

Clinical Evaluation of a Low-Friction Attachment Device during Canine Retraction

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ABSTRACT

Objective: The present study used a split-mouth design to compare the amount of canine movement and the retraction time between brackets with Clear Snap and brackets with stainless steel ligature wires for three different levels of retraction force.

Materials and Methods: A sample of 30 patients was used. After initial leveling, the canine was retracted using a 50-g ($n = 10$), 100-g ($n = 10$), or 150-g ($n = 10$) closed-coil spring. The canine on one side was chosen at random, and Clear Snap was attached to the bracket during the retraction period. The other side was used as a control. The amount of canine retraction was measured with a digital vernier caliper. Statistical analysis was performed by analysis of variance.

Results: The average canine retraction time was approximately 2 to 3 months less in all experimental groups (50, 100, and 150 g) compared to the control group. In the control group, 150 g resulted in a shorter duration of canine retraction compared to 50 g. There was no significant difference in the duration of canine retraction among the experimental groups. A greater amount of mean total canine movement was observed in all experimental groups compared to the control groups.

Conclusion: A shorter duration of canine retraction time was observed with Clear Snap attached when compared with the control. The authors suggest that with the use of Clear Snap, less than 50 g of force may effectively retract a canine.

KEY WORDS: Orthodontic treatment; Clear Snap; Canine retraction

INTRODUCTION

Reducing the duration of orthodontic treatment is of great interest to orthodontists.¹ Several bracket types and methods have previously been reported to effi-

ciently move teeth.²⁻¹⁰ For instance, the advantages of the use of a retraction spring during canine retraction has been reported.^{3,10}

In the past few years, self-ligating brackets have been introduced to reduce frictional resistance during orthodontic tooth movement.^{2,5,6,8,9} However, most of those studies focused on only experimental procedures that evaluated friction using testing machines. Self-ligation brackets are often known to be relatively large and costly compared to conventional brackets and require additional instruments. Furthermore, these brackets have no advantage over clear brackets from an esthetic point of view. Recently, a new device named Clear Snap was introduced. In contrast to other low-friction brackets, this device is a simple cap that is attached to conventional clear brackets. It is more cost-effective and does not require any other instruments, but no study has been reported that analyzed the effects of this device.

Only a few human studies have investigated the effectiveness of self-ligating brackets.^{1,11} One study reported shorter treatment times using fewer appoint-

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ments with self-ligating brackets compared to conventional brackets.¹¹ However, the stage of orthodontic treatment that was reduced was not well documented. Generally, orthodontic treatment with extraction consists of stage 1, initial leveling; stage 2, canine retraction (for sliding mechanics); stage 3, incisor retraction; and stage 4, detailing. To reduce the treatment time with self-ligation, it is necessary to clarify which sequence of clinical tooth movement can be reduced to effectively use these brackets.

Thus, in this split-mouth design study, we documented the duration of canine retraction time and analyzed the amount of canine movement during each appointment. The results were compared between brackets with Clear Snap and those with steel ligature wire in the same patient. Furthermore, we analyzed three different levels of retraction force (50 g, 100 g, and 150 g) using a closing coil to investigate the optimum force that could effectively retract the canine most extensively in the shortest time.

MATERIALS AND METHODS

The study protocol was reviewed and approved by the Institutional Board of Okayama University. The subjects in this study included 30 patients (24 females and 6 males), ranging in age from 14 to 27 years (average \pm SD = 21.3 ± 4.2 years) in Okayama University Dental Hospital. The cephalometric characteristics of the subjects were skeletal 1 ($n = 7$) or 2 ($n = 23$), with angle class I ($n = 10$) or class II ($n = 20$), and an average mandibular plane angle of $36.2^\circ \pm 3.8^\circ$ (SN-mandibular plane). The average amount of arch length discrepancy in the maxillary arch was 6.4 ± 2.5 mm. Furthermore, participation in the study was based on the following criteria:

- no significant medical history such as diabetes or metabolic diseases,
- all teeth to the second molars were fully erupted before beginning orthodontic treatment,
- treatment required symmetric extraction of the first premolars in the maxillary arch,
- no evidence of periodontal or gingival problems at the beginning of orthodontic treatment,
- no significant morphological anomalies in the canines determined by either panoramic or periapical radiographs, and
- symmetrical arch length discrepancy in the maxillary arch.

