Original Article

Effectiveness of Laceback Ligatures on Maxillary Canine Retraction

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ABSTRACT

Objective: To evaluate the effects of laceback ligatures on canine distalization during the leveling and aligning stage and to compare the effectiveness of laceback ligatures with that of superelastic NiTi closed coil springs.

Materials and Methods: Fifteen subjects were included in this study. Fixed orthodontic treatment was planned with the extraction of first premolars to solve crowding in upper and/or lower arches. Stainless steel direct-bonding Roth brackets (0.022-inch) were used. For canine distalization superelastic NiTi closed coil springs generating 150 g of force were used on one side. Lacebacks made from 0.010-inch ligature wire were applied on the contralateral side. Dental and skeletal changes were evaluated from predistalization and postdistalization lateral cephalometric and submento vertical radiographs. A Wilcoxon test was applied to determine the differences between predistalization and postdistalization mean values and to determine the mean differences between the groups.

Results: Upper incisor crowns moved posteriorly. Distal movement and tipping of the canines were significant for both groups. Likewise, mesial movement and tipping of the first molars were significant for both groups. Furthermore, distopalatinal rotation of the canines was significant in the coil group. Canine and molar movements were greater for the coil group than for the laceback group, and the differences were significant. These differences may be attributed to force characterization, as well as to arch wire size and material.

Conclusion: The laceback ligatures proved to be effective for canine distalization. Less canine and molar movement was found for the laceback group, but more controlled movements were obtained for the sagittal, vertical, and transverse planes.

KEY WORDS: Laceback; Canine distalization

INTRODUCTION

In preadjusted edgewise appliances, the tip built into the anterior brackets increases the tendency for anterior teeth to tip forward. This tendency is greater in the upper arch than in the lower arch because of the greater amount of tip in the upper anterior brackets.[1]

To prevent the forward tipping of anterior teeth, McLaughlin and Bennett[1] introduced a figure eight ligature wire, called "laceback," placed from the most distally banded molar to the canine. The lacebacks not only prevented the forward tipping of anterior teeth, but also resulted in an effective distal canine movement.

There are limited studies in the literature concerning the effects of lacebacks on the forward tipping of anterior teeth.[2–4] In two studies, the anteroposterior position of lower incisors was evaluated during the leveling and aligning stages.[2,4] Usmani et al[3] evaluated the anteroposterior position of upper incisors. However, a literature search showed that the effectiveness of lacebacks on canine distalization has not yet been investigated.

The aim of this study was to evaluate the effects of lacebacks on canine distalization during the leveling and aligning stage and to compare the effectiveness of lacebacks with a different distalization method (superelastic NiTi closed coil springs).

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Accepted: December 2005. Submitted: October 2005.

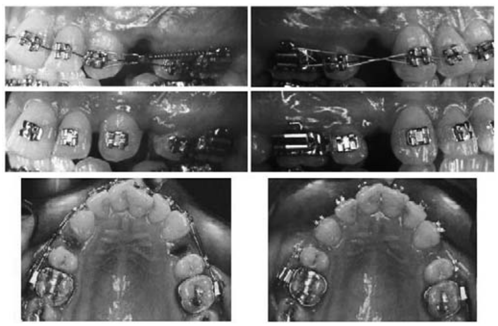

Figure 1. Changes observed with superelastic NiTi closed coil spring and laceback.

MATERIALS AND METHODS

Fifteen subjects (12 females, 3 males) aged between 12 and 18 years (average chronological age, 14 years 11 months) were included in this study. All subjects had an Angle Class I molar relationship. Fixed orthodontic treatment was planned with the extraction of first premolars to solve crowding in the upper and lower arches. Stainless steel direct-bonding Roth brackets (0.022-inch) (Leone SpA, Firenze, Italy) were used in all patients.

