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Original Research Article

Comparison of two methods in maxillary canine retraction

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ABSTRACT

Objective: The aim of this prospective clinical study is to evaluate the effects of laceback and Uprighter techniques on maxillary canine retraction using digital models and panoramic radiographs and to compare the results.

Materials and Methods: Sixteen patients (10 females, 6 males) with an average chronological age of 16.24±2.99 years, requiring fixed orthodontic treatment with upper canines located in a high vestibular position and the need for bilateral first premolar extraction, were included in this study. 0.018-inch Roth brackets were used in the patients. In this split-mouth design study, while laceback was used on one side, Uprighter was used on the other side. Tooth movements were measured on three-dimensional models and panoramic radiographs obtained at the beginning of treatment (T0), 2 months later (T1), and 3.5 months later (T2). Two-way analysis of variance was applied for the comparison of differences between the groups in repeated measurements.

Results : The difference between groups was found to be statistically significant in terms of canine distalization, canine rotation, and molar angulation amounts. There was no statistically significant difference in the other parameters.

Conclusions: Both uprighter and laceback techniques can be applied in maxillary canine cases located in the high vestibule. When Uprighter is used, the canine is distalized much more. However, it should be noted that while more molar tipping may occur when laceback is used, more canine distopalatal rotation may occur when uprighter is used.

1. Introduction

Maxillary canines positioned in the high vestibule are one of the most common conditions observed in orthodontic practice, and this condition is strongly associated with crowding.[1,2] Treatment for this malocclusion typically involves the extraction of first premolar teeth and the subsequent retraction of canine teeth into the extraction space.[3] The usual course of action in this treatment planning often involves the placement of thin NiTi wires to bracket and level the teeth in the arch.[4] This allows the canine teeth to move vertically and take their place within the arch. An additional method offered by the MBT technique during leveling is the use of laceback to connect the canine teeth, which not only facilitates vertical movement but also directs the canine teeth distally.[5,6] In our study, this well-established method, which can be considered as the gold standard, was compared with a relatively new technique, Uprighter application.

Uprighter, particularly in cases where the canines are distally inclined, is a unique appliance that facilitates the easy and rapid movement of the canine (PCT number:W02016114731A1, Firdevs Dental Medical, USA). It consists of a wire bracket divided into four parts: head,

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neck, body, and a wire groove dividing the body into thick and thin legs. Uprighter is attached to the canines adjacent to the extraction space and the second premolars using an elastic chain, and it creates a small curve by bending the lightweight and round NiTi archwire (Figure 1). The force of the elastic chain brings the teeth closer together, and thanks to the slope created in the archwire. As the teeth move closer to each other with the force of the elastic chain, the inclination formed in the archwire ensures the closure of the retraction space without the teeth tipping over. With this appliance, without the need for additional mechanics, all teeth begin to level in the first session by placing NiTi wires on all teeth.

In the literature, there are only few studies carried out on the retraction of canines located in the high vestibule in both friction and non-friction systems and those studies are case reports.[7–9] The effectiveness of the Uprighter has not yet been investigated in any controlled study. This study will contribute to the literature since it is the first study examining the effects of the laceback and Uprighter methods during the leveling phase. The aim of this study is to compare these two techniques. The null hypothesis suggests that there is no significant difference between the two techniques in maxillary canine retraction.

2. Materials and Methods

2.1. *Study design and patients*

This study was approved by the Clinical Research Ethics Committee of the ————. All participants were informed verbally and in writing about the study and received an informed consent letter to read and sign. The inclusion criteria for the study are as follows: (1) Maxillary canines positioned high vestibularly within the range of 1.5-5 mm. (2) Patients with skeletal Class 1 and Class 2 malocclusions requiring bilateral maxillary first premolar extraction for orthodontic treatment purposes. (3) Permanent maxillary central, lateral, canine, premolar, and first molar teeth erupted. (4) Good oral hygiene. Patients with poor cooperation, systemic and/or hormonal disorders, previous orthodontic treatment, and congenital deformities such as cleft lip and palate were excluded from this study.