Since maximum anchorage was required in the present study, all 30 patients received a Nance appliance, and 25 patients also had headgear. All cases were treated by a single doctor (Dr Deguchi). The brackets were preadjusted 0.018-inch slot clear plastic

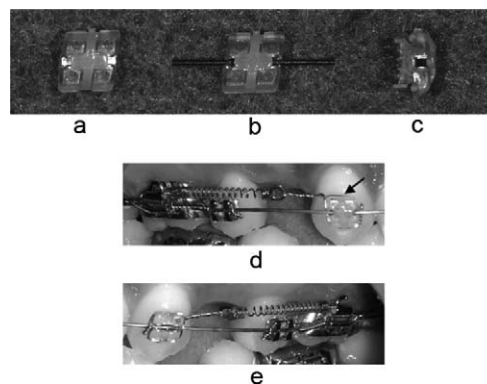


Figure 1. (a) Photograph of canine bracket with the Clear Snap. (b) Frontal view of Clear Snap with arch wire placed into the slot. (c) Side view of canine bracket with Clear Snap. (d, e) Intraoral photographs of how canine retraction was performed. On the experimental side (d), the self-ligation device (arrow) was attached to the canine bracket. On the control side (e), the closed coil was attached to the hook of the first molar to the canine bracket without the Clear Snap attached.

brackets with a metal slot (Dentsply Sankin Inc, Tokyo, Japan).

After initial leveling with 0.016-inch nickel titanium, 0.016-inch stainless steel wire was placed, and the maxillary canine was retracted using a 50-g ($n = 10$), 100-g ($n = 10$), or 150-g ($n = 10$) closed-coil spring (Tomy International Inc, Tokyo, Japan). The closed-coil spring was attached from the hook on the first molar to the canine bracket. On the experimental side, a device (Clear Snap; Dentsply Sankin Inc, Tokyo, Japan) Figure 1a-c) was attached only to the canine bracket (Figure 1d). The other side of the same patient was used as a control, and the canine was ligated with steel ligature wire (Figure 1e). In addition, the experimental side was randomly assigned according to random number tables. All of the patients had periapical radiographs taken as initial records. At the end of canine retraction, a periapical radiograph was taken in some patients ($n = 5$ in the 100-g and $n = 5$ in the 150-g experimental groups) to confirm that no significant root resorption occurred during the retraction period.

The amount of remaining space on the right and the left sides was measured after completion of leveling prior to the analysis of the tooth movement. Canine retraction was measured to 0.01 mm with a digital vernier caliper (Shinwa Co, Osaka, Japan) using the mesial surface of the mesial wing of the premolar bracket and the distal surface of the distal wing of the canine bracket as reference points (Figure 2). Measurements were made twice, and the mean was recorded. These measurements were made at 4-week intervals at every appointment until canine retraction was completed. The amount of canine retraction force was checked

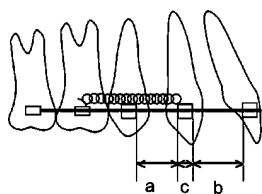


Figure 2. The amount of canine retraction was recorded at each appointment by measuring (a) the distance from the mesial surface of the second premolar to the distal surface of the canine bracket, (b) the distance from the mesial surface of the canine bracket to the distal surface of the lateral incisor bracket, and (c) the width of the canine bracket.

Table 1. Total Duration of Canine Retraction (Mo)

	Maximum	Minimum	\bar{x}	SD
50-g control	8	5	6.3 ^a	1.0
50-g experimental	5	3	3.5 ^b	0.5
100-g control	7	5	5.5	0.3
100-g experimental	4	2	3.1 ^b	0.6
150-g control	6	4	5.0	0.8
150-g experimental	4	2	2.9 ^b	0.6

^a Significant difference compared to 150 g ($P < .05$).

^b Significant difference compared to control ($P < .05$).

every appointment with a force gauge (Teclock Co, Nagano, Japan). We confirmed that constant force was produced throughout the experimental period, and no significant difference was observed in the amount of retraction force between the control and experimental groups. However, since in most of the experimental groups canine retraction was completed within 3 months after tooth movement began, a statistical comparison was performed only at the initial stage (3 months) of tooth movement. Accidental errors in duplicate measurements were calculated from the equation

$$S_x = \sqrt{\frac{\sum D^2}{2N}}$$

where S_x is the error of the measurement, D is the difference between duplicated measurements, and N

is the number of double measurements.¹² The error of measurement was found to be 0.11 mm using this analysis.

