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Journal of Oral Medicine, Oral Surgery, Oral Pathology and Oral Radiology

Journal homepage: www.joooo.org

Original Research Article

Comparison of canine retraction in maxillary arch using self-ligating brackets and conventional brackets: An in vivo study

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ARTICLE INFO

Article history:
Received 14-09-2024
Accepted 19-10-2024
Available online 18-12-2024

Keywords:
Self- ligating brackets
Conventional brackets
Canine retraction
Anchorage loss

ABSTRACT

Background: In sliding mechanics, a considerable amount of applied force is lost to frictional resistance which places undue stress on the anchor unit. Therefore, for a clinical success with maximal efficiency for canine retraction with sliding mechanics, reduction of the resistance due to friction between brackets and arch wires is important. Self-ligating brackets are claimed to reduce the sliding resistance.

Aim & Objectives: Aim of the study was to compare the clinical outcome of canine retraction using Self ligating brackets and Conventional Brackets during canine retraction. Objectives of the study were to compare the amount of canine retraction using Self ligating brackets and Conventional Brackets and to compare the amount of anchorage loss during canine retraction (CR) using Self ligating brackets and Conventional Brackets.

Materials and Methods: The study comprised a total of 20 patients aged between 13 and 22 years. Bilateral extraction of the first premolars in maxilla and separate canine retraction was done. A split mouth study design was conducted in which maxillary canines randomly bonded with self-ligating and conventional brackets. Study models were used for the measurement of canine retraction, anchorage loss and canine rotation. Statistical analysis was done.

Results: Self-ligating and conventional brackets produced similar amount of canine retraction and anchorage loss of the maxillary molars. Self-ligating brackets gave better rotation control of maxillary canines than conventional brackets.

Conclusions: Self-ligating and conventional brackets gave similar results for the amount of canine retraction and anchorage loss. Self-ligating brackets give better rotational control.

1. Introduction

The options and techniques of mechanotherapy have expanded significantly in the field of Orthodontics with time. The new dental materials have led to a persistent accomplishment of technological achievements. Advancement in bonding techniques, wire alloys, bracket design, have increased not only the clinical options, but also the clinical efficiency. Appliance biocompatibility, efficiency of treatment and patient convenience are the most important factors in success of orthodontic treatment. However, the utilization of mechanical forces to produce required tooth movement remains the basic principle of orthodontic therapy. In the orthodontic treatment the most commonly extracted teeth are the first premolars. If extractions are carried out, space closure is generally done by either separate Canine retraction (CR) or en- masse retraction of the entire anterior segment depending upon the requirements of each particular case. Both sliding and frictionless mechanics can be used for Canine retraction.

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https://doi.org/10.18231/j.jooo.2024.054

Not only the retraction of teeth but also the control of the anchor teeth is very important so as to achieve the best possible results. In sliding mechanics, a considerable amount of applied force is lost to frictional resistance which places undue stress on the anchor unit. Therefore, for a clinical success with maximal efficiency for Canine retraction (CR) with sliding mechanics, reduction of the resistance due to friction between brackets and arch wires is of paramount importance. In orthodontics several ways to minimize sliding resistance have been recommended which include alteration in wire size, coating on wire and ligatures, varying the ligature materials, and the most recent, self-ligation. Self-ligating brackets are claimed to reduce the sliding resistance. Self-ligating brackets negate the requirement of a steel or elastomeric ligature to grasp the wire into the bracket slot rather they grip the wire into the slot with a door that changes the bracket slot into a tube. Burrow (2010)[1] concluded that Canine retraction was faster with Conventional brackets than with Self-ligating brackets. Study by Mezomo et al., (2011)[2] suggested that the amount of Canine retraction and Anchorage loss of first molars were similar in both the Conventional brackets and the Self-ligating brackets but Self-ligating brackets had better rotation control. Whereas Hassan et al., (2016)[3] concluded that extraction space closure was more with Self -ligating brackets while canine rotation and Anchorage loss were less with Self-ligating brackets than with the Conventional brackets. A number of studies looking into the ligation methods and friction found that SLBs give rise to less friction than conventional brackets (CBs) with elastomeric modules and SS ligatures.[4] Decrease in chairside time, increase in clinical efficiency, faster arch wire ligation, optimum force delivery within physiological limits, improved plaque control, decline in treatment time, and enhancement of patient comfort are claimed assets of SL brackets, in spite of they being expensive.[5] Due to the multiple opinions available in the literature, it becomes imperative to compare the efficacy of both of these bracket systems. This split mouth clinical study was conducted to analyze the rate of Canine retraction, Anchorage loss and change in rotation of canines in the maxillary arch using Self-ligating brackets and Conventional brackets.

