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ORIGINAL RESEARCH


# The Effect of Using Self-ligating Brackets on Maxillary Canine Retraction: A Split-mouth Design Randomized Controlled Trial

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## ABSTRACT

**Introduction:** The results of previous studies about the efficacy of using self-ligating brackets (SLBs) in controlling canine movement during retraction are not in harmony. Therefore, the current study aimed to compare the effects of using new passive SLBs on maxillary canine retraction with sliding mechanics *vs* conventional ligating brackets (CLBs) tied with metal ligatures.

**Materials and methods:** The sample comprised 15 adult patients (4 males, 11 females; 18–24 years) requiring bilateral extraction of maxillary first premolars. Units of randomization are the left or right maxillary canines within the same patient. The two maxillary canines in each patient were randomly assigned to one of the two groups in a simple split-mouth design. The canines in the SLBs group (n = 15) were bracketed with SLBs (Damon Q™), while the canines in the CLBs group (n = 15) were bracketed with conventional brackets (Mini Master Series). Transpalatal bars were used for anchorage. After leveling and alignment, 0.019 × 0.025″ stainless steel working archwires were placed. Canines were retracted using a nickel-titanium close-coil springs with a 150 gm force. The amount and rate of maxillary canine retraction, canine rotation, and loss of anchorage were measured on study models collected at the beginning of canine retraction (T0) and 12 weeks later (T1). Differences were analyzed using paired-samples t-tests.

**Results:** The effect differences were statistically significant ($p < 0.001$). Using Damon Q™ SLBs, the amount and rate of canine retraction were greater, while canine rotation and anchorage loss were less.

**Conclusion:** From a clinical perspective, extraction space closure can be accomplished more effectively using SLBs.

**Clinical significance:** Self-ligating brackets gave better results compared to the CLBs in terms of rate of movement, amount of canine rotation following extraction, and anchorage loss.


**Keywords:** Anchorage loss, Canine retraction, Conventional brackets, Randomized clinical trial, Self-ligating.

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## INTRODUCTION

During fixed appliance therapy, friction generated at the bracket/wire and wire/ligature interfaces is a critical factor in determining the efficiency of biological tooth movement.[1] Many studies have proposed different methods to limit frictional forces, such as loosely tied stainless steel ligatures[2] and self-ligating brackets (SLBs).[3] Chen et al[4] in a systematic review of the clinical effectiveness of the SLBs reported that the existing evidence does not support the claim that lower friction in SLBs permits faster space closure in a clinical setting.

A clinical study compared SmartClip™ SLBs and conventional brackets tied with stainless steel ligatures that were used for en-masse retraction of the six anterior teeth with sliding mechanics and found similar rates of space closure in both techniques.[5] Few clinical studies have investigated the canine retraction phase using SLBs in comparison with conventional-ligating brackets (CLBs).[6,7] Mezomo et al[6] used sliding mechanics on 0.018″ stainless steel archwire and found that distal movement of the maxillary canines and anchorage loss of the first molars were similar with both Gemini™ CLBs and SmartClip™ SLBs, while rotation of the maxillary canines was minimized when SLBs were used. On the other hand, Burrow[7] found that the rate of canine retraction on 0.018″ stainless steel archwire tends to be faster with Victory Series™ CLBs than Damon3™ and SmartClip™ SLBs.

Sirinivas[6] used sliding mechanics on 0.018 × 0.025 stainless steel archwire for canine retraction and found that when using Damon SL™ SLBs the retraction was more rapid and the anchorage loss and canine rotation were reduced.

In the light of this controversy, this randomized clinical trial aimed to compare the effectiveness of maxillary canine retraction using CLBs (Mini Master Series, American Orthodontics, USA) and new passive SLBs (Damon Q™, Ormco, USA). We tested the null hypothesis that there were no significant differences in the effectiveness of maxillary canine retraction between CLBs and SLBs.

## MATERIALS AND METHODS

The current investigation was a randomized clinical trial conducted at the Department of Orthodontics between January 2013 and November 2013. The research protocol was approved by the University of Damascus Dental School Local Research Ethics Committee (UMDS2187) and was funded by the University of Damascus Postgraduate Research Budget (77981200987DEN).

### Sample Size Estimation

Clinical and statistical significant difference in extraction space closure was defined, in the literature, as at least a 3 mm (± 2 mm) per 4-month time period, in each quadrant.[8] Based on that difference and standard deviation, a power analysis determined that, for a two-sided 5% significance level and a power of 90%, a sample size of 10 for each group would be required. Accordingly, assignment continued until 15 consecutive orthodontic patients had enrolled in this investigation to compensate for any unexpected dropouts.