To evaluate the dental and skeletal changes, predistalization lateral cephalometric and submento vertical radiographs were obtained. To minimize measurement errors, reference bars (0.019 times; 0.025-inch rectangular arch wire) inserted into the canine bracket and molar tube, were used. Longer reference bars on the right than on the left side were inserted to identify left and right teeth.

Leveling of the teeth was started with a 0.012-inch NiTi arch wire (Leone SpA). For canine distalization, superelastic NiTi closed-coil springs (GAC International Inc, Central Islip, NY) generating 150 g of force were used on one side (coil group). Superelastic NiTi closed coil springs, placed from the first molar to the canine, were activated at three times their original length. Lacebacks made from 0.010-inch ligature wire (Leone SpA) were applied on the contralateral side (laceback group) (Figure 1). The coil or laceback allocations were randomly decided. The closed coil springs were controlled and reactivated, and lacebacks were reapplied at each appointment.

All subjects were controlled once a month. Leveling and aligning was carried out with 0.014-inch and 0.016-inch NiTi arch wires. Canine distalization was stopped when anterior crowding was solved on one segment. Subsequently, lateral cephalometric and submento vertical radiographs were obtained.

Local superimpositions were carried out with reference to the palatal cortex of the maxilla. A coordinate system was set up on the preretraction lateral cephalometric films. The line through pterygomaxillary point

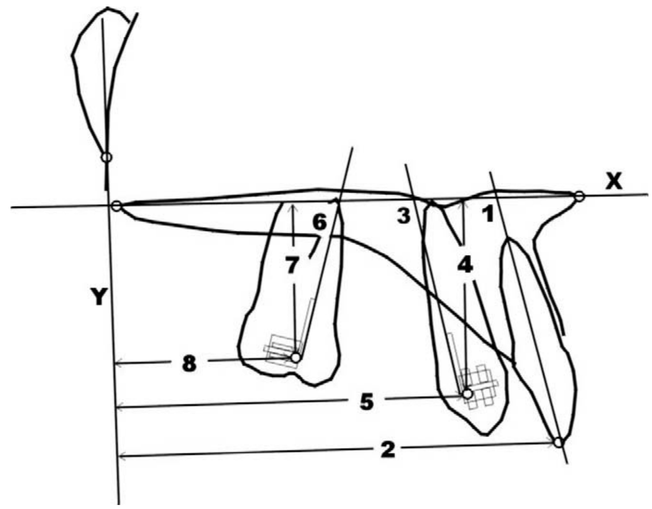

Figure 2. Linear and angular parameters measured on the predistalization and postdistalization lateral cephalometric films. (1) x/U1 indicates angle between the long axis of the upper central incisor and x-axis (°); (2) y-U1, distance between the incisal edge of the upper central incisor and y-axis (mm); (3) x/U3, angle between the long axis of the upper canine reference bar and x-axis (°); (4) x-U3, distance between the upper canine and x-axis (mm); (5) y-U3, distance between the upper canine and y-axis (mm); (6) x/U6, angle between the long axis of the upper first molar reference bar and x-axis (°); (7) x-U6, distance between the upper first molar and x-axis (mm); and (8) y-U6, distance between the upper first molar and y-axis (mm).

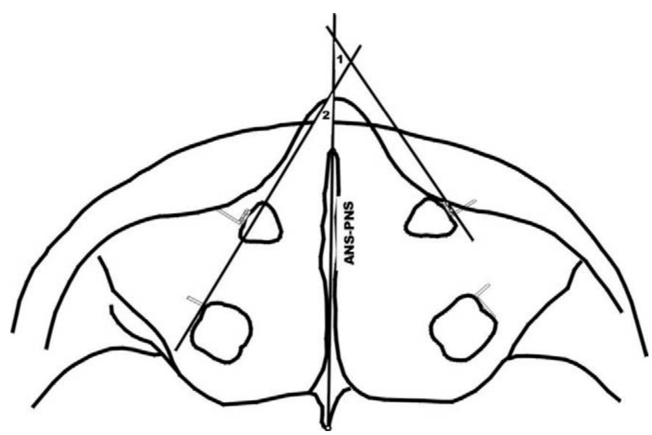

Figure 3. Angular parameters measured on the predistalization and postdistalization submento vertical films. (1) ANS-PNS/U3 indicates angle between the horizontal axis of the upper canine reference bar and ANS-PNS plane (°); (2) ANS-PNS/U6, angle between the horizontal axis of the upper first molar reference bar and ANS-PNS plane (°).

