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Canine retraction and anchorage loss using self-ligating and conventional brackets with sliding mechanics: A split-mouth clinical study

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Abstract

OBJECTIVE: Appliance biocompatibility, orthodontic treatment efficiency and patient convenience are the major issues confronting contemporary orthodontic practice. Very few studies have been published till date regarding the efficiency of self-ligating brackets as against conventional brackets. Hence, the present study was planned to compare the rate of canine retraction between self-ligating and conventional brackets and to determine the amount of anchorage loss during canine retraction.

METHODS: The present clinical study was designed as a prospective, observational study comprising of 25 patients requiring first premolar extraction as a part of orthodontic treatment. Self-ligating and conventional brackets were bonded using a split-mouth study design randomly. Retraction of canines was done with 150 grams of force using Dontrix gauge with E-chains. The study was conducted in relation to upper arch only, while the rate of retraction was evaluated every 4 weeks for 3 months. Average rates of retraction in 3 months were calculated. For anchorage loss, an acrylic guide plug was used in mid-treatment cast (T0) and after 3 months of retraction (T3). The statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 17.0 (SPSS Inc., Chicago, IL, USA). Independent t-test was used to compare the means of the two variables studied, while Pearson's correlation coefficient was used to evaluate the correlation between the variables studied in the groups included. $P < .05$ was considered statistically significant.

RESULTS: The correlation coefficient between the average rate of canine retraction with self-ligating brackets vs. conventional brackets over a period of 3 months came out to be 0.6434, while on comparing the data in terms of anchorage loss over a period of 3 months, the respective correlation coefficient value was found to be 0.6659 with the results being statistically highly significant in either case ($P < .001$).

CONCLUSIONS: Self-ligating brackets showed double the amount of displacement compared to conventional brackets in some of the cases. Also, chair side time was significantly reduced with self-ligating brackets as against conventional brackets.

Keywords:

Anchorage loss, canine retraction, conventional brackets, E-chain, self-ligating brackets

Introduction

The orthodontic fixed appliance therapy consists of different types of attachments such as brackets, bands, cleats, buttons, eyelets, archwires and ligatures to name a few, though, the most commonly used attachments are the brackets. Self-ligating brackets utilize a permanently installed, moveable component to entrap the arch

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wire.[1] Self-ligating brackets appear to be the beneficiary of the most recent studies as their design and engineering can offer clinicians an ability to take advantage of the understanding of arch wire/bracket interaction.[2] The major advantage of self-ligating brackets is that they have lower kinetic frictional forces than the conventional brackets. These factors can be important for sliding mechanics.[3] A better description is that they are ligature-less brackets in that they do not use ligatures but require some procedures to be carried out on the brackets in order to either secure or release the arch wire.[4] Very few studies have been published till date regarding the efficiency of self-ligating brackets as against the conventional brackets. The aim of the present study is to compare the rate of canine retraction between self-ligating and conventional brackets and to determine the amount of anchorage loss seen during canine retraction.

Materials and Methods

The present clinical study was designed as a prospective, observational study comprising of 25 patients requiring first premolar extraction as a part of orthodontic treatment. A split-mouth clinical study design was used in the present study as it allowed a direct comparison of the response to each bracket type used with MBT prescription of 0.022-inch slots for conventional brackets on one side and 0.022-inch slots for self-ligating brackets on the other, in the maxillary arch. The MBT bracket system has been the mainstay in the practice of orthodontics since its introduction by McLaughlin, Bennett and Trevisi[5] in the year 1993. A written consent form was signed by all the patients before their inclusion into the study, while ethical clearance was obtained from the Institutional Ethics and Review Board via. Letter approval no. SDDC/IERB/01-43-2022 before the start of the study. Furthermore, patients who were willing to participate in the study, those who were with no past record of maxillary lateral incisor, second premolar and first molar extraction, those who had not undergone enameloplasty or, had prosthesis of the said teeth, and those who were having no history of previous orthodontic treatment were included in the study, while cleft lip and/or, palate patients and those who had any other craniofacial anomalies were excluded. Bonding sites for self-ligating brackets were chosen using a randomization sequence, while 0.009-inch stainless steel ligature wire was used for ligation for the pre-adjusted edgewise appliance. Trans-palatal arch was used for anchorage. At the start of canine retraction, maxillary second premolars and first molars of the same side were consolidated with ligature wire for getting anchorage. Retraction of canines was done with the help of 0.019 × 0.025-inch stainless steel wires using 150 grams of force through Dontrix gauge with E-chains. The amount of canine retraction was measured after every 4 weeks for 3 months [Figures 1-3]. The distance from the distal aspect of canine bracket to the mesial aspect of the first molar tube was recorded using a digital vernier calliper calibrated to an accuracy of 0.01 mm.[6] Average rate of space closure per month was calculated. The rate of canine retraction was evaluated before the start of retraction (T0) and then, after 4 weeks (T1), 8 weeks (T2) and 12 weeks (T3) of canine retraction. At each follow-up visit of the patient, impression of the maxillary arch was taken using alginate, while the distance between the contact points on the distal surface of the canine and the mesial surface of the second premolar was measured using a digital vernier calliper.[7] The amount of monthly rate of canine movement was measured by calculating the differences between the sequential measurements (T0-T1, T1-T2 and T2-T3). Palatal rugae were used as a landmark to assess the anteroposterior anchorage loss.[8] For anchorage loss, an acrylic guide plug was used in the mid-treatment cast (T0) and after 3 months of retraction (T3) [Figures 4 and 5]. The anchorage loss was evaluated through a transfer guide made up individually in the initial models of each patient (T0).[8] For this, a plate of auto-polymerizing acrylic resin was adapted in the region of palatine rugae with a 0.7 mm stainless steel wire extending as far up to the tip of the mesiopalatal cusp of the first molar. The guide made on T0 models was, then, positioned in T3 models, while the distance between the mesiopalatal cusps of the molars and the tip of the wire was considered as the amount of anchorage loss. The data obtained were subjected to statistical analysis.

