing the need for wire bending that was dominant in the standard edgewise technique. Sliding movement along the archwire implies friction between archwire, bracket and ligature surfaces. It is estimated that 50% of the orthodontic force applied is used to overcome the friction (Proffit 2000). It is claimed that SLB fulfilled the ideal properties by providing a more certain full archwire engagement with low frictional force between the bracket and the archwire. Elimination of ligature ties also creates a friction-free environment. Numerous investigators showed that SLB demonstrated very low friction in relations to wire stiffness (Meling et al. 1997), archwires types (Kapur et al. 1998) and angulation (Pizzoni et al. 1998).

SLB permits anchorage conservation (Harradine & Birnie 2006). Traditionally, transpalatal arch has been used for anchorage reinforcement (Lee & Kim 2011). When applied to orthodontic treatment, transpalatal arch is applied to stabilize molar position. The anchorage conservation is due to lower forces are used for tooth moving and thus reciprocal forces are correspondingly smaller. Lower forces per unit area lead to more anchorage preservation (Harradine & Birnie 2006). Lower net forces

deflect archwires less and thus releasing some of the binding forces between wire and bracket to enhance sliding the wire. Individual teeth can slide along an archwire with less anchorage demand and undesirable rotations do not occur because of full bracket engagement. Other than that, SLB system aligns teeth at a faster rate than the CLB due to the capacity of the wire to slide through the brackets of rotated teeth. A fully secure bracket engagement permits full embrasure of the displaced teeth and therefore full control of the tooth movement can be achieved. Another advantage of SLB is it was designed to speed up archwire changes by eliminating the use of any type of ligation. This results in faster archwire ligation and removal as well as lessens the need for chairside assistance. Voudouris (1997) reported that a 4-fold reduction in archwire change time was observed with SLB. Hence, clinical time used to ligate and remove archwire can be 80% shorter. Furthermore, it is proposed to acquire less chair side assistance and assists in faster archwire insertion and removal.

Many studies investigated the effectiveness of both SLB and CLB in orthodontic treatment but the validity of past *in vitro* studies on SLB was questionable (Rinchuse & Miles 2007). *In vitro* studies could not simulate the biologic responses in the oral cavity. Most of *in vitro* studies were limited to small aspects of the orthodontic treatment. Although it was claimed that the modification of a fretting machine could evaluate the dynamic frictional behavior of brackets and archwires in *in vitro* studies (Mohrbacher et al. 1995), however, *in vitro* vibration simulation of the *in vivo* occlusal and masticatory forces could still face lack of validity (Harradine 2003). Few clinical studies have compared space closure with SLB and CLB (Miles 2007; Sirinivas 2003) but using different types of SLB. In this study, we compared the efficacy of Damon™ 3 SLB with Mini Diamond CLB during canine retraction and space closure stage of a fixed orthodontic appliance therapy by comparing the rate of canine movement on both brackets types.

Materials and Methods

The reference population was made up of patients who were placed on either the orthodontic waiting list at the Faculty of Dentistry of Universiti Kebangsaan Malaysia or Pusat Pergigian Angkatan Tentera in Kementah, Kuala Lumpur. Twenty conveniently sampled patients, between 14 and 30 years who have met the inclusion criteria, participated in the study. Prior to this study, clearance from the Research and Ethical committee was sought out and all patients were explained about the study and signed the consent forms.

INCLUSION CRITERIA

Healthy patients with permanent dentition at least to the first molars, in good periodontal health (periodontal pocket ≤ 4 mm, full mouth plaque score ≤ 20% and full mouth bleeding score ≤ 20%), Class I or II division 1 incisor relationship with overjet ≤ 6.0 mm, who required extraction of both upper first premolars to relieve crowding and/or to reduce overjet and at least an upper fixed appliance treatment to retract maxillary canines are included in this study. Every patient must show no radiographic bone loss in orthopantomogram image.

EXCLUSION CRITERIA

Patients with craniofacial and dental anomalies, had previous upper orthodontic treatment, or anti-inflammatory drugs usage preceding the beginning of study are excluded from this study.

CLINICAL PROCEDURE PRIOR TO STUDY

All patients underwent a routine orthodontic assessment, a full mouth scaling, prophylaxis treatment and were taught the proper oral hygiene practice. A transpalatal arch was constructed with suitable molar bands (ORMCO molar band, Trimline, ORMCO Corp.) and cemented to each patient's maxillary first molars. Patient was then sent to the oral surgery department for extraction of both the maxillary first premolars in two separate appointments.