### Inclusion Criteria

Patients who were referred to the Orthodontic Department and who had the following criteria were considered suitable to be included in the trial: Healthy periodontal tissue treatment plan with extraction of both upper first premolars and anterior teeth protrusion requiring canine retraction. The demographic characteristics of patients are shown in Table 1.

### Exclusion Criteria

The exclusion criteria were the presence of any craniofacial syndromes, extreme vertical skeletal disproportion, previous orthodontic therapy, or significant medical history. All enrolled patients were included in a prospective manner and agreed to participate in this investigation by signing an informed written consent.

**Table 1:** Demographic characteristics of study sample: Sex distribution, and chronological age of patients at the beginning of treatment

| *Gender* | | *Male (n = 4)* | *Female (n = 11)* | *Total (n = 15)* |
|---|---|---|---|---|
| Age (years) | Mean ± SD | 21.17 ± 2.75 | 20.93 ± 2.35 | 20.99 ± 2.36 |
| | Range | 18.42–24.42 | 18.33–24.33 | 18.33–24.42 |

### Canine Retraction

Each patient was treated with full-fixed pre-adjusted appliance (Mini Master Series; American Orthodontics, Sheboygan, Wisconsin, USA). The brackets were metal and had a 0.022″ slot with MBT prescription. The first molars were stabilized with 0.9 mm stainless steel transpalatal bars with no additional anchorage for posterior teeth.

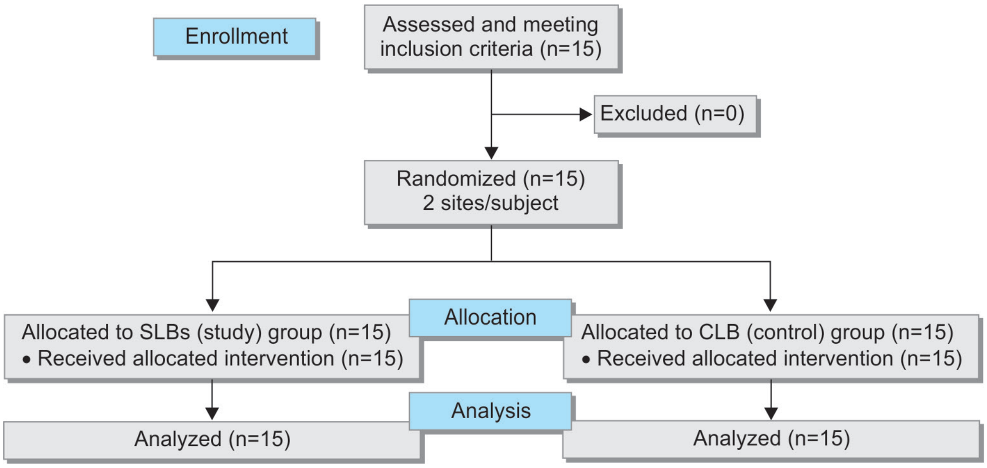
Before commencing canine retraction procedure, the upper dental arches were leveled and aligned using 0.014, 0.016, and 0.016 × 0.022″ nickel-titanium (NiTi) memory archwires (Therma-Ti, American Orthodontics, Sheboygan, Wisconsin, USA) and 0.016 × 0.022 and 0.019 × 0.025″ stainless steel archwires (American Orthodontics, Sheboygan, Wisconsin, USA). At the end of leveling and aligning, the upper 0.019 × 0.025″ stainless steel working archwires were placed for at least 4 weeks to ensure that the archwires were passive by sliding the archwire through the bracket slots.

Canine retraction was started at the same time on both sides in all patients. Canines were retracted using a 12 mm heavy NiTi Sentalloy closed coil springs (GAC International, York, Pennsylvania, USA) with 150 gm force level, stretched between the hooks on the labial surface of the molar bands and the canine brackets. The applied force was checked with a small model of correx tension gauge (Haag-Striet, Bern, Switzerland). There were no stopping rules identified for this trial as the two types of brackets used are in routine use and no special problems were expected.