2. Materials and Methods

2.1. Inclusion criteria

1. Patients requiring bilateral first maxillary premolar extraction.
2. Patients with without any history of prior orthodontic treatment.
3. Patients with full complement of teeth till first molars.
4. Patients with without any history of any prior trauma or bruxism.
5. Patients with no symptom of an active periodontal disease.
6. Patients with no significant medical history like any syndrome or systemic disease.

The study comprised a total of 20 patients aged between 13 and 22 years. Bilateral extraction of the first premolars in maxilla and separate Canine retraction was the treatment plan of all the patients. Approval of the ethical committee was taken. The maxillary canines were randomly bonded with Self-ligating brackets and Conventional Brackets in each quadrant. Alignment and leveling of the arches were performed using 0.014-inch, 0.016-inch and 0.018-inch niti followed by 0.018- inch SS round arch wires, 0.016-inch× 0.022-inch SS and 0.017-inch× 0.025-inch SS wires. Canine Retraction (Figure 3) was carried out using 0.019-inch × 0.025-inch stainless-steel wires. Conventional brackets were ligated with 0.010-inch stainless steel ligatures. Retraction of the canines was accomplished with elastomeric chain one month after insertion of 0.019-inch × 0.025-inch stainless-steel wires. The force of 150 g was employed which was checked with a dynamometer. Patients were recalled after every 4 weeks. At each appointment ligature wires and stainless-steel arch wires were removed and impressions of the patients were taken with alginate and wires were re-ligated and new elastomeric chains were replaced for the next 4 weeks for carrying out the Canine retraction on both sides of the maxillary arch. To assess the amount of Canine retraction and Anchorage (Figure 4) loss high-quality alginate impressions of the upper arch were obtained. Patients' records were taken before the start of Canine retraction (T0), after 4 weeks (T1), after 8 weeks (T2) and after 12 weeks (T3) of Canine retraction. At each appointment, impressions of upper jaw were taken. These impressions were immediately poured to ensure minimal distortion. Casts were poured in dental stone. The quantity of Canine retraction and Anchorage loss were measured from the pre and post study models. Dental casts were employed for all the study measurements. A transfer guide was employed for measurement of the mesial movement of first molars (Anchorage loss) and distal movement of canine. Transfer guide was made on the initial models of each patient (T0) (Figure 1). A digital vernier caliper was utilized to measure the linear displacement between anatomic points. The difference between the values of T0 and T3 (Figure 2) was considered the total amount of movement. The differences between sequential measurements (T0-T1, T1-T2, T2-T3) was the amount of monthly movement. The rate of Canine retraction and rate of Anchorage loss was obtained by dividing the total amount of movement by three. The measurement of the rotation of the maxillary canines was done with the help of a Protractor angle finder (Figure 5). The scale of the angle finder was placed on the mid-palatal suture of the patients and the protractor on the buccal surface of the maxillary canines on

the T0 casts and then on the subsequent casts. The monthly rotation (T0-T1, T1-T2, T2-T3) and the total rotation of the maxillary canines (T3-T0) were recorded in both the maxillary quadrants.