RETRACTION OF CANINES

Ten patients from each group were selected to participate in the canine retraction stage. A 0.36 mm and later 0.46 mm NiTi round archwire (TruFlex™, OrthoTechnology) were used during aligning and leveling stage before canine traction started.

A simple randomization was used to divide patients into two groups: Damon™ 3 SLB and Mini Diamond CLB. A 0.46 mm. Stainless Steel archwire (TruForce™, OrthoTechnology) was fitted to the upper arch and left passively for one visit. At the subsequent visit, canine retraction was commenced using a 6.0 mm light NiTi close-coil spring (Figure 1). The forces were measured and standardized with a Correx® gauge. Canine retraction was performed for 3 visits with each visit at 4 weeks interval. An impression of the maxillary arch was taken before the commencement of canine retraction (T_0) and subsequently at every retraction review appointments (T_1, T_2 and T_3).

MEASUREMENTS OUTCOME

The distance between the tip of the canine and the mesiobuccal groove of the upper first molar was used to assess the bracket efficiency using study models of T_0, T_1, T_2 and T_3. These measurements were carried out using electronic digital calipers (Absolute Digimatic, AMZ Germany Series 600 – Manual) (Figure 2). The canine distance tooth movement was assessed by subtracting the presented distance from the previous distance reading.

STATISTICAL ANALYSIS

Kolmogorov Smirnov test was used to test the normal distribution of the each group of data. The values for the distance of canine retraction on Mini Diamond CLB and

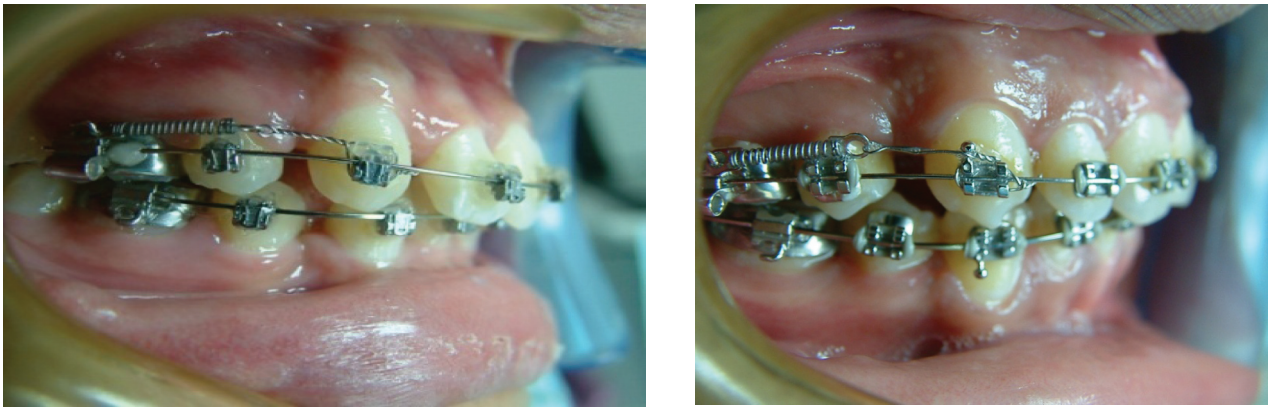

FIGURE 1. Retraction of maxillary canine of a patient treated with Damon™ 3 SLB using NiTi closed coil spring (A). Retraction of maxillary canine of a patient treated with Mini Diamond CLB (B)

FIGURE 2. Measurement of the distance for canine retraction

Damon™ 3 SLB were analyzed by unpaired student's t-test. The criterion for statistical significance was considered to be $p<0.05$.

RESULTS AND DISCUSSION

The canine retraction was used in this study as to simulate tooth movement during space closure stage of a fixed appliance orthodontic treatment. It is also one of the aims in every orthodontic management of a Class II canine relationship in achieving a Class I canine relationship at the end of treatment. In straight-wire orthodontic appliance treatment in which sliding mechanics is the basic principle, it was suggested by Kanupriya Sethi et al. (2011) that space closure to be carried out on a 0.48 mm × 0.64 mm rectangular stainless steel archwire. This is due to the movement of the crown mostly precedes displacement of the root during tooth movement because a tipping moment is placed on the tooth crown.