Formula used to calculate sample size:
Standard deviation in the I group S1 = 0.2935
Standard deviation in the II group S2 = 0.2111
Mean difference between I and II sample = 0.22021
Effect size = 0.872810146650813
Alpha Error (%) =5

Figure 1: 1 month after retraction

Power (%) = 85
Sided = 2

Number needed (n) =25 needed in each group to achieve 90% power and 95% confidence with error of margin as 0.22021.

Statistical analysis used

The statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 17.0 (SPSS Inc., Chicago, IL, USA). Independent t-test was used to compare the means of the two variables studied, while Pearson's correlation coefficient was used to evaluate the correlation between variables in the groups included. $P < .05$ was considered statistically significant.

Results

Table 1 and Graph 1 show the average rate of canine retraction and anchorage loss in 3 months wherein the mean rate of canine retraction with self-ligating brackets was found to be 0.9014 ± 0.3021 mm as against a mean of 0.8358 ± 0.2514 mm with conventional brackets over a period of 3 months. Likewise, the mean anchorage loss with self-ligating brackets came out to be 0.6985 ± 0.2514 mm over a period of 3 months as against conventional brackets wherein the mean anchorage loss over a period of 3 months was calculated as 0.5474 ± 0.2633 mm [Table 1 and Graph 1]. The results were found to be statistically significant for the mean anchorage loss ($P = .0210$), though, not in case of the average rate of canine retraction with the corresponding $P = .4081$ [Table 1]. On further analysing this data using paired samples' correlations, the correlation coefficient between the average rate of canine retraction with self-ligating brackets vs. conventional brackets over a period of 3 months came out to be 0.6434 with the corresponding $P = .0010$, while on comparing the data in terms of anchorage loss in self-ligating brackets vs. conventional brackets over a period of 3 months, the correlation coefficient value was found to be 0.6659 and $P = .0010$, respectively, with the results being statistically highly significant in either case ($P = .001$) [Table 2].