### Allocation Method

Units of randomization are the left or right maxillary canines within the same patient. The two maxillary canines, in each patient, were randomly assigned to either the SLBs or CLBs group in a simple split-mouth design. The canines in the SLBs group (15 canines) were bracketed with new generation SLBs (Damon Q™, Ormco, Orange, California, USA), while the contralateral canines in the CLBs group (15 canines) were bracketed with CLBs (Mini Master Series, American Orthodontics,

**Flow Chart 1:** CONSORT flow diagram of participants through each stage of the trial




Sheboygan, Wisconsin, USA). Maxillary canine brackets had a +7° of torque, +5° of angulation, and 0.022″ slots. The SLBs were 2.8 mm wide whereas the CLBs were 3 mm wide. The conventional canine brackets were tied with a 0.010″ soft stainless steel ligature to minimize rotation during movement. A CONSORT flow diagram of the recruited patients is given in Flow Chart 1 and sample characteristics are given in Table 1.

## Analysis of Study Models

At the beginning of maxillary canine retraction (T0), the working archwire was removed and impressions of the upper dental arches were taken with Orthoprint® alginate (Zhermack, Badia Polesine, Italy). Other impressions were also taken after 12 weeks (T1) of canine retraction. From these impressions, stone models were poured with white orthodontic plaster (ZETA, Orthodontic Stone; WhipMix Corp, Louisville, Kentucky, USA).

To evaluate the rate of maxillary canine retraction, canine rotation, and anchorage loss, the following landmarks were marked on the collected study models with a 0.5 mm pointed pencil: (M), point of intersection of the transverse fissure with the buccal fissure of maxillary first permanent molar; (C), cusp-tip of the maxillary canine, if wear had occurred, the center of the wear facet; (CM and CD), mesial and the distal anatomical contact points of the maxillary canine; and (R), median end of a distinct posterior rugae.[9,10] The median palatal suture of the study models was defined by tracing as well. To minimize error in landmark identification, all landmarks in all models were identified in one session.

The occlusal view of all models was photocopied on a Panasonic 8016e digital photocopier to obtain model photocopies as described by Champagne.[11] All model photocopies were digitized by the same investigator in one session to minimize error in landmark digitization and analyzed in a blind manner using orthodontic software (Viewbox, version 3.1.1.13; dHal Software, Kifissia, Greece). Measurements were repeated after 2 weeks by the same investigator. The landmark lines used as well as the distances and angle that were measured in the model analysis are illustrated in Figure 1.

The measurements studied in the current trial included: (1) Retraction distance which was the total amount of maxillary canine retraction (mm) and the difference between the values of the distance (R′ – C′) measured between T0 and T1. (2) The rate of retraction (mm/month) was defined as the distance traveled divided by the time interval needed. In this current trial, the retraction rate represents the primary outcome measure.

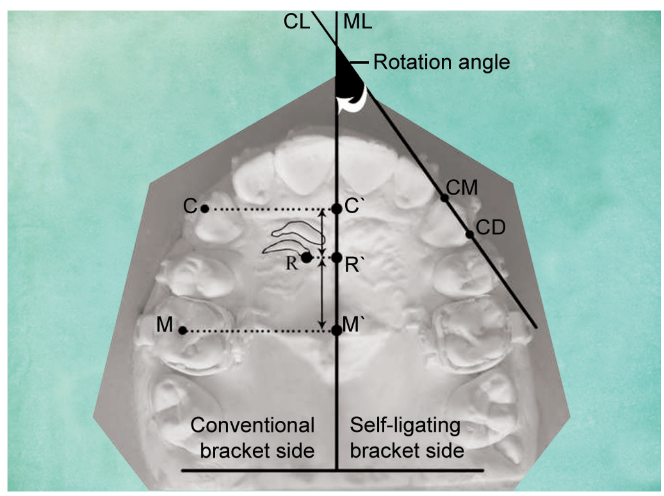



**Fig. 1:** Study model analysis. Median line (ML): A line passing along medial palatal suture; Canine line (CL): A line passing through points (CM) and (CD); Points (R′), (C′), and (M′) are the perpendicular projections of the points (R), (C), and (M) on the ML respectively; Rotation angle: An angle formed between ML and CL; Canine location (R′ − C′): A distance used to calculate the amount of posterior movement of maxillary canine; Molar location (R′ − M′): A distance used to calculate the amount of anterior movement of maxillary first molar

(3) Canine rotation: The rotation of maxillary canines was found by calculating the differences between the values of the rotation angle measured between T0 and T1.
(4) Anchorage loss: The anchorage loss was represented by the amount of mesial movement of first molars. It was found by calculating the differences between the values of the distance (R′ – M′) between T0 and T1.

