AL-AZHAR
Dental Journal
For Girls

The Official Publication
of The Faculty of Dental
Medicine For Girls,
Al-Azhar University
Cairo, Egypt.

Print ISSN 2537-0308 • Online ISSN 2537-0316

ADJ-for Girls, Vol. 9, No. 2, April (2022) — PP. 349:354

Assessment of Rate of Orthodontic Tooth Movement with Different Modalities of Ligations

Aya E. Nasef [1]*, Samir A. Ibrahim[2], Sara M. El kabbany[3]

Codex : 18/22.04

azhardentj@azhar.edu.eg

http://adjg.journals.ekb.eg

DOI: 10.21608/adjg.2022.76226.1385

Pediatric Dentistry & Orthodontics
(Pediatric Dentistry, Orthodontics)

ABSTRACT

Purpose: This study was carried out to assess the effect of different types of ligatures on the rate of canine retraction. **Materials and Methods**: 14 participants requiring extraction of upper first premolars, were randomly assigned into 2 groups; group 1 had passive self-ligating bracket on the upper right canine, figure of 8 module ligature on the upper left canine and group 2 also had self-ligating bracket on the upper right canine, and slide-low friction elastic module on the left side. Canines retraction were done under 150 gm of force using a 9 mm nickel-titanium closed-coil spring .Alginate impression was taken at the onset of canine retraction(T0), and every month (T1-T4). Study casts were fabricated and then scanned with a 3D scanner. **Results:** The statistical analysis showed no statistically significant difference in the rate of canine retraction between the 2 groups, and between the control and intervention sides within each group. **Conclusion:** The difference in rate of upper canine retraction between self- ligation brackets, figure of 8 elastic module and slide –low friction ligature was not statistically significant.

KEYWORDS

Orthodontics,
Canine Retraction,
Self-ligation

INTRODUCTION

In extraction orthodontics canine retraction represents a fundamental stage. The mechanical principles of canine retraction could be delineated either: a frictionless or frictional systems, in frictionless system the canine is retracted through a couple of force built into the loops of sectional arch wire, while in frictional system the canine through application of force slides distally along and guided by a continuous arch wire[(1)].

- This paper was extracted from Master thesis titled "Assessment of Rate of Orthodontic Tooth Movement with Different Modalities of ligations".

1. Demonstrator at orthodontic department, Faculty of Dental Medicine for Girls, Al-Azhar University, Cairo, Egypt.
2. Professor of Orthodontics, Faculty of Dental Medicine for Girls, Al-Azhar University, Cairo, Egypt.
3. Lecturer at Orthodontic Department, Faculty of Dental Medicine for Girls, Al-Azhar University, Cairo, Egypt.

* Corresponding author email: ayaelsayed.2158@azhar.edu.eg

The prevalence of the sliding mechanics has created significant interest in researching the frictional forces generated between bracket slot and arch wire. It is important to minimize the frictional forces when orthodontic tooth movement is planned[2], otherwise tooth movement could be entirely inhibited or anchorage will be jeopardized[3].

Frictional force is heavily influenced by the nature of ligation. Despite the fact that elastomeric modules are the most widely used, they generate higher frictional forces than other methods of ligation[4,5]. It has been widely reported that loose stainless steel ligatures are associated with lower friction than conventional elastomeric ligatures[6]. However stainless steel ligatures require longer time to apply, produce variable ligation forces, with risk of tearing the patient's soft tissue or the orthodontist fingers[7].

It is assumed that the use of self-ligating brackets considerably reduce friction and therefore the burden on anchorage. Self-ligating brackets have a lower degree of frictional resistance during sliding mechanics, according to studies comparing them to different ligating systems for conventional brackets [8,9]. However a large number of systematic reviews have studied the evidence for the efficacy of self-ligating brackets and conventional brackets, and the conclusions reached are not conclusive to support the superiority of one method over the other [10,11].

Elastomeric modules tied in a 'figure-of-8' pattern cause substantially more friction than those elastomeric modules tied in conventional pattern, or stainless steel ligatures. This can be explained on the basis of additional stretching of module which results in increasing the normal force and the three point contact between arch wire and module, and as a consequence the archwire is pushed more tightly against the bracket slot[12].