However, the wire used in this study was a 0.46 mm stainless steel archwire, which was similar to the study by Mezomo et al. (2011) in retracting canine. Smaller archwire was used as it had lower friction comparing with the larger one (Hain et al. 2006; Henao & Kusy 2004; Shivapuja & Berger 1994; Voudouris 1997). Constituent material and orthodontic archwire diameter can influence tooth movement during sliding mechanics. It is known that stiffer wires can better resist the tendency of teeth tilting during sliding (Huffman & Way 1983; Kojima et al. 2006). Although some studies had found that increase in archwire dimension showed insignificant different (Peterson et al. 1982; Tidy 1989) with some contradict result that shown smaller dimension archwires produced the highest friction (Ireland et al. 1991). For the mentioned evidences, a round, 0.018-inch SS archwire (TruForce™, Ortho Technology) was selected for this study.

Optimal force in orthodontic known to produce excellent biological response with minimal tissue damage, resulting in rapid tooth movement with little discomfort, minimizing or avoiding hyalinized areas (Storey & Smith 1952). However, the magnitude and duration of the ideal force remain controversial (Ren et al. 2003). Lotzof et al.

TABLE 1. Canine retraction distance (mm) in Mini Diamond CLB and Damon™ 3 SLB

Brackets type and magnitude of orthodontic force	Patients No.	LCD1	LCD2	LCD3	RCD1	RCD2	RCD3
Mini Diamond CLB	1	0.31	0.11	0.00	0.34	1.19	0.52
	2	2.46	0.66	0.04	0.88	0.28	0.72
	3	1.00	0.71	2.06	2.22	0.64	1.08
	4	2.46	2.75	0.81	3.37	1.71	1.21
	5	1.95	0.53	0.25	1.25	1.76	1.03
	6	1.22	1.30	1.74	0.99	1.37	1.27
	7	2.70	0.59	0.31	1.58	0.26	0.58
	8	1.09	1.10	0.84	1.34	1.29	1.57
	9	1.31	0.67	0.47	1.88	0.84	1.70
	10	2.02	1.57	0.25	1.47	2.26	1.97
Damon™ 3 SLB	1	1.73	0.07	0.36	1.28	1.74	1.08
	2	1.39	0.96	0.97	1.29	1.58	1.26
	3	1.69	2.87	1.11	0.22	2.22	1.42
	4	1.43	1.52	0.58	1.41	0.84	0.87
	5	3.10	0.72	1.46	2.11	1.65	0.85
	6	2.25	1.40	1.95	2.25	2.85	1.41
	7	2.26	1.00	0.94	2.04	1.18	1.02
	8	1.40	2.18	0.92	1.51	1.17	0.72
	9	1.42	1.80	1.77	0.54	0.12	0.32
	10	2.14	1.05	1.03	1.25	1.42	2.22

LCD1= Left canine distance movement after T1 reading
LCD2= Left canine distance movement after T2 reading
LCD3= Left canine distance movement after T3 reading
RCD1= Right canine distance movement after T1 reading
RCD2= Right canine distance movement after T2 reading
RCD3= Right canine distance movement after T3 reading

(1996) suggested the use forces between 100 g and 200 g for canine retraction, therefore the force of 150 g was employed in this study followed their recommendation.

The distance of canine retraction distance of Mini Diamond CLB and Damon™ 3 SLB was presented in Table 1. Kolmogorov Smirnov test showed normal distribution of the data. Therefore, the unpaired student's t-test was used to compare the differences in canine retraction of two types of brackets. It is found that there was no significant difference (p>0.05) between Mini Diamond CLB and Damon™ 3 SLB. This result was in accordance with Mezomo et al. (2011), while Srinivas (2003) found differently, which is higher rates of distal movement of canines were found with SLB as compared with CLB.

In orthodontic treatment, anchorage was defined as the resistance to unwanted tooth movement (Proffit 2000) involved in the restriction of certain tooth movements while encouraging others, to ensure that the dentition was in the ideal position at the end of treatment. In comparison to conventionally ligated orthodontic bracket system, SLB were said to consume less anchorage demand and claimed to omit the use of extra anchorage reinforcement regime due to its properties of using less force to produce tooth movement. The transpalatal arch as anchorage reinforcement was used in this study to prevent mesial movement of molar and maintain intermolar width (Stivaros et al. 2010) while retracting canines distally. In this study, we used transpalatal arch to stabilize molar position whilst Mezomo et al. (2011) applied no anchorage for posterior teeth. There was recorded of anchorage loss in other studies (Mezomo et al. 2011; Sirinivas 2003).

CONCLUSION

Damon™ 3 SLB showed same efficacy in canine retraction stage compared with Mini Diamond CLB where the rates of distal movement of the upper canines were similar with both self-ligating and conventional brackets.

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