### Statistical Analysis

The data were checked for normality using nonparametric Kolmogorov-Smirnov tests, which showed normal data distribution. Pretreatment equivalence and differences in the treatment effects between the two types of brackets were tested with the paired sample t-test using the statistical software Statistical Package for the Social Sciences (SPSS) (version 21.0; SPSS Inc., Chicago, IL). The significance level was set at 5%.

Random error was addressed by repeating the measurements after 2 weeks and calculating intra-class correlation coefficients. Systematic differences between duplicate measurements were tested with paired t-tests. There were no significant systematic differences between the duplicate measurements and the calculated inter-class correlation coefficients, which indicate very good intra-assessor reliability (Table 2).

## RESULTS

Descriptive statistics of the evaluated variables are given in Table 3. Whatever the type of bracket used, there was a significant amount of maxillary canine retraction, rotation, and anchorage loss (Fig. 2). Statistical analysis showed pre-treatment insignificant differences in these two variables: Initial total extraction space and canine rotation angle between the two groups (Table 3).

**Table 2:** Intra-examiner reliability using intra-class correlation coefficients for the three trait measurements

| *Retraction* | | *Rotation* | | *Anchorage loss* | |
|---|---|---|---|---|---|
| *1st measurement* | *2nd measurement* | *1st measurement* | *2nd measurement* | *1st measurement* | *2nd measurement* |
| 0.90 | 0.91 | 4.00 | 5.00 | 0.30 | 0.25 |
| 0.90 | 0.94 | 5.00 | 6.00 | 0.40 | 0.45 |
| 0.95 | 0.97 | 3.00 | 3.00 | 0.40 | 0.30 |
| 1.04 | 0.98 | 9.00 | 8.00 | 0.20 | 0.15 |
| 0.50 | 0.55 | 3.00 | 5.00 | 1.50 | 1.40 |
| 0.55 | 0.63 | 13.00 | 11.00 | 1.50 | 1.60 |
| 0.60 | 0.65 | 8.00 | 9.00 | 0.50 | 0.60 |
| 0.81 | 0.70 | 10.00 | 8.00 | 1.90 | 1.80 |
| 0.81 | 0.72 | 12.00 | 12.00 | 1.00 | 1.10 |
| 0.85 | 0.74 | 4.00 | 5.00 | 0.10 | 0.15 |
| ICC = 0.907 | | ICC = 0.917 | | ICC = 0.991 | |

**Table 3:** Pre- and postretraction descriptive statistics and significance of differences between the two types of brackets

| | | *Pretreatment (T0)* | | | *Treatment effects (T1-T0)* | | |
|---|---|---|---|---|---|---|---|
| *Patient* | *Bracket type* | *Extraction space (mm)* | *Rotation angle (°)* | *Total retraction (mm)* | *Retraction rate (mm/month)* | *Rotation angle (°)* | *Anchorage loss (mm)* |
| 1 | Self-ligating | 5.38 | 42 | 2.70 | 0.90 | 2.00 | 0.30 |
| | Conventional | 5.27 | 31 | 2.25 | 0.75 | 11.00 | 1.10 |
| 2 | Self-ligating | 7.01 | 30 | 3.60 | 1.20 | 9.00 | 0.20 |
| | Conventional | 7.00 | 39 | 2.40 | 0.80 | 7.00 | 1.50 |
| 3 | Self-ligating | 5.82 | 33 | 2.85 | 0.95 | 3.00 | 0.40 |
| | Conventional | 5.33 | 35 | 1.50 | 0.50 | 3.00 | 1.50 |
| 4 | Self-ligating | 5.33 | 32 | 2.70 | 0.90 | 5.00 | 0.40 |
| | Conventional | 5.22 | 33 | 2.43 | 0.81 | 12.00 | 0.80 |
| 5 | Self-ligating | 6.82 | 43 | 3.24 | 1.08 | 8.00 | 0.40 |
| | Conventional | 6.57 | 43 | 2.40 | 0.80 | 10.00 | 1.90 |
| 6 | Self-ligating | 5.90 | 36 | 2.91 | 0.97 | 3.00 | 0.10 |
| | Conventional | 5.72 | 43 | 2.13 | 0.71 | 4.00 | 0.70 |
| 7 | Self-ligating | 6.99 | 35 | 3.36 | 1.12 | 4.00 | 0.20 |
| | Conventional | 6.95 | 42 | 2.25 | 0.75 | 9.00 | 0.90 |
| 8 | Self-ligating | 7.10 | 36 | 3.90 | 1.30 | 9.00 | 0.30 |
| | Conventional | 7.00 | 31 | 2.40 | 0.80 | 15.00 | 0.80 |
| 9 | Self-ligating | 4.96 | 44 | 2.55 | 0.85 | 4.00 | 0.10 |
| | Conventional | 4.76 | 42 | 1.80 | 0.60 | 8.00 | 0.50 |