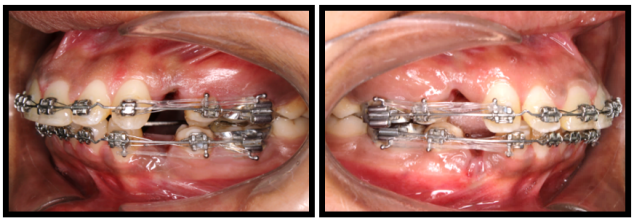

Figure 1: T0 stage photographic records of the patient

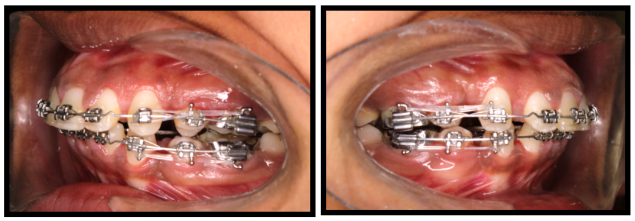

Figure 2: T3 stage photographic records of the patient

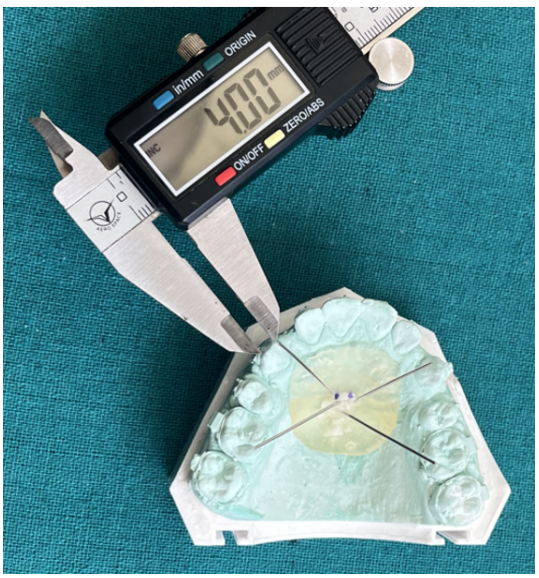

Figure 3: Measurement of canine retraction with vernier calliper

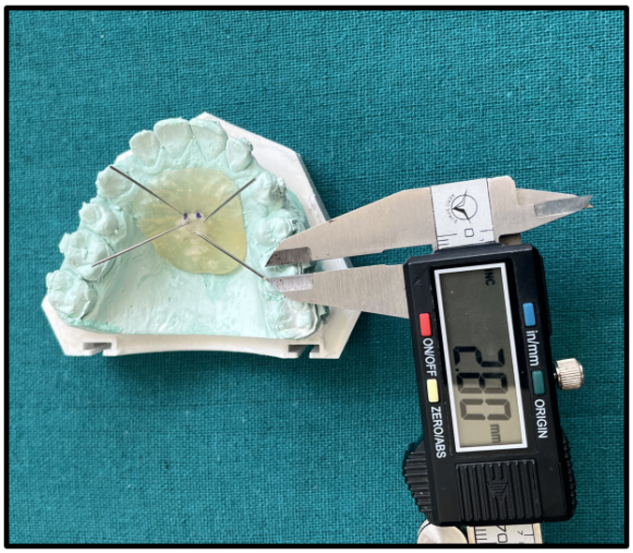

Figure 4: Measurement of anchorage loss with vernier calliper

Figure 5: Measurement of rotation with protractor angle finder

3. Results

To ensure consistency between the observation values, intra-class correlation coefficient (ICC) was performed. The table shows that Intraobserver reliability for measuring each outcome variable was excellent (>0.80) at every time (Table 1). The comparison of Total initial space, Canine retraction after 3 months, rate of retraction per month, Anchorage loss of molar after 3 months, rate of Anchorage loss per month and total rotation was shown (Table 2). The study groups showed no statistically significant difference in mean values ($p \geq 0.05$) of all the variables except rotation which was statistically significant ($p \leq 0.05$). (Table 3) It shows the comparison of Canine retraction on the monthly basis for Self-ligating brackets and Conventional brackets. The study groups showed no statistically significant difference within groups ($p \geq 0.05$).

(Table 4) It shows the comparison of Canine retraction on the monthly basis between SLBs and CBs. The study groups showed no statistically significant difference in mean values (p values = 0.529, 0.608,0.407 for 1st, 2nd, 3rd month respectively). (Table 5) It shows the comparison of Anchorage loss on the monthly basis for Self-ligating brackets and Conventional brackets. The study groups showed no statistically significant difference within groups ($p \geq 0.05$). (Table 6) It shows the comparison of Anchorage loss on the monthly basis between Self-ligating brackets and Conventional brackets. The study groups showed no statistically significant difference in mean values (p values= 0.654, 0.520, 0.878 for the 1st, 2nd and 3rd month respectively). (Table 7) It shows the comparison of rotation on the monthly basis for Self-ligating brackets and Conventional brackets. The study groups showed statistically significant difference within groups (p values = 0.03 for Conventional brackets and 0.002 for Self-ligating brackets). (Table 8) It shows the comparison of rotation on the monthly basis between Self-ligating brackets and Conventional brackets. The study groups showed statistically significant difference in mean value ($p \leq 0.05$).