A nonparametric test was chosen to examine the total duration and average rate of canine retraction time. The method analyzed fixed effects for the experimental and control groups and different forces (50 g, 100 g, and 150 g). All comparisons were carried out by the Mann-Whitney U -test. Significance was defined as $P < .05$. All data are presented as the mean \pm the standard deviation.

RESULTS

The remaining spaces were 5.3 ± 0.5 mm, 5.3 ± 0.6 mm, 5.2 ± 0.8 mm, 5.5 ± 0.5 mm, 5.1 ± 0.8 mm, and 5.4 ± 0.8 mm in the 50-g control, 50-g experimental, 100-g control, 100-g experimental, 150-g control, and 150-g experimental group, respectively. In all groups, there was no significant difference in the spaces remaining between the control and the experimental side.

Total Duration of Canine Retraction Time

The total duration of canine retraction time is presented in Table 1. A significantly shorter duration was observed on the experimental side compared to the control in all groups ($P < .05$). Furthermore, the shorter duration of canine retraction time was observed only in the 50-g control compared to the 150-g control group ($P < .05$).

The Rate of Canine Retraction at the Initial Stage (First 3 Months)

The average rate of canine retraction is presented in Table 2 and Figure 3. In the 50-g group, a significantly greater amount of tooth movement was observed in the first 3 months in the experimental group compared to the control group ($P < .05$). In the 100-g groups, a significantly greater amount of tooth movement was observed in the first and second

Table 2. Amount of Canine Movement (mm)

	First Month		Second Month		Third Month		Total	
	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
50-g control	0.5 ^{a,b}	0.3	0.6 ^{a,b}	0.2	1	0.3	0.7 ^{a,b}	0.3
50-g experimental	1.4 ^{a,b,c}	0.3	1.7 ^{a,b,c}	0.2	1.8 ^c	0.3	1.6 ^{b,c}	0.3
100-g control	1.1	0.3	1.2	0.4	1.2	0.2	1.2 ^b	0.3
100-g experimental	2.2 ^c	0.4	2.2 ^c	0.2	1.1	0.5	1.8 ^c	0.6
150-g control	1.1	0.3	1.2	0.4	1.1	0.3	1.5	0.6
150-g experimental	2 ^c	0.3	2.1 ^c	0.2	1.3	0.8	2 ^c	0.3

^a Significant difference compared to 100 g ($P < .05$).

^b Significant difference compared to 150 g ($P < .05$).

^c Significant difference compared to control ($P < .05$).

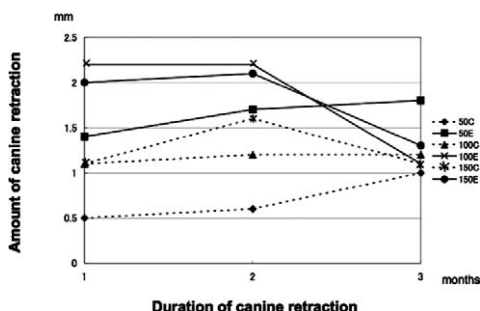


Figure 3. Line chart shows the average rate of canine movement in each month.

months in the experimental group compared to the control group ($P < .05$). In the 150-g groups, a significantly greater amount of tooth movement was observed in the first and second months in the experimental group compared to those in the control group ($P < .05$).

Within groups, a significantly greater amount of canine movement was observed in the 100-g and 150-g groups compared to that of 50 g in the control group. However, there was no significant difference in the experimental group compared with the 100-g group ($P < .05$). Furthermore, a significantly greater amount of canine movement was observed in the 150-g compared to the 100-g group in the control group ($P < .05$) but not in the experimental group.

In addition, periapical radiographs showed no significant canine root resorption in both the 100-g and 150-g experimental groups despite the rapid tooth movement (Figure 4).

DISCUSSION

In the present study, an approximately 2- to 3-month shorter canine retraction time was observed on the experimental side compared to the control side. In the past, one study indicated that 4 fewer months of total orthodontic treatment time was needed with patients treated with self-ligating brackets compared to patients treated with conventional brackets.¹¹ Several other in vitro studies have also suggested that the reason for a shorter treatment duration is that there is significantly lower friction between the bracket and the wire with self-ligation brackets.^{8,13,14}

Since the outer labial wall of Clear Snap creates a tube to house the arch wire, in the present study, there was no tight contact between the bracket and the wire as with other self-ligating brackets.^{2,5,9,13} With the lack of contact between the arch wire and the bracket, less friction is produced during tooth movement.^{4,6,8,14} Less friction with self-ligation brackets is suggested to enable faster tooth movement, resulting in a shorter treatment time compared with conventional brackets.