*(Contd…)*

*(Contd…)*

| | | *Pretreatment (T0)* | | | *Treatment effects (T1-T0)* | | |
|---|---|---|---|---|---|---|---|
| *Patient* | *Bracket type* | *Extraction space (mm)* | *Rotation angle (°)* | *Total retraction (mm)* | *Retraction rate (mm/month)* | *Rotation angle (°)* | *Anchorage loss (mm)* |
| 10 | Self-ligating | 6.76 | 37 | 3.00 | 1.00 | 7.00 | 0.20 |
| | Conventional | 6.89 | 36 | 2.16 | 0.72 | 12.00 | 1.20 |
| 11 | Self-ligating | 6.95 | 38 | 3.30 | 1.10 | 9.00 | 0.40 |
| | Conventional | 6.81 | 40 | 2.22 | 0.74 | 14.00 | 1.40 |
| 12 | Self-ligating | 5.77 | 41 | 2.82 | 0.94 | 8.00 | 0.40 |
| | Conventional | 5.69 | 35 | 1.89 | 0.63 | 10.00 | 1.60 |
| 13 | Self-ligating | 6.07 | 39 | 2.94 | 0.98 | 6.00 | 0.10 |
| | Conventional | 5.88 | 32 | 1.95 | 0.65 | 10.00 | 0.80 |
| 14 | Self-ligating | 7.00 | 44 | 3.24 | 1.08 | 4.00 | 0.30 |
| | Conventional | 7.14 | 45 | 2.43 | 0.81 | 12.00 | 1.00 |
| 15 | Self-ligating | 5.69 | 39 | 2.73 | 0.91 | 8.00 | 0.20 |
| | Conventional | 6.00 | 39 | 1.65 | 0.55 | 13.00 | 1.50 |
| Mean ± SD | Self-ligating | 6.24 ± 0.74 | 37.93 ± 4.37 | 3.06 ± 0.38 | 1.02 ± 0.13 | 5.93 ± 2.49 | 0.27 ± 0.12 |
| | Conventional | 6.15 ± 0.80 | 37.73 ± 4.76 | 2.12 ± 0.30 | 0.71 ± 0.10 | 10.00 ± 3.40 | 1.15 ± 0.40 |
| Range | Self-ligating | 4.96–7.10 | 30.00–44.00 | 2.55–3.90 | 0.85–1.30 | 2.00–9.00 | 0.10–0.40 |
| | Conventional | 4.76–7.14 | 31.00–45.00 | 1.50–2.43 | 0.50–0.81 | 3.00–15.00 | 0.50–1.90 |
| Statistical inference | 95% Confidence interval | –0.016 to 0.192 | –2.85 to 3.25 | 0.25 to 0.37 | 0.76 to 1.11 | –5.73 to –2.39 | –1.07 to –0.68 |
| | p-value* | 0.09 | 0.89 | <5000.001 | < 0.001 | < 0.001 | < 0.001 |

SD: Standard deviation; *Employing paired t-tests with a significance level set at 5%

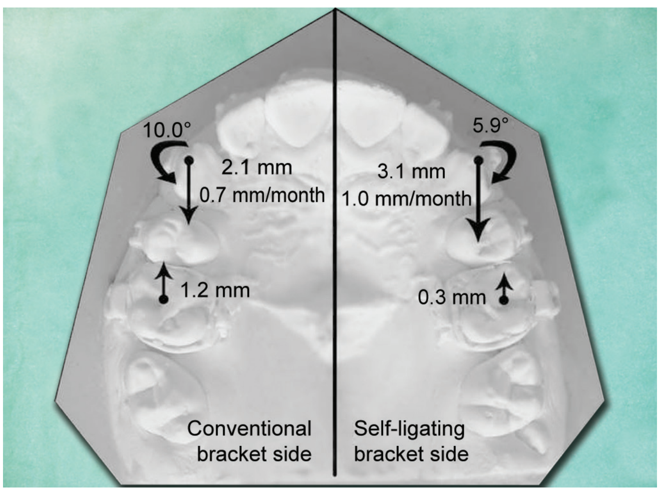



**Fig. 2:** Results summary after 3 months of maxillary canine retraction

There was a significantly ($p < 0.001$) more canine retraction with SLBs (3.06 mm ± 0.38) than with the CLBs (2.12 mm ± 0.30). It is evident that the rate of retraction for the SLBs (1.02 mm/month ± 0.13) was greater than that for the CLBs (0.71 mm/month ± 0.10), with the SLBs significantly faster ($p < 0.001$). All canines rotated mesiolabially during the retraction. Canine rotation was less pronounced when retracting the canine with the SLBs (5.93° ± 2.49) than with the CLBs (10.00° ± 3.40) and the difference between both the types was statistically significant ($p < 0.001$).