A new type of ligation has recently become available to the orthodontic community, aiming to retain the ease of placement and removal of the elastomeric ligation, while reducing sliding resistance. This ligature is made of a specialized medical polyurethane, applied to the bracket in the same way as a classic elastomeric ligature, it allows the arch wire to freely slide through the slot. This ligature when applied to the bracket forms a tube-like structure, with no forces exerted on the archwire. This ligature is called slide ligature. Some studies showed that this ligature produced significant lower resistance to sliding than conventional elastic ligatures[12,13].

The aim of this study was to assess the rate of canine retraction, using different modalities of ligation (passive self-ligation, figure of 8, and slide ligature).

SUBJECTS AND METHODS

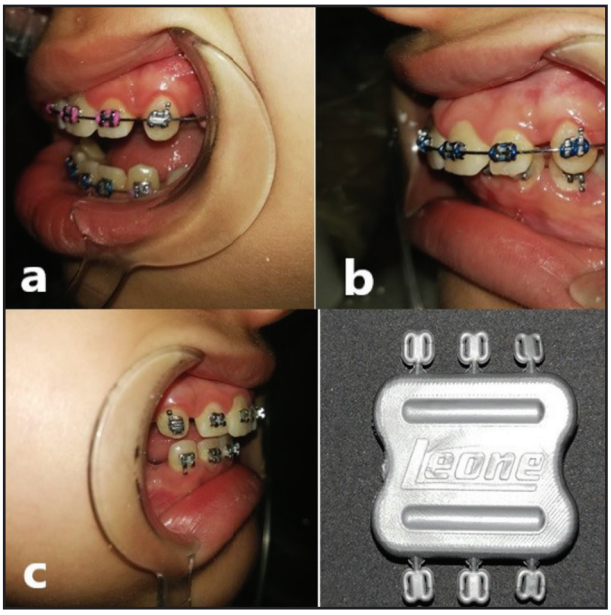
This study was a prospective randomized split-mouth controlled clinical trial. It was approved by the Research ethics committee of Faculty of Dental Medicine for girls, Al-Azhar university, in Cairo, code(REC18-028). To determine the difference between any time point within the groups, the following parameters were considered to the sample size: Acceptable level of significance $p<0.05$ (Type I or α error=5%), Power of the study =0.8, Expected effect size=1.467 The sample size was adjusted to 7 patients per group.

The participants were 3 males, 11 females, age ranged from 14-18 years. The patient or guardians were informed about the procedure, written informed consents were assigned. All participants went through careful examination, to ensure they met the following inclusion criteria: patients with malocclusion requiring maxillary first premolar extraction followed by canine retraction, no previous orthodontic treatment, all permanent teeth should be present except for the third molar

The orthodontic appliance was bonded up to the first permanent molar, transpalatal arch combined with nance button was selected for anchorage, leveling and alignment was achieved with the following arch-wire sequence:

0.014, 0.016, 0.018 NiTi, then 0.018 round SS after that the 1st premolars were extracted. And the subjects were ready for canine retraction.

The participants were randomly assigned into one of 2 groups: group 1 had passive self-ligating bracket(DamonQ, Ormco Corp,USA) on the upper right canine, figure of 8 module ligature on the upper left canine, group 2 also had self-ligating bracket on the upper right canine, and slide-low friction elastic module(Slide –ligature,Leone) on the left side. (fig.1)



Figure(1) a) Slide low-friction ligature, b) figure of 8 module, c)self-ligating bracket.

Canine retraction:

Both canines were retracted with sliding mechanics on 0.019x0.025 SS arch wire .A 9 mm nickel titanium closed coil springs (Oramco, USA) which delivered a constant force of 150 gm, measured by force gauge. The force was checked and reactivated every month. Alginate impression was taken immediately before canine retraction, and every month for 4 months. Study casts were fabricated, then scanned with 3-d scanner (Open Technologies 3-D scanner, Italy) to produce three dimensional image of the study cast.