(Ptm) perpendicular to the ANS-PNS plane represented the y-axis, and the ANS-PNS plane represented the x-axis (Figure 2). For evaluation of the submento vertical radiographs, a midsagittal line through the ANS and PNS points served as a reference line (Figure 3).

A Wilcoxon test was applied to determine the significance of the differences of predistalization and

Table 1. Predistalization and Postdistalization Descriptive Values of Skeletal and Dental (Upper Incisors) Variables and Changes in These Values During Retraction

Parameters	Preretraction		Postretraction		Change		P
	Mean	SD	Mean	SD	D	SD	
Skeletal							
SNA	79.79	3.34	79.75	3.40	−0.04	0.49	.624[NSa]
SNB	76.93	3.12	76.78	3.03	−0.15	0.42	.179[NS]
ANB	2.74	2.04	2.84	2.14	0.10	0.59	.476[NS]
SN/ManD	35.65	4.20	35.83	4.19	0.19	0.64	.363[NS]
SN/MaxD	8.47	3.23	8.39	3.13	−0.08	0.43	.509[NS]
MaxD/ManD	27.17	4.02	27.42	3.93	0.25	0.66	.065[NS]
Dental							
x/U1 (°)	111.43	3.83	109.07	5.37	−2.37	3.39	.017*
y-U1 (mm)	54.03	3.16	52.77	3.45	−1.27	1.33	.002**
Chronological age (mo)	179.00	26.41	—	—	—	—	—

[a] NS Indicates nonsignificant; * $P < .05$; ** $P < .01$.

Table 2. Predistalization and Postdistalization Descriptive Values of Dental (Canine and Molar) Variables

Parameters	Laceback Group				Coil Group			
	Preretraction		Postretraction		Preretraction		Postretraction	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
x/U3 (°)	81.77	6.06	77.27	5.67	81.97	5.85	70.33	6.57
x-U3 (mm)	23.17	3.55	23.83	3.03	23.67	2.83	23.20	2.38
y-U3 (mm)	44.97	3.00	43.30	2.98	44.97	3.57	40.90	3.59
x/U6 (°)	80.60	8.09	84.50	8.72	78.83	8.33	81.93	9.84
x-U6 (mm)	18.07	2.73	18.53	2.90	18.87	2.67	19.63	2.10
y-U6 (mm)	25.30	2.26	26.00	2.16	25.97	3.63	27.90	3.46
ANS-PNS/U3 (°)	35.04	9.71	37.71	8.23	27.32	13.78	19.57	8.50
ANS-PNS/U6 (°)	18.00	9.78	19.89	8.89	20.07	9.31	24.00	10.29

postdistalization values and to determine the significance of the mean differences of the two groups.

RESULTS

Descriptive statistical values of predistalization and postdistalization skeletal and dental (upper incisors) measurements and the significance of the differences between predistalization and postdistalization are given in Table 1. Skeletal changes were not found to be statistically significant ($P > .05$). However, x/U1 angle and y-U1 distance showed statistically significant decreases at the levels of .05 and .001, respectively.

Descriptive statistical values of predistalization and postdistalization dental (canine and molar) measurements are given in Table 2. The significance of the differences between predistalization and postdistalization ($P1$, $P2$) and the significance of the differences ($P3$) between the changes occurring during the distalization period (2.53 months) are given in Table 3.