Loss of anchorage occurred in this study regardless of the type of bracket used. The anchorage loss was (0.27 mm ± 0.12) on the side with the SLBs and (1.15 mm ± 0.40) on the side with the CLBs; a difference which was statistically significant.

## DISCUSSION

Considering that orthodontic treatment is an elective type of treatment, recent trends in orthodontic treatment are shortening the orthodontic treatment time and reducing the possible risks involved in treatment.

Self-ligating brackets have gained popularity in recent years. They hypothetically reduce friction in sliding mechanics,[12,13-17] deliver forces at more biological levels,[12,14] permit anchorage conservation.[9] Damon™ and SmartClip™ are popular brands of passive design.[4] New designs have continued to appear, and Damon Q (Ormco, USA) became available in 2011.[12]

The present randomized clinical trial used a simple split-mouth design, i.e., the measurements for both the type of brackets are taken from the same patients which resulted in reduced variance and higher study power compared to conventional parallel-group designs in which both maxillary canines of the same patient receive only one of the two types of brackets.[18]

The precision in bracket positioning could vary according to the patient's side, and such bias could especially influence the assessment of canine rotation.[6] To reduce this clinical bias in the current study, SLBs were randomly assigned to the left or right canine using a randomization sequence.

The amount of extraction space closure can be measured intraorally,[5] whereas the amount of anchorage loss can be measured on cephalometric radiographs with the accompanying radiation exposure.[19] In contrast, the amount of canine rotation cannot be measured intraorally or cephalometrically.[6] All these measurements can be made on study models without unnecessarily exposing the patient to radiation. Therefore, in the current trial all measurements were made on study models.

To ensure the measurement validity on the study model, a stable reference point was needed. For this reason, the distinct posterior palatine rugae close to the midline was used as an anatomic reference area to measure the anterior and posterior movements of molars and canines; palatine rugae are considered reliable as reference points as they are stable and easy to recognize. Lysell[20] affirmed that the palatine rugae have unique characteristics and may be used for identification purposes. Peavy and Kendricks[21] also verified that the palatine rugae do not undergo appreciable alteration during orthodontic treatment. Moreover, Hoggan and Sadowsky[22] proved the stability of the palatine rugae in a sample treated with extraction of the first maxillary premolars. In the same framework, Nance holding appliance was avoided as a posterior anchorage unit since the inflammation of the palatal mucosa could be observed under the acrylic button of Nance appliance at the end of the retraction period and these inflammatory changes might have a real impact on palatal morphology.

Overall, the results of this study suggest that Damon Q SLBs are more efficient in terms of canine retraction than CLBs. These results disagree with those of Burrow[7] but are in agreement with the findings of Sirinivas and Mezomo et al[6,12] (Table 4). Maxillary canines were retracted about 1.5 times faster with Damon Q SLBs than with CLBs. This difference might be attributed to substantially greater "free play" or clearance of the archwire into the slot walls of the SLBs, an effect that facilitates undisturbed movement of the canine crown.[23] In contrast, steel ligatures act as obstacles because of the stress they exert on the wire adjacent to the CLBs sides, precluding free sliding of the wire into the slot walls and adversely affecting retraction rate.[23] In sliding mechanics, to achieve efficient canine retraction, friction must be kept as minimum as possible.[24] Usually, the canine rotates because of the clearance between the archwire and the bracket slot and/or the elastic deformation of the archwire. Disto-palatal rotation of the maxillary canines during retraction was minimized with Damon Q SLBs. In the present study, in comparison with studies of Sirinivas and Mezomo et al,[6,12] a stainless