Figure 2: 2 months after retraction

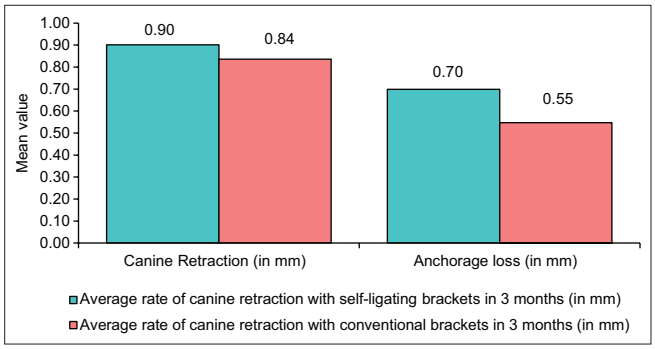
Figure 3: 3 months after retraction

Figure 4: Acrylic plug made in T0 cast

Figure 5: Acrylic plug in T3 cast

Discussion

Self-ligating brackets have been developed in an attempt to overcome the limitations of stainless-steel wire and elastomeric ligatures in terms of comfort, efficiency, ease of use, friction, plaque accumulation and discolouration. Numerous *in-vitro* studies have demonstrated a dramatic decrease in friction in case of self-ligating brackets shortening the overall treatment time considerably, especially, in cases where extractions are a part of treatment.[9-16] The mean rate of canine retraction with self-ligating brackets was found to be 0.9014 ± 0.3021 mm in the present study as against a mean of 0.8358 ± 0.2514 mm with conventional brackets over a period of 3 months. Likewise, the mean anchorage loss with self-ligating brackets came out to be 0.6985 ± 0.2514 mm over a period of 3 months as against conventional brackets wherein the mean anchorage loss over a period of 3 months was calculated as 0.5474 ± 0.2633 mm in the present study. Sirinivas S[17] found higher rates of distal movement of canines with self-ligating brackets compared with the conventional brackets. Likewise, Paulson *et al*.,[18] in their laminographic study of cuspid retraction vs. molar anchorage loss, also, found the greatest amount of cuspid retraction (6.0 mm) in the shortest amount of time with self-ligating brackets in their study which they concluded that it might be attributed to the lower kinetic frictional forces of self-ligating brackets. Similar conclusion was drawn in the study conducted by Taylor and Ison[19] which suggested that lesser friction in the case of self-ligating brackets would allow lighter forces to retract anterior teeth and thus, suboptimal forces would be applied to the posterior teeth. In the present study, too, some cases showed double the amount of displacement clinically with self-ligating brackets. Roncone R,[20] on the contrary, contradicted all such findings for self-ligating brackets based on his 25 years of practice. Fewer of the systematic reviews and studies conducted in this regard have, also, failed to report superiority of self-ligating brackets over conventional brackets when tooth movement velocity was assessed.[21-25] Burrow SJ,[23] in his study, also, found the retraction rate to be higher with conventional brackets than self-ligating brackets in contradiction with the findings of other studies that might be attributed to the narrower bracket width of self-ligating brackets used. Similarly, Agrawal *et al*.[26] found only a small, insignificant clinical difference in the rate of retraction between the passive, self-ligating brackets and conventional, pre-adjusted edgewise brackets tied with stainless steel ligature wires, while de Almeida *et al*.,[27] in accordance with the findings of the reported studies, found no significant difference in the amount of anchorage loss in case of maxillary first molars when compared between self-ligating bracket and conventional bracket systems. In this context,



Graph 1: Average rate of canine retraction and anchorage loss with self-ligating and conventional brackets in 3 months

Table 1: Average rate of canine retraction and anchorage loss with self-ligating and conventional brackets in 3 months using independent *t*-test

	n	Mean	Std. Dev.	Std. Error	*t*	*P*
Canine Retraction (in mm)						
Average rate of canine retraction with self-ligating brackets in 3 months (in mm)	25	0.9014	0.3021	0.0604	0.8346	0.4081
Average rate of canine retraction with conventional brackets in 3 months (in mm)	25	0.8358	0.2514	0.0503		
Anchorage loss (in mm)						
Anchorage loss with self-ligating brackets in 3 months (in mm)	25	0.6985	0.2514	0.0503	2.0898	0.0210*
Anchorage loss with conventional brackets in 3 months (in mm)	25	0.5474	0.2633	0.0527		

*P<0.05 – Statistically significant

Table 2: Paired samples' correlations for average rate of canine retraction and anchorage loss with self-ligating and conventional brackets in 3 months using Pearson's correlation coefficient

	n	*r*	*t*	*P*
Canine Retraction (in mm)				
Average rate of canine retraction with self-ligating brackets in 3 months (in mm) vs. average rate of canine retraction with conventional brackets in 3 months (in mm)	25	0.6434	3.0577	0.0010**
Anchorage loss (in mm)				
Anchorage loss with self-ligating brackets in 3 months (in mm) vs. anchorage loss with conventional brackets in 3 months (in mm)	25	0.6659	3.1626	0.0010**

**P<0.001 – Statistically highly significant

da Costa *et al*.,[28] also, in their split-mouth study design similar to the methodology adopted in the present study, observed the same velocity of canine retraction and loss of anteroposterior anchorage of molars between self-ligating brackets and conventional bracket systems. Miles PG,[6] also, concluded that the rates of space closure were almost identical with the passive SmartClip brackets and the conventional brackets tied with stainless steel ligature wires distal to the extraction site in their study. Thus, the findings of the present study were found to be in accordance with the above-mentioned studies, though, the present study did have a restriction in sample size that was one of the major limitations of the present study.

Strengths and limitations of the present study

The present clinical study was designed as a prospective, observational study to compare the rate of canine retraction between self-ligating and conventional brackets and to determine the amount of anchorage loss during canine retraction. The split-mouth study design used in the present study removed any kind of inter-subject variability. One of the major limitations of the present study, though, was in the form of the smaller sample size used in the study due to which generalization of the results becomes difficult. The results of the present study, thus, mandate further studies to be conducted in this regard with larger sample sizes so as to come to valid conclusions and draw exacting differences between the two bracket systems used in the present study delineating their usage as per the need of the individual case reported.

Conclusions

Within the limitations of the present study, the results of the study suggested that the rate of distal movement of canines as well as anchorage loss was found to be similar for both self-ligating and conventional brackets, though, in some cases, self-ligating brackets showed double the amount of displacement compared to the conventional brackets that may be attributed to the lower kinetic frictional forces of self-ligating brackets as against the conventional brackets. Also, chair side time was significantly reduced with self-ligating brackets as against conventional brackets.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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