Measurements:

Upper casts for each case were superimposed by setting the pre-retraction model as a reference, and each of the post retraction scans as a test, by using the software(Mimics medical 21, Materialize N.G, Belgium.),Incisive papilla midline with the median palatine raphe were used to draw midline vertical plane.

Horizontal plane line was drawn tangent to the most posterior convex point distal to the second molar. The vertical and horizontal planes were perpendicular to each other. Two perpendicular lines were drawn, one from the right and one from the left canine tip to the vertical line, forming two points used for measurement of the canine anteroposterior movement. The distances between each of these points and the horizontal plane were measured using the former software.

Statistical analysis:

Statistical analysis was performed with IBM SPSS software (Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp).Normality of the numerical data was explored by checking the distribution of data and using normality tests (Kolmogorov-Smirnov and Shapiro-Wilk tests). All data showed non-normal (non-parametric) distribution. Data were presented as median, range, mean and standard deviation (SD) values. Wilcoxon signed-rank test was used to compare between experimental and control sides within each group. Mann-Whitney U test was used to compare between the two groups. The significance level was set at $P \leq 0.05$.

RESULTS

Statistical analysis was carried out on fourteen patients who had extraction of upper first premolars, with no loss to follow up. The mean age of participants was 15.9±1.3 in group1, 16±1.8 in group 2,

Rate of canine retraction:

In **group1** There was no statistically significant difference between mean rates of canine retraction in control(SLBs) (4.07 ± 1.33 mm/month), and intervention(figure of 8 module) (3.95 ± 1.08 mm/month) sides .

In **group2** There was no statistically significant difference between mean rates of canine retraction in control(SLBs) (3.36 ± 0.83 mm/month), and intervention(Slide- low friction ligature) (3.54 ± 0.8 mm/month) sides .

There was no statistically significant difference between mean rates of canine retraction in the side of figure of 8 module, and the side of slide ligature during all time intervals. (fig. 2)

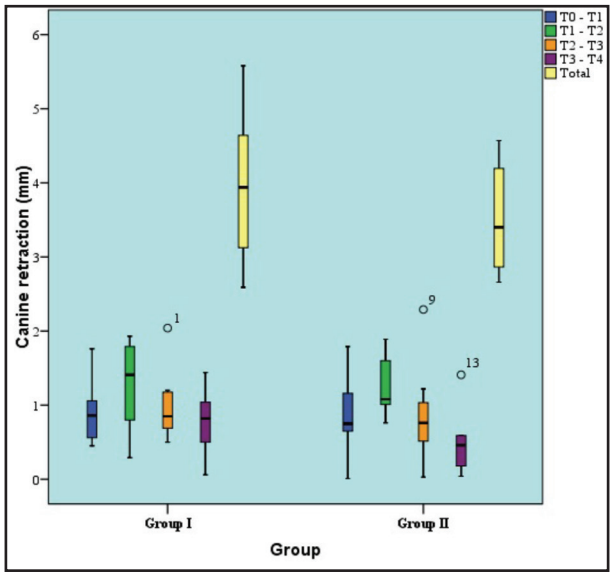


Figure (2) Box plot representing median and range values for rates of canine retraction in the two groups through tested time intervals.

Table (1): *Descriptive statistics and results of Mann-Whitney U test for comparison between rates of canine retraction intervention side of the two groups*

Time	Group I (n = 7)		Group II (n = 7)		P-value	Effect size (d)
	Median (Range)	Mean (SD)	Median (Range)	Mean (SD)		
T0 – T1	0.86 (0.45-1.76)	0.9 (0.45)	0.75 (0.01-1.79)	0.88 (0.61)	0.949	0.034
T1 – T2	1.41 (0.29-1.93)	1.26 (0.63)	1.08 (0.76-1.89)	1.28 (0.42)	1	0
T2 – T3	0.85 (0.5-2.04)	1.02 (0.52)	0.76 (0.03-2.29)	0.88 (0.72)	0.609	0.276
T3 – T4	0.82 (0.06-1.44)	0.77 (0.46)	0.46 (0.04-1.41)	0.49 (0.46)	0.179	0.768
Overall	3.94 (2.59-5.58)	3.95 (1.08)	3.4 (2.66-4.57)	3.54 (0.8)	0.609	0.276

**: Significant at P ≤ 0.05*

DISCUSSION

14 patients were enrolled for this study, all of them had extraction of maxillary first premolars. Because of the fact that age affects the rate of tooth movement the age was confined between 14 and 18 years. This age range was intended to minimize the anticipated effect related to age, so the sample is homogeneous.