**Table 4:** Summary of three previous studies on maxillary canine retraction using self-ligation brackets[2-4]

| *Study* | *Sirinivas (2003)* | *Burrow (2010)* | *Mezomo et al (2011)* | | *Present trial* |
|---|---|---|---|---|---|
| Protocol of the study | | | | | |
| Mean age of patients (years) | NA* | 14.8 | 18 | | 20.99 |
| Retraction mechanics | Sliding | Sliding | Sliding | | Sliding |
| Working archwire (SS)† | 0.018 × 0.025 | 0.018 | 0.018 | | 0.019 × 0.025 |
| Retraction force | 150 | 150 | 150 | | 150 |
| Force delivery | NA | NiTi coil spring | Elastic chain | | NiTi coil spring |
| Transpalatal bar | NA | Yes | No‡ | | Yes |
| Study design | Split-mouth randomized | Split-mouth randomized | Split-mouth randomized | | Split-mouth randomized |
| SLBs group (self-ligating brackets) | | | | | |
| Bracket type | Damon SL | Damon 3 | SmartClip | SmartClip | Damon Q |
| Bracket manufacturer | "A" Company | Ormco | 3M-Unitek | 3M-Unitek | Ormco |
| Bracket marketed | 1996 | 2004 | 2004 | 2004 | 2011 |
| Retraction rate (mm/month) | 0.24 | 0.9 | 1.10 | 0.90 | 1.02 |
| Canine rotation (degrees) | 8 | NM§ | NM | 9.15 | 5.93 |
| Anchorage loss | 0.43 mm/month | NM | NM | 0.66 mm | 0.27 mm |
| CLBs group (conventional ligated brackets) | | | | | |
| Bracket type | NA* | Victory Series | Gemini | | Mini Master Series |
| Bracket manufacturer | NA | 3M-Unitek | 3M-Unitek | | American Orthodontics |
| Bracket ligation | NA | Metal ligature | Elastic ligature | | Metal ligature |
| Retraction rate (mm/month) | NA | 1.17 | 0.84 | | 0.71 |
| Canine rotation (degrees) | 12 | NM | 12.27 | | 10.00 |
| Anchorage loss | 0.53 mm/month | NM | 0.59 mm | | 1.15 mm |

*Not available; †Stainless steel; ‡First molars and second premolars were tied together as a posterior anchorage; §Not measured steel archwires with a larger diameter (0.019 × 0.025″) was used (Table 3). Therefore, a better rotational control for SLBs during canine retraction was achieved. Disto-palatal rotation was < 10° in all canines boned with Damon Q SLBs and > 10° of 80% of canines boned with CLBs. It was reported in the orthodontic literature that canine rotations > 10° may be critical for the sequence and quality of orthodontic treatment.[6] A "derotation" phase should be followed once canine retraction has been completed.[25] Such an interval would extend treatment time and eventually compromise finishing quality. From this prospective, Damon Q brackets could prevent excessive canine rotation during sliding mechanics, and more importantly reduce overall treatment time.

Today, anchorage control is a major concern in the orthodontic treatment. The requirements of posterior anchorage must be managed by orthodontists individually according to each patient's treatment plan. In this study, using springs loaded with 150 gm force acting on 0.019 × 0.025″ working archwires (Table 4), the largest mesial movement of the first molars was 0.4 mm using Damon Q™ brackets. This supports the hypothesis that the combination of low friction and good rotational control exhibited by SLBs may also preserve anchorage.[12] However, during canine retraction with SLBs, Mezomo et al[6] found that anchorage loss was similar with both CLBs and SLBs (0.66 and 0.59 mm respectively); whereas Burrow[7] did not measure the amount of anchorage loss in his study (Table 3). Patients' drop-out rate is an important element in randomized clinical trials because any withdrawals may distort the assumption of equal effect on both treatment groups.[23] In the present study, this source of bias was not introduced since the drop-out rate was nonexistent.

## CONCLUSION

- The amount and rate of posterior movement of the maxillary canines were greater with SLBs compared to the CLBs.
- Canine rotation and anterior movement of maxillary molars during retraction were less prominent with SLBs compared to the conventional ones.