Large standard deviations for the dental values were observed. Several subjects had a great variation in tooth movement, and this accounts for the rather large standard deviations. This variation in tooth movement might be explained by individual response to orthodontic treatment and by the severity of malocclusion presented at the beginning of treatment.

Changes in the Laceback Group

Distal movement (y-U3, 1.67 mm) and distal tipping (x/U3, 4.50°) of the canines were significant ($P1 < .01$ and $P1 < .001$, respectively). Mesial tipping (x/U6, 3.90°) and mesial movement (y-U6, 0.70 mm) of the first molar teeth were found statistically significant ($P1 < .05$).

Changes in the Coil Group

Distal movement (y-U3, 4.07 mm) and distal tipping (x/U3, 11.63°) of the canines were statistically significant ($P2 < .001$). Mesial movement (y-U6, 1.93 mm) ($P2 < .001$), mesial tipping (x/U6, 3.10°), and extrusion (x-U6, 0.77 mm) of the first molar were significant ($P2 < .05$). Furthermore, distopalatinal rotation (ANS-PNS/U3, 7.75°) of the canines was significant ($P2 < .05$).

Table 3. Changes in Dental (Canine and Molar) Values During Distalization and the Comparison of These Changes

Parameters	Laceback Group			Coil Group			P3
	D	SD	P1	D	SD	P2	
x/U3 (°)	−4.50	4.11	.003**	−11.63	4.55	.001***	.003**
x-U3 (mm)	0.67	1.53	.118[NS]	−0.47	1.16	.114[NSa]	.046*
y-U3 (mm)	−1.67	1.06	.001***	−4.07	0.96	.001***	.001***
x/U6 (°)	3.90	6.64	.030*	3.10	5.82	.50*	.917[NS]
x-U6 (mm)	0.47	1.04	.150[NS]	0.77	1.03	.15*	.591[NS]
y-U6 (mm)	0.70	0.86	.014*	1.93	1.13	.001***	.008**
ANS-PNS/U3 (°)	2.68	6.40	.239[NS]	−7.75	9.34	.019*	.006**
ANS-PNS/U6 (°)	1.89	3.87	.108[NS]	3.93	7.94	.079[NS]	.330[NS]
Rate of movement (mm/mo)	0.66	0.54	—	1.61	0.44	—	.001***

[a] NS indicates nonsignificant; * $P < .05$; ** $P < .01$; *** $P < .001$.

Comparison of the Changes Between Laceback and Coil Spring Groups

A statistically significant difference was found between the canine distal tipping in the laceback group (4.50°) and in the coil group (11.63°; $P3 < .01$).

A significant difference was observed between canine extrusion in the laceback group (0.67 mm) and in the coil group (0.47 mm; $P3 < .05$).

A statistically significant difference was found between canine distal movement in the laceback group (1.67 mm) and in the coil group (4.07 mm; $P3 < .001$).

The amount of first molar mesial movement was bigger in the coil group (1.93 mm) than in the laceback group (0.70 mm); this difference was significant between groups ($P < .01$).

Distobuccal canine rotation showed a significant difference between the laceback group (2.68° distobuccal) and the coil group (7.75°, distopalatal; $P3 < .01$).

The rate of canine movement showed a statistically significant difference between the laceback and the coil groups ($P3 < .001$).

DISCUSSION

The inclination of the upper incisors decreased (2.37°) and posterior movement of the upper incisor crowns was observed (1.27 mm). Robinson,[2] in a study investigating the effects of lacebacks, showed that lower incisors moved posteriorly. Usmani et al[3] observed the retroinclination of upper incisors with canine lacebacks. However, Irvine et al[4] found that canine laceback ligatures convey no differences in the anteroposterior position of the lower labial segment. In our study, two different force systems were used along the same arch wire. Thus, it is impossible to attribute the posterior movement of the upper incisors to a particular force system, ie, laceback or superelastic NiTi coil spring. It can be argued that the pulling back of the canines has a retraction effect on the upper incisors.