The split-mouth design was chosen to reduce the biologic variability between the individuals. Split moth design was used by several researchers to compare between the intervention and the control side[14].

The suitable force for orthodontic tooth movement is the lightest force, which produces a maximum response. The ideal force to slide a canine

distally along a continuous arch wire is 150-200 grams. In this study, nickel-titanium coil spring delivering 150 g force was used .The coil spring is superior to the elastomeric chain in maintaining a long-range of activation[15].

We compared the mean rates of upper canine retraction between passive self-ligation, and figure of 8 ligation. The results were in accordance with a study showed that the rate of lower incisor alignment was unaffected by ligation with figure of 8 elastic modules. Therefore figure of eight ligation don't appear to hinder alignment of the teeth[16].

The self-ligation brackets also had no statistically significant on the rate of canine retraction, which was in accordance with number of studies and systematic reviews[11,17,18] showed that no significant differences were detected regarding canine retraction rate with SLBs" ,another systematic review[19] stated "Since there was no major impact of the bracket type on the degree and duration of retraction; it can be concluded that self-ligating brackets offer no particular therapeutic benefits over the conventional ones in terms of efficacy and performance".

We also evaluated rate of upper canine retraction with slide- low friction ligature, but despite Previous ex-vivo studies and a few clinical studies[12,13,20] showed that compared to conventional ligatures, the slide elastomeric ligatures can minimize frictional resistance during leveling and alignment, and in the canine retraction phase of treatment: our study didn't find significant difference between it and other types of ligation during canine retraction.

By comparing the rate of canine retraction in the intervention side of group 1 (figure of 8 module) and the intervention side in group 2 (Slide- low friction module); they were statistically insignificant. According to Mote et.al.[6] resistance to sliding along the arch wire has other components besides friction, these components are binding and notching. When the contact angle between the arch wire and the bracket increase during sliding the resistance to sliding is affected mainly by binding while friction have a minor role.

The resistance to sliding is affected by friction when the arch wire is not angulated in relation to the bracket, and this clinically don't occur very often, as the tooth usually tips in relation to the arch wire during space closure, which will increase the contact angle between the wire and the brackets. This increase the binding of the arch wire with the corners of the brackets, and binding becomes the major source of resistance to sliding while friction is insignificant.[6]

So no matter if the used ligation reduces friction like the passive self-ligating brackets, and the slide elastomeric ligature, or it increases the friction like the figure of 8 module, the rate of tooth movement wouldn't be affected significantly unless the other components of the resistance to sliding like binding are decreased or eliminated as well.

Finally these findings could imply that the time needed for space closure was unaffected by the type and technique of ligation used during sliding mechanics for space closure. However, the amount of anchorage loading, canine tipping, and rotation may be influenced by the ligation material and technique (due to different magnitudes of friction).

CONCLUSION

The rate of upper canine retraction wasn't significantly different between self- ligation brackets, figure of 8 elastic module and Slide –low friction ligature. Because of the higher cost of slide elastomeric ligatures and self-ligating brackets their clinical efficiency over the traditional ligation systems and brackets needs further substantiation.

RECOMMENDATIONS

Further studies are recommended to assess the effect of these ligatures during alignment, leveling and during en-mass retraction. Also more research is needed to prove their clinical effectiveness over conventional ligation systems.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

FUNDING

The authors did not receive any external funding to perform this study.