## ACKNOWLEDGMENTS

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## REFERENCES

1. Frank CA, Nikolai RJ. A comparative study of frictional resistances between orthodontic bracket and arch wire. Am J Orthod 1980 Dec;78:593-609.
2. Hain M, Dhopatkar A, Rock P. The effect of ligation method on friction in sliding mechanics. Am J Orthod Dentofacial Orthop 2003 Apr;123(4):416-422.
3. Kim T-K, Kim K-D, Baek S-H. Comparison of frictional forces during the initial leveling stage in various combinations of self-ligating brackets and archwires with a custom-designed typodont system. Am J Orthod Dentofacial Orthop 2008 Feb;133(2):187.e15-187.e24.
4. Chen SS-H, Greenlee GM, Kim J-E, Smith CL, Huang GJ. Systematic review of self-ligating brackets. Am J Orthod Dentofacial Orthop 2010 Jun;137(6):726.e1-726.e18.
5. Miles PG. Self-ligating *vs* conventional twin brackets during en-masse space closure with sliding mechanics. Am J Orthod Dentofacial Orthop 2007 Aug;132(2):223-225.
6. Mezomo M, de Lima ES, de Menezes LM, Weissheimer A, Allgayer S. Maxillary canine retraction with self-ligating and conventional brackets: a randomized clinical trial. Angle Orthod 2011 Mar;81:292-297.
7. Burrow SJ. Canine retraction rate with self-ligating brackets *vs* conventional edgewise brackets. Angle Orthod 2010;80:626-633.
8. Dixon V, Read M, O'Brien K, Worthington H, Mandall N. A randomized clinical trial to compare three methods of orthodontic space closure. J Orthod 2002 Mar;29(1):31-36.
9. Hasler R, Schmid G, Ingervall B, Gebauer U. A clinical comparison of the rate of maxillary canine retraction into healed and recent extraction sites – a pilot study. Eur J Orthod 1997 Dec;19(6):711-719.
10. Ziegler P, Ingervall B. A clinical study of maxillary canine retraction with a retraction spring and with sliding mechanics. Am J Orthod Dentofacial Orthop 1989 Feb;95(2):99-106.
11. Champagne M. Reliability of measurements from photocopies of study models. J Clin Orthod 1992 Oct;26(10):648-650.
12. Harradine N. The history and development of self-ligating brackets. Semin Orthod 2008 Mar;14(1):5-18.
13. Khambay B, Millett D, McHugh S. Evaluation of methods of archwire ligation on frictional resistance. Eur J Orthod 2004 Jun;26(3):327-332.
14. Rinchuse DJ, Miles PG. Self-ligating brackets: present and future. Am J Orthod Dentofacial Orthop 2007 Aug;132(2):216-222.
15. Cacciafesta V, Sfondrini MF, Ricciardi A, Scribante A, Klersy C, Auricchio F. Evaluation of friction of stainless steel and esthetic self-ligating brackets in various bracket-archwire combinations. Am J Orthod Dentofacial Orthop 2003 Oct;124(4):395-402.
16. Pizzoni L, Ravnholt G, Melsen B. Frictional forces related to self-ligating brackets. Eur J Orthod 1998;20:283-291.
17. Shivapuja PK, Berger J. A comparative study of conventional ligation and self-ligation bracket systems. Am J Orthod Dentofacial Orthop 1994 Nov;106(5):472-480.
18. Pandis N, Walsh T, Polychronopoulou A, Katsaros C, Eliades T. Split-mouth designs in orthodontics: an overview with applications to orthodontic clinical trials. Eur J Orthod 2013 Dec;35(6):783-789.
19. Thiruvenkatachari B, Ammayappan P, Kandaswamy R. Comparison of rate of canine retraction with conventional molar anchorage and titanium implant anchorage. Am J Orthod Dentofacial Orthop 2008 Jul;134(1):30-35.
20. Lysell L. Plicae palatinae transversae and papilla incisiva in man; a morphologic and genetic study. Acta Odontol Scand 1955;13(Suppl 18):5-137.

21. Peavy Jr DC, Kendrick GS. The effects of tooth movement on the palatine rugae. J Prosthet Dent 1967 Dec;18(6):536-542.
22. Hoggan BR, Sadowsky C. The use of palatal rugae for the assessment of anteroposterior tooth movements. Am J Orthod Dentofacial Orthop 2001 May;119(5):482-488.
23. Pandis N, Polychronopoulou A, Eliades T. Self-ligating *vs* conventional brackets in the treatment of mandibular crowding: a prospective clinical trial of treatment duration and dental effects. Am J Orthod Dentofacial Orthop 2007 Aug;132(2):208-215.
24. Kojima Y, Fukui H, Miyajima K. The effects of friction and flexural rigidity of the archwire on canine movement in sliding mechanics: a numerical simulation with a 3-dimensional finite element method. Am J Orthod Dentofacial Orthop 2006 Sep;130(3):275.e1-275.e10.
25. Shpack N, Davidovitch M, Sarne O, Panayi N, Vardimon AD. Duration and anchorage management of canine retraction with bodily versus tipping mechanics. Angle Orthod 2008 Jan;78(1):95-100.