4. Discussion

Technological innovations in orthodontics have led to the systematic development of dental materials. The major challenging factors in successful outcome of orthodontic treatment are appliance biocompatibility, treatment efficiency and patient convenience.[2] Force applied to an orthodontic bracket would be flawlessly transmitted to the tooth, in a perfect environment. However resistant forces make the synergy between the bracket and the arch-wire less than perfect. This deprivation of force due to sliding resistance makes Orthodontic treatment uncertain so in order to facilitate tooth movement greater than ideal force is required. Self-ligating brackets do not need any external ligation method but have an inbuilt ligation mechanism to keep the arch-wire in the slot. Self-ligating brackets keep the wire into the slot, with a door converting the bracket slot into a tube, nulifying the requirement for a steel or elastomeric ligature to keep the wire into the bracket slot.[6] The present study randomization was chosen because the precision in bracket positioning could vary according to the patient's side. Yassir et al., 2019[7] investigated the first molar Anchorage loss between 0.018- and 0.022-inch slot. He concluded that the maxillary molar Anchorage loss during orthodontic treatment was not influenced by bracket slot. So, 0.022 slot was used in this study. Many studies[8] used plaster models to obtain the measurements. The basis for analysis for Canine retraction and Anchorage loss during orthodontic treatment was the stability of the region of the palatine rugae. Radiographic methods though used effectively for determining Canine retraction and loss of anchor expose patients to unnecessary radiation and hinder the evaluation of canine rotation. Study models can be used effectively for all of these measurements without unnecessarily exposure of the patient to radiation. Therefore, in this study, study models were used for measurements. Lotzof et al.,1996[9] proposed using an acrylic guide adapted to the anterior palate. He concluded that medial and lateral points of the third palatal rugae are the stable landmarks for the construction of reference planes. These can be used to evaluate tooth movements in a transverse and anteroposterior direction, whether the treatment of patients is done with or without extraction. The anterior rugae are more affected by anterior tooth movement so the rugae position is an important element in their stability.[10] So, this study used an acrylic transfer guide based on the stability of medial aspect of the third rugae for measurement of Canine retraction and Anchorage loss. Orthodontic arch-wire diameter and constituent material are known to influence movement of the tooth during sliding mechanics. The stiffer wires resist the tendency of teeth tilting during sliding.[8] Better rotational control is achievable by an arch-wire of greater diameter because there was less space between wire and cover of the self-ligating bracket. Canine retraction was carried out using 0.019-inch -inch × 0.025 stainless-steel wires in this study. Huffman proposed 200 g as optimal force for Canine retraction. Hixon et al.,1969[11] have reported that effective tooth movement was produced by higher forces. The force of 150 g was used in the present study due to suggestions found in the literature that employ forces between 100 g and 200 g for Canine retraction.[9,12] The clinical effectiveness of elastomeric chains is similar to the NiTi springs and it affords easy installation and reduced patient discomfort. The rates of space closure employing either pre-calibrated NiTi closing springs or premeasured elastomeric chains are proven to be similar. So, elastomeric chains were used in this study for force application. In the present study to ensure consistency between the observation values, intra-class correlation coefficient (ICC) was performed. The table shows that Intra-observer reliability for measuring each outcome variable was excellent (>0.80) at every time. It was suggestive that results of the study were highly reliable. The study results showed no significant difference in means of total Canine retraction (CR) (p-value= 0.705) and rate of CR (p-value=0.671) between Self-ligating brackets and Conventional brackets. It was suggestive from this study that Self-ligating brackets and Conventional Brackets were equally effective in rate and total amount of Canine Retraction during the three months. Some studies have been conducted in the past that are in accordance with the findings of this study. Mezomo et al., 2011[12] conducted a study on 15 patients in whom Self-ligating brackets and Conventional brackets were randomly placed on the maxillary canines. This study found that the amount of Canine retraction was same in both the

Table 1: Intra-examiner reliability table (KAPPA value)

Parameters	Self-ligating				Conventional			
	T0	T1	T2	T3	T0	T1	T	T3
Initial Space	0.93	-	-	-	0.94	-	-	-
CR	-	0.82	0.86	0.93	-	0.94	0.94	0.94
AL	-	0.93	0.87	0.94	-	0.86	0.94	0.93
Rotation	0.87	0.85	0.91	0.91	0.88	0.92	0.93	0.96

0.8 to 1.0: Excellent reliability

Table 2: Intergroup comparison between self-ligating and CBs using student's t-test