REFERENCES

1. Sreenivasagan S, Kumar A, Varghese R, Rengalakshmi S. Assessment of type of retraction mechanics commonly chosen by orthodontic residents. Euo J Molec clinic Med 2020;7:1068-74.
2. Cury SE, Castillo A, Pinzan A, Sakoda KL, Bellini SA, Janson G. et al Orthodontic brackets friction changes after clinical use: A systematic review. J Clin Exp Dent. 2019; 11:482-90.
3. Alsabti N, Bourauel C. and Talic N. Comparison of force loss during sliding of low friction and conventional TMA orthodontic archwires. J Orthod Sci 2021;10:2-10.
4. Desai H, Gandhi FM, Patel K, Agrawal S. Comparison of Friction in Sliding Mechanics Using Different Ligation Methods on Ceramic Bracket with Metal Slot and Epoxy Resin-Coated Stainless Steel Esthetic Wire: An in Vitro Study. J Ind Orthod Soci. 2019;53:101-8.
5. Chen H, Han B, Xu T. Effect of different combinations of bracket, archwire and ligature on resistance to sliding and axial rotational control during the first stage of orthodontic treatment: An in-vitro study. Korean J Orthod 2019;49:21-3.
6. Mote N, Dhanjani V, Das S, Pallan K. Governing the Friction in Fixed Orthodontic Appliance, Iran J Ortho 2020;14:103-9.
7. Sachin R, Tripti T, Rohit K, Maurya, R, Sneh V, Kamana S. et al Various types of ligation ties in orthodontics. Int J Orthod Rehab 2020;11:193-8.
8. Mascarelo A, Godoi A, Furletti V, Custodio W, Valderighi H. Evaluation of friction in metal, ceramic and self-ligating brackets submitted to sliding mechanics. Rev Odontol UNESP. 2018; 47: 244-8.
9. Nadim M, Morcos S. Frictional resistance of different types of self-ligating brackets with different wire combinations. Egyp Dent J 2018;64:1949-54.
10. Dehbi H, Azaroual MF, Zaoui F, Halimi A, Benyahia H. et al Therapeutic efficacy of self-ligating brackets: A systematic review. Int Orthod. 2017 ;15:297-311.
11. Li P, Luo Z, Yi J, Dong C, Yang P, Zhao Z. et al Comparison of self-ligating brackets and conventional brackets in canine retraction during orthodontic treatment: systematic review and meta-analysis. Int J Clin Exp Med 2020;13:2655-66.
12. Alhuwaizi A, Jasim E. The effect of bracket ligation method on canine retraction. J Bagh Coll Dent 2017; 29:93-9.
13. Gómez S, Villarraga J, Diosa J. Comparison of frictional resistance between passive self-ligating brackets and slide-type low-friction ligature brackets during the alignment and leveling stage. J Clin Exp Dent 2019;11:593-600.
14. Karamouzos A, Zafeiriadis AA, Kolokithas G, Papadopoulos MA, Athanasiou AE. In vivo evaluation of tooth colour alterations during orthodontic retention: A split-mouth cohort study. Orthod Craniofac Res. 2019; 2:124-30.
15. Alsagheer A, Abdullah K, Abd Elazeem A, Salama A. The Effect of Stem Cells on the Rate of Canine Retraction. Azhar Dent J Girls 2020;8:129-36.
16. Little R, Spary D. The effect of conventional versus figure-of-eight module ligation on mandibular incisor alignment: a randomised controlled trial. J Orthod. 2017;44:231-40.
17. Mittala R, Attria S, Batrab P, Sonarc S, Sharmad K. Comparison of orthodontic space closure using micro-osteoperforationand passive self-ligating appliances or conventional fixed appliances:A randomized controlled trial. Angel Orthod 2020;90:634-9.
18. Xianrui A, Chaoran X, Yiruo H, Mengyuan Z, Mengqi L, Peiqi W, et al. Transversal changes, space closure, and efficiency of conventional and self-ligating appliances: A quantitative systematic review. J Orofac Orthop 2018;79:1-10.
19. Dehbi H, Azaroual M, Zaoui F, Halimi A, Benyahia H. Therapeutic efficacy of self-ligating brackets: A systematic review. Int Orthod. 2017;15:297-311.
20. Salim M, Gouda W, Hemdan O. A comparative study of the frictional forces between metallic bracket and ceramic bracket using conventional and unconventional elastomeric ligature. Egyp Dent J 2018; 64:1999-2006.