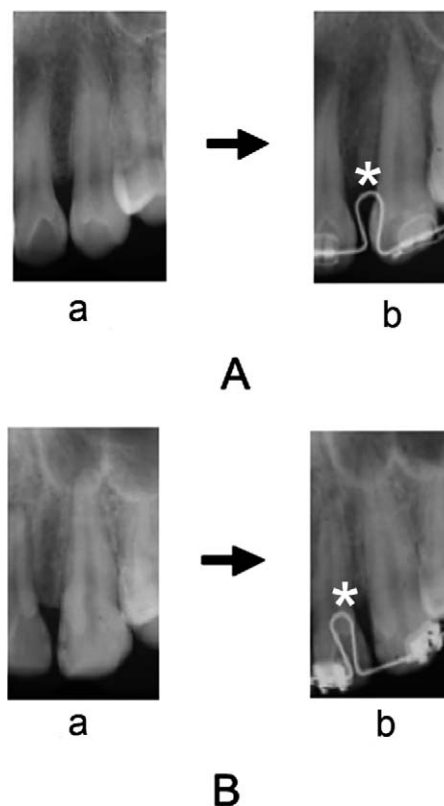


Figure 4. Periapical radiographs (a) before the initiation of orthodontic treatment and (b) during the incisor retraction in the 100-g group (A) and in the 150-g group (B). *Vertical loop to be used during the next stage (incisor retraction) after the canine retraction was completed.

ets.^{11,15,16} In this study, the shorter duration of canine retraction time is suggested to have been the result of less friction in the brackets using Clear Snap compared to ligation with ligature wire. In the control group, there was a significant difference in the total duration between the 50-g and 150-g groups. Our results are consistent with past reports indicating that the rate of tooth movement increases with the amount of force within the optimal range (50–200 g) of orthodontic force.^{17,18} On the other hand, in the experimental groups, there was no significant difference in the total duration of time between the 50-g and 150-g group. We suggest that rapid canine retraction is possible even with lower forces using Clear Snap.

Since a significant difference in the amount of canine movement was observed between the 50-g and 100-g groups in the control situation, but not between the 100-g and 150-g groups, 100 g may be the least amount of force needed to effectively move the canine approximately 1.0 mm/month. In the past, ligation force (tight or loose) and/or method used were demonstrated to affect the frictional force.^{19,20} Thus, in this study, the same operator ligated the ligature wire on the control side to minimize interoperator error. How-

ever, approximately 1.5 times more tooth movement occurred in the experimental group than that in the control group in all three different force ranges. This suggests that the reason for this greater tooth movement in the experimental group was the lower friction between these brackets and the wire. Therefore, with Clear Snap, faster canine retraction was possible with less force compared with conventional brackets. In the total average canine movement in the experimental groups, a significant difference was not observed between the 50-g and 100-g groups. The time course in the 50-g experimental group indicated a gradual increase in the amount of canine movement. Moreover, there was no significant difference in the total time between the 50-g and 100-g groups. Taken together, these results indicate that when using Clear Snap, less than 50 g may be the ideal amount of force to effectively move the canine approximately 1.5 mm/month.

One clinical advantage of Clear Snap is that less friction between the arch wire and the bracket results in a rapid and shorter duration of canine movement with less force compared to conventional brackets. Moreover, Clear Snap can be easily attached to and removed from any desired tooth at any time during different stages (ie, leveling, incisor retraction, finishing) of tooth movement without changing brackets and/or additional instruments.

In addition, periapical radiographs were taken in some patients after canine retraction to verify that there was no significant root resorption in the rapidly translated canines. This finding was consistent with a past report that rapid canine retraction does not generally result in significant root resorption.²¹ Therefore, we suggest that similar clinical effects can be achieved using Clear Snap as with other self-ligation brackets without causing significant root resorption.

CONCLUSIONS

- An approximately 2- to 3-month faster canine retraction was observed with Clear Snap compared with the control.
- The least amount of orthodontic force needed to effectively retract the canine is suggested to be less than 50 g when using Clear Snap. Furthermore, with Clear Snap, rapid canine movement is possible from the initial stage of orthodontic tooth movement without causing undesirable side effects.

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