Parameters	Self-ligating		Conventional		Mean diff	p-value
	Mean (mm)	SD	Mean (mm)	SD		
Total Initial Space	7.34	1.12	7.33	1.19	-0.01	NS
Total CR after 3 months	2.34	0.73	2.26	0.59	-0.08	NS
Rate of retraction/month	0.78	0.25	0.75	0.19	-0.03	NS
Total AL of molar after 3 months	1.84	0.54	1.84	0.58	0.00	NS
Rate of AL/month	0.61	0.18	0.61	0.19	0.00	NS
Change in Rotation(degrees)	2.55	1.31	4.49	2.65	1.94	*

p≥0.05 non-significant (NS), p≤0.05 significant (*)

Table 3: Intragroup comparison of CR for self-ligating and CBs using repeated ANOVA test

CR	T0-T1		T1-T2		T2-T3		
	Mean (mm)	SD	Mean (mm)	SD	Mean (mm)	SD	p-value
Conventional	0.75	0.20	0.76	0.19	0.71	0.20	NS
Self-ligating	0.80	0.29	0.80	0.29	0.77	0.25	NS

p≥0.05 non-significant (NS)

Table 4: Intergroup comparison of CR between self-ligating and CBs using independent t Test

CR	Conventional		Self-Ligating		Mean diff	p-value
	Mean (mm)	SD	Mean (mm)	SD		
T0-T1	0.75	0.20	0.80	0.29	-0.05	NS
T1-T2	0.76	0.19	0.80	0.29	-0.04	NS
T2-T3	0.71	0.20	0.77	0.25	-0.06	NS

p≥0.05 non-significant (NS)

Table 5: Intragroup comparison of AL for self-ligating and CBs using repeated ANOVA test

Anchorage loss	T0-T1		T1-T2		T2-T3		
	Mean (mm)	SD	Mean (mm)	SD	Mean (mm)	SD	p-value
Conventional	0.61	0.21	0.64	0.19	0.60	0.21	NS
Self-ligating	0.64	0.21	0.60	0.20	0.59	0.20	NS

p≥0.05 non-significant (NS)

Table 6: Intergroup comparison of AL between self-ligating and CBs using independent t test

AL	Conventional		Self-Ligating		Mean diff	P-value
	Mean (mm)	SD	Mean (mm)	SD		
T0-T1	0.61	0.21	0.64	0.21	-0.03	NS
T1-T2	0.64	0.19	0.60	0.20	0.04	NS
T2-T3	0.60	0.21	0.59	0.20	0.01	NS

p≥0.05 non-significant (NS)

Table 7: Intragroup comparison of rotation for self-ligating and CBs using repeated ANOVA test

Rotation	T0-T1		T1-T2		T2-T3		
	Mean (degrees)	SD	Mean (degrees)	SD	Mean (degrees)	SD	p- value
Conventional	1.80	0.98	1.65	1.12	1.04	1.03	*
Self-ligating	1.15	0.48	1.00	0.84	0.40	0.66	*

p≤0.05 significant (*)

Table 8: Intergroup comparison of rotation between self-ligating and CBs using independent t Test

Rotation	Conventional		Self-Ligating		Mean diff	p-value
	Mean (degrees)	SD	Mean (degrees)	SD		
T0-T1	1.80	0.98	1.15	0.48	0.65	*
T1-T2	1.65	1.12	1.00	0.84	0.65	*
T2-T3	1.04	1.03	0.40	0.66	0.64	*

p≤0.05 significant (*)