In the laceback group the canine moved and tipped distally (1.76 mm, 4.50°). However, in the coil group, the canine movement and tipping (4.07 mm, 11.63°) were significantly different from the laceback group. Correspondingly, in the coil group, the rate of canine movement (1.61 mm/mo) was bigger than in the laceback group (0.66 mm/mo). The posterior teeth moved anteriorly in both groups. However, the anchorage loss for the coil group (1.93 mm) was significantly different from the laceback group (0.70 mm). These results clearly demonstrate that faster movement and more displacement are achieved by continuous forces. Other studies comparing continuous and interrupted forces showed the same results. Daskalogiannakis and McLachlan[5] compared the effects of continuous and impulsive forces on tooth movement. Twice the amount of tooth movement was obtained with continuous force application after 3 months. Owmann-Moll et al[6] stated that continuous force was more efficient than interrupted force.

Huffman and Way[7] investigated canine distalization with the Pletcher spring. This biweekly activated spring produced a force of 200 g along different arch wire sizes with the 0.022-inch slot appliance. Canine movement was 3.37 mm and canine tipping was 5.30° along the 0.016-inch arch wire during a distalization period of 10 weeks. The canine movement rate was 1.4 mm/mo. For the 0.020-inch arch wire the canine movement and tipping was 2.99 mm and 1.70°, respectively. The canine movement rate was 1.2 mm/mo.

Canine distalization with nickel-titanium coil springs producing a force of 150–200 g along a 0.016-inch arch wire was investigated by Rajcich and Sadowsky.[8] During a period of 7.1 months, right and left canine distalization was 5.6 mm and 5.8 mm, respectively.

Average canine distalization was 3.9 mm, with latex elastics producing a force of 75–100 g during a period of 4–8 months.[9]

Canine distalization with chain elastics producing a force of 380 g along a 0.018-inch arch wire showed a rate of movement of 1.4 mm/mo. The amount of distalization was 6 mm and the amount of tipping was 8.5°.[10]

The main differences between our study and the other studies might be summarized in two points: First, in the coil group, the amount of distal tipping was greater than in the other studies. This can be explained by the size and material of the arch wire. Small (0.012-, 0.014-, and 0.016-inch) NiTi arch wires were used in our study. However, in the other studies, the canine distalization was performed on larger stainless steel arch wires. The strength and stiffness of NiTi arch wires are quite different from those of stainless steel arch wires. Niti arch wires are 60% as strong as steel, and the stiffness of NiTi arch wires is one third that of steel.[11] It is difficult to control canine movement and to make the canine root upright with NiTi arch wires because of their low strength and stiffness. Second, in the laceback group, the amount and the rate of canine movement were smaller than measurements found in the other studies. This can be explained by the force characteristics of laceback ligatures. Laceback ligatures, when tied to the canine, cause a slight tipping of the canines with compression of the periodontal ligament. Then, the cuspid roots have enough "rebound time" to move upright into the correct position as the main arch wire takes effect.[1] The movement of the canine crown is limited by the width of the periodontal ligament and the elastic capacity of the alveolar crest.

Rotation of canines showed a statistically significant difference between the two groups. In the laceback group, the canine rotated distobuccally (2.68°), whereas in the coil group, the canine rotated distopalatally (7.75°). Ziegler and Ingervall[10] and Rajcich and Sadowsky[8] observed distopalatal rotation of the canine (24° and 15.3°, respectively) during retraction.

Distopalatal rotation of the canines should be observed because of the relationship between the force application point and the center of resistance of the canine. In both groups the line of action of force passed buccally to the center of resistance. However, distobuccal rotation was observed in the laceback group. This distobuccal rotation may be explained by force duration and by arch wire control. As mentioned above, after the movement of the canine with laceback ligatures (interrupted force), the cuspid is given enough "rebound time" to rotate distobuccally