This study included 16 patients (10 female, 6 male) with upper canines located in the high vestibule, with a mean chronological age at the start of treatment of 16.24±2.99 years. According to the power analysis conducted, it was found that including 13 patients with 80% power, a 5% margin of error, and a 0.5 effect size would be sufficient for this study. However, considering the potential decrease that might occur during the study, it was conducted with 16 patients. Fixed treatment with extraction of upper first premolars was planned for each patient. Standard Velocity Series Roth brackets (Lancer Orthodontics, Vista, USA) with a 0.018-inch slot width were used in each patient, and the upper second molars were not included in the treatment.

In this planned prospective clinical study with a split-mouth design, the distance from the cusp tip of the canines to the occlusal table was measured, revealing that the canines were positioned in the high vestibule with varying amounts ranging from 1.5 to 5 mm. The upper first premolars were extracted at the onset of treatment. In patients, 0.014-inch and 0.016-inch NiTi wires (Preformed Nickel Titanium, Ortho-Byte, Wilmington, USA) were sequentially used. Leveling and retraction were performed simultaneously on these wires. While laceback was used on one randomly selected side, a size 2 Uprighter was used on the other side (Figure 2). Treatment started with 0.014-inch NiTi wire, and 0.016-inch NiTi wire was inserted after 2 months. The lateral incisors, which did not have crossbites and had sufficient space for leveling, were remotely tied with elastic ligatures for the first 2 months. Subsequently, the archwire was fully seated in the brackets of these teeth. The archwire was loosely ligated with wire ligatures to minimize friction on the canine brackets. Patients were called for check-ups every 4 weeks. At each session, the laceback was activated, and the elastic chain was renewed, and a size larger Uprighter was placed. The study duration was planned to be a total of 3.5 months from the start of treatment. Anchorage-reinforcing appliances such as transpalatal arch were not used in this study because we believed they would complicate the interpretation of the effects of laceback and Uprighter techniques on tooth movement rates.

To evaluate tooth movements, study models and panoramic radiographs were taken from patients at the beginning of treatment (T0), 2 months later (T1), and at the end of the 3.5-month period (T2). The T0, T1, and T2 models were digitized using a 3D scanner (MSD 400 Dental Scanner, Pisa, Italy). They were then overlapped using Orthomodel (Pisa, Italy) analysis software. The medial points of the right and left 3rd palatal rugae were used as reference points for overlap, and the palatal rugae in the anterior region of the hard palate were used for surface area measurement.[10,11]

Canine distalization, rotation, extrusion, and anchorage loss were measured on digital models, while canine, 2nd premolar, and molar angulation were measured on panoramic radiographs.

2.2. *Dental cast and panoramic analysis*

In the measurements conducted on the T0, T1, and T2 models, the lowest part of the incisive papilla was taken as the reference point. A vertical reference line parallel to the median palatal suture passing through this point was drawn. A perpendicular line was dropped from the cusp tip of the canines and the mesial contact point of the first molars to this reference line. Canine distalization was calculated by measuring the vertical distance between the point where the perpendicular line intersects the reference line and the lowest part of the incisive papilla in the T0, T1, and T2 models (Figure 3). Canine rotation was calculated by measuring the angle between the reference point and the points placed on the mesial and distal contact points of the canine (Figure 4). For canine extrusion, the vertical distance between the cusp tips of the canines along the long axis of the tooth was measured in the overlapped T0-T1, T1-T2, and T0-T2 models (Figure 5). Anchorage loss was calculated by measuring the vertical distance between the point where the perpendicular line dropped from the mesial contact point of the first molar intersects the reference plane and the lowest part of the incisive papilla in the T0, T1, and T2 models (Figure 3).

In the radiographs, the lower points of the right and left orbits were joined to create the reference line for the upper jaw.[12] Lines connecting the apical and coronal points of the palatal root canal of the molar teeth and the apical and coronal points of the root canals of the canine and second premolar teeth were drawn to create the molar and canine/premolar axes, respectively. The angles formed by these axes with the reference line for the upper jaw were measured using a digital protractor, and angular changes in the respective teeth were evaluated (Figure 6).

2.3. Statistical analysis

Statistical analysis was conducted using the IBM SPSS Statistics 22 software (SPSS Inc., an IBM Co., Somers, NY). Repeated measures two-way analysis of variance (ANOVA) was employed to compare the means of repeated quantitative variables between groups. Bonferroni correction was applied for within-group comparisons. For within-group comparisons, repeated measures ANOVA was used, and for between-group differences, the test of significance of the difference between the means was utilized. To control for measurement error, the measurements of 9 randomly selected patients were repeated.

3. Results

Examining intra-class correlations, it was determined that the correlation coefficients ranged between 0.974 and 1 for all parameters measured. This result suggests a high level of consistency between the measurement values.

Descriptive values and intergroup comparisons of dental variables (canine, 2nd premolar, and molar) for the periodical (T0-T1, T1-T2) and total durations (T0-T2) are provided in Table 1.

4. Comparison of Changes Between Uprighter and Laceback Groups

A statistically significant difference was found between the Uprighter group (4.38 mm) and the laceback group

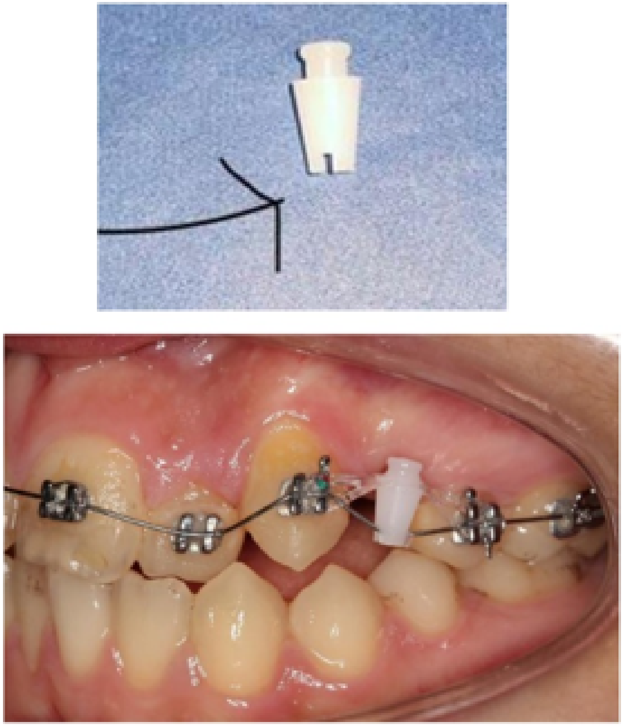

Figure 1: Uprighter

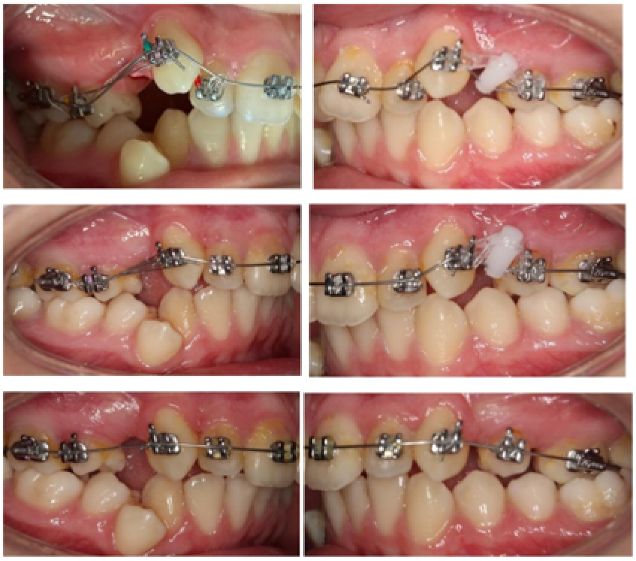

Figure 2: Changes observed with uprighter and laceback (T0,T1 and T2).

Table 1: Descriptive values and intergroup comparison of dental (canine, second premolar and molar) variables occurring in periodic (T0-T1, T1-T2) and total times (T0-T2).

	Method			
Değişkenler	**Uprighter**	**Laceback**	**F**	**P**
	Ort±SS	Ort±SS		
T0_T1 distalization	3.09±1.43 (a)	2.18±1.66 (a)	2.768	0.107
T1_T2 distalization	1.29±0.98 (b)	1.12±0.82 (b)	0.279	0.601
T0_T2 distalization	4.38±0.91 (c)	3.29±1.46 (c)	6.320	0.018*
F;p	119.984; <0.001	71.317; <0.001		
T0_T1 rotation	-6.21±3.12 (a)	-1.21±6.44 (a)	7.828	0.009*
T1_T2 rotation	-1.94±2.42 (b)	-1.56±3.42 (a)	0.133	0.718
T0_T2 rotation	-8.15±3.31 (c)	-2.76±7.21 (a)	7.382	0.011*
F;p	16.331; <0.001	2.789; 0.078		
T0_T1 ekstrusion	2,25±0,91 (a)	2.26±1.23 (a)	0.001	0.987
T1_T2 ekstrusion	0,75±0,72 (b)	0.77±0.66 (b)	0.006	0.939
T0_T2 ekstrusion	3±0,76 (c)	3.03±1.22 (c)	0.005	0.945
	68.589; <0.001	69.850; <0.001		
T0_T1 canine tipping	3.69±4.97 (ab)	3.91±5.33 (a)	0.014	0.905
T1_T2 canine tipping	-1.03±4.2 (a)	-2.29±4.07 (b)	0.740	0.396
T0_T2 canine tipping	2.69±4.1 (b)	1.62±6.02 (a)	0.346	0.561
F;p	4.018; 0.029	4.987; 0.014		
T0_T1 premolar tipping	-1.42±5.1 (ab)	-0.63±1.93 (a)	0.339	0.565
T1_T2 premolar tipping	-1.12±5.5 (b)	-1.04±2.65 (a)	0.003	0.956
T0_T2 premolar tipping	-2.54±4.92 (a)	-1.66±2.45 (a)	0.409	0.527
F;p	3.439; 0.046	1.417; 0.259		
T0_T1 molar tipping	-0.7±2.45 (a)	-2.64±1.54 (a)	7.228	0.012*
T1_T2 molar tipping	-1.75±2.02 (ab)	-2.3±2.08 (a)	0.574	0.455
T0_T2 molar tipping	-2.45±2.27 (b)	-4.94±1.6 (b)	13.339	0.001*
F;p	12.617; <0.001	49.555; <0.001		
T0_T1 anchor loss	0.73±0.38 (a)	0.66±0.36 (a)	0.279	0.601
T1_T2 anchor loss	0.46±0.44 (a)	0.63±0.55 (a)	0.880	0.356
T0_T2 anchor loss	1.2±0.49 (b)	1.29±0.56 (b)	0.270	0.607
F;p	49.527; <0.001	51.878; <0.001		

*P<.05 significance, (abc): A common letter as a colon indicates statistical insignificance.

Figure 3: Measurement of canine distalization and anchorage loss

Figure 4: Measurement of canine rotation

Figure 5: Measurement of canine extrusion

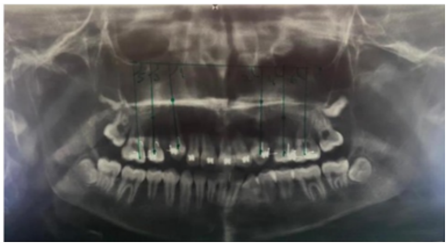

Figure 6: Measurement of canine, second premolar and molar angulation

(3.29 mm, P=0.018) in terms of T0-T2 canine distalization (Table 1).

The T0-T1 canine rotation (6.21° distopalatal in the Uprighter group; 1.21° distopalatal in the laceback group, P=0.009) and T0-T2 canine rotation (8.15° distopalatal in the Uprighter group; 2.76° distopalatal in the laceback group, P=0.011) were higher in the Uprighter group. This difference between the groups was statistically significant (Table 1).

The mesial tipping value of the first molar was higher in the laceback group (T0-T1=2.64°, P=0.012; T0-T2=4.98°, P=0.001) compared to the Uprighter group (T0-T1=0.7°, P=0.012; T0-T2=2.45°, P=0.001). This difference between Moreover, it was observed that the second premolar tooth exhibited mesial tipping of 2.54° between T0-T2 in the Uprighter group and 1.66° in the laceback group. This difference between groups was not statistically significant (p>.05) (Table 1).

There were no statistically significant differences between the groups in the other variables (P>.05) (Table 1).

4.1. Harm

As the maxillary canines were retracted, the reduction in extraction space necessitated the placement of larger Uprighters each month. Additionally, due to concerns about the Uprighter separating from the wire while brushing, some patients may have neglected to brush this area effectively, resulting in more challenging maintenance of oral hygiene on the side where the Uprighter was applied.

5. Discussion

In most of the studies in the literature, maxillary canines located in the high vestibule were retracted by using segmental mechanics in a frictionless system, and no information has been provided regarding the initial position of canines in these studies. These studies are case reports and do not have a sufficient sample size.[7–9]The present study will contribute to the literature since it is the first study examining the effects of laceback and Uprighter methods used during the leveling phase in a frictional system.

Hoggan and Sadowsky[11] reported that the lateral points of the 3^{rd} palatal rugae could be affected in canine tooth movement. In this study, superimpositions were performed by making references to the studies indicating that overlaps are stable regions for palatal rugae in the anterior region of the hard palate and that the medial side of the 3^{rd} palatal ruga can be used for overlaps.[10,13]

Various methods are used in measuring tooth movement.[6,14–16] However, 3D digital models were preferred in the present study in order to enable more precise measurements by eliminating disadvantages such as ionizing radiation. In addition, panoramic radiographs were used for better determination of root angulation, as it was found to be at least as reliable as other methods.[17]

In the Uprighter group (4.38 mm), there was more canine distalization in the total time (T0-T2) when compared to the laceback group (3.29 mm). The higher level of distalization in the Uprighter group is an expected outcome due to the elastic chain force. The lesser canine distalization observed in the laceback group is attributed to the heavy and intermittent force characteristics of the laceback ligatures.[5] In addition, the Uprighter distributes the orthodontic force along the canine root by bending the archwire and this force can be considered as a biological force that allows faster canine movement. In a study comparing the effects of laceback ligatures applying 150 g force and NiTi closed coil springs on canine retraction, Sueri and Türk reported 1.67 mm canine distal movement in the laceback ligature group and 4.07 mm in the NiTi closed coil spring group.[6] Despite using the same wires as the study carried out by Sueri and Türk, the lower level of distal movement of canines in the laceback side in the present study is due to the initial positioning of canines in the high vestibule, a longer study period, and the possibility of applying a higher level of force during laceback placement depending on the practitioner. Moreover, in the study carried out by Sueri and Türk, the higher level of distal tipping of canines was attributed to the use of 0.022-inch brackets, which resulted in more space between the archwire and bracket slot when compared to the present study. In another study, canine distal movement was observed as 0.98 mm in the laceback group and 1.09 mm in the modified group.[16] The lesser distal movement observed in their study is attributed to the canine retraction being performed on 0.019x0.025-inch SS wires and the higher age range of the patients compared to the present study.

In the T0-T1 and T0-T2 periods, a higher level of distopalatal rotation was found in the canine teeth of the Uprighter group (6.21°, 8.15°) in comparison to the laceback group (1.21°, 2.76°). This finding indicates that laceback ligatures provide more controlled tooth movement in terms of buccolingual rotation. Distopalatal rotation can occur in canine teeth since the point of force application during canine retraction is buccal to the resistance center of the tooth. Since the Uprighter pushes the archwire slightly palatally rather than vertically, it is expected to observe more distopalatal rotation in the Uprighter group. This phenomenon is also attributed to the higher level of force applied distally to the canine in the high vestibule area in the Uprighter group when compared to the force applied mesially, in comparison to the laceback group. The rotation measured for the period T1-T2 in the Uprighter group is significantly less than that measured between T0-T1. This can be explained by the attachment of laterals in the first 2 months and the creation of an anti-rotation moment due to the application of larger Uprighter wires in each session. Although the mean values in the laceback group show distopalatal rotation, distobuccal rotation occurred in

5 patients when lateral incisors were included in the study. This is thought to be due to the higher force applied mesially than distally on the canine tooth due to the shorter inter-bracket distance at the mesial of the canine. The finding reported by Sueri and Türk detecting 2.68° distobuccal rotation in the laceback group supports this idea.[6] Rajchich and Sadowsky found 15.3° distopalatal rotation in canine teeth. In their study with Ni-Ti closed coil springs, whereas Ziegler and Ingervall reported a 30° distopalatal rotation in the PG retraction spring group and 24° in the elastic chain group.[15–18] The amount of rotation that occurs during the canine retraction in friction-based systems is influenced by factors such as the intensity, type, and duration of the applied force, as well as the elasticity of the archwire used.

Although no statistically significant difference was observed, mesial tipping in the second premolars occurring between T0-T2 was greater in the Uprighter group (2.54°) than in the laceback group (1.66°). This is explained by the elastic chain transmitting force from the canine to the second premolar in the Uprighter group.

In the T0-T1 and T0-T2 periods, molars in the Uprighter group (0.7°, 2.45°) exhibited less mesial tipping when compared to the laceback group (2.64°, 4.94°). Mesial tipping of molars is expected during their mesial movement. The higher degree of mesial tipping observed in the laceback group is attributed to the direct application of force to the molars in this group and the type of back bend effect created on the wire in the Uprighter group, pushing the first molar crown distally. The degree of mesial tipping observed in molars in this study is consistent with the study carried out by Sueri and Türk.[6] Charoemratrote et al. reported 0.40° mesial tipping in molars in the laceback ligature group and 0.10° in the modified group.[16] The lower level of mesial tipping observed in this study is attributed to the use of 0.019x0.025-inch SS wires for canine retraction.

Additionally, the mean anchorage loss measured from T0 to T2 in the Uprighter group was 1.2 mm, while it was 1.29 mm in the laceback group. Despite the expectation of greater anchorage loss in the Uprighter group due to some mesialization of the second premolar caused by the elastic chain attached to the canine and second premolar teeth, there was no statistically significant difference in anchorage loss between the groups in the intergroup comparison. This phenomenon is explained by the tip-back bending effect of the wire in the Uprighter group, which pushes the first molar crown distally.

6. Limitations

Since this study was planned with a split-mouth design, lateral intrusion and changes occurring in the occlusal plane could not be measured. Further parallel-group studies with larger sample sizes are needed to investigate the effect of Uprighter application on canine teeth in the high vestibule area.

7. Conclusion

When compared to the laceback technique, the use of Uprighters resulted in much greater distalization of the canine without causing unwanted tipping complications. However, it should be noted that while using laceback may lead to more molar tipping, using Uprighters may result in greater distopalatal rotation of the canine.

8. Source of Funding

None.

9. Conflict of Interest

None.

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