Conventional brackets and the Self-ligating brackets. Wahab et al., 2013[13] compared the clinical efficacy of Damon™ 3 Self-ligating brackets and Mini Diamond Conventional brackets on the tooth movement during Canine retraction. They concluded that the Damon SLB and Mini Diamond brackets had similar efficacy in Canine retraction. All the above-mentioned studies were in accordance with the present study results but there are some studies that are not in agreement with the conclusion drawn from the present study. In contrast steel ligatures act as hinderance because of the stress they exert on the wire adjacent to the Conventional bracket's, preventing the free sliding of the wire into the slot walls thus adversely affecting Canine retraction The intragroup comparison of Canine retraction for Self-ligating brackets and Conventional brackets showed no significant difference in mean values (p≥0.05). It was suggestive from this study that within the study groups, the amount of Canine retraction on monthly basis for Self-ligating brackets and Conventional brackets gave similar results. The intergroup comparison of Canine retraction between Self-ligating brackets and Conventional brackets showed no significant difference in mean values (p≥0.05). It was suggestive from this study that between the study groups, the amount of Canine retraction on monthly basis for both Self-ligating brackets and Conventional brackets gave similar results. Ong 2010[14] compared the efficiency of Self ligating brackets and Conventional brackets. 50 patients who 25 had premolar extractions in the maxillary and/or mandibular arch, At pretreatment (T0), 10 weeks (T1), and 20 weeks (T2) the models were evaluated for extraction spaces closure. No statistically significant differences were found between the first and second measurements(T0-T1), (T1-T2) for extraction space closure. In the present study a total of 20 patients who had maxillary canines bonded randomly with self-ligating and Conventional brackets were examined for Anchorage loss for 3 months and rate of Anchorage loss per month. The study results showed no significant difference in means of total Anchorage loss (p≥0.05) and rate of Anchorage loss (p≥0.05) between self-ligating and Conventional brackets. It was indicative from this study that Self-ligating brackets and Conventional brackets resulted in equal amount of Anchorage loss. Both of the brackets gave similar results. Mezomo et al., 2011[2] conducted a study on 15 patients. Self-ligating brackets and Conventional brackets were randomly placed on the maxillary canines. This study found that the amount of Anchorage loss of first molars was same in both the Conventional brackets and the Self-ligating brackets. The author claimed that he used extra hard 0.018-inch SS archwire to increase the friction as the bracket slot was better filled, which resulted in equal Anchorage loss in both the bracket systems. It was concluded that the rate of Anchorage loss was less with Self ligating brackets than with the Conventional brackets. It was claimed by the author that low friction and good rotation control provided by Self-ligating brackets may also preserve Anchorage loss. The intragroup comparison of Anchorage loss for Self-ligating brackets and Conventional brackets showed no significant difference in mean values (p≥0.05). It was indicative from this study that within the study groups, the amount of Anchorage loss on monthly basis for Self-ligating brackets and Conventional brackets gave similar results. Not much information is available in literature for the amount of Anchorage loss on the monthly base for the Self-ligating brackets and Conventional brackets. The intergroup comparison of Anchorage loss between Self-ligating and Conventional brackets showed no significant difference in mean values (p≥0.05). It was indicative from this study that between the study groups, the amount of Anchorage loss on monthly basis between Self-ligating and Conventional brackets gave similar results. Some studies have been done in the past which are in accordance with the findings of this study. Soegiharto, B.M., 2016[15] conducted a study to compare the clinical efficacy of Self-ligating and Conventional brackets. The measurement of AL was done at T0, T1(4weeks), T2(8 weeks). In the present study

a total of 20 patients who had maxillary canines bonded randomly with self-ligating and Conventional brackets were examined for total change in rotation for 3 months. The total change in rotation showed significant results favoring better rotation control with SLBs ($p \leq 0.05$) Some studies have been done in the past that are in agreement with the findings of this study. Mezomo et al., 2011[2] conducted a study on 15 patients. Self-ligating brackets and conventional brackets were randomly placed on the maxillary canines. After levelling and alignment, Canine retraction was done with elastomeric chains. Patients were recalled after every 4 weeks. The change in rotation of upper canines was represented by the angle formed between the median palatine suture and a line passing through the mesial and distal contact points of the canines. Rotation of the upper canines was minimized with Self-ligating brackets. Because of their full bracket engagement, SLBs ensure that the unwanted consequences of space closure such as rotation into the extraction space, do not occur. The intergroup comparison of rotation per month between SLBs and Conventional brackets showed no significant difference in mean values ($p \geq 0.05$). It was indicative from these studies that between the study groups, on the comparison of amount of rotation on monthly basis, SLBs gave better rotation control than Conventional brackets.

5. Conclusions

Self-ligating brackets and Conventional brackets produced similar amount of canine retraction in sliding mechanics. They gave better rotation control of maxillary canines than Conventional brackets. The amount of Anchorage loss of the maxillary molars was similar for both Conventional brackets and Self-ligating brackets. The amount of rotation on monthly basis for Self-ligating brackets was maximum in the first month, decreased in second month and was least in the third month.

6. Source of Funding

None.

7. Conflict of Interest

None.

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Cite this article: Bali G, Jain P, Singla SK, Sharma A, Jindal A. Comparison of canine retraction in maxillary arch using self-ligating brackets and conventional brackets: An in vivo study. *J Oral Med, Oral Surg, Oral Pathol, Oral Radiol* 2024;10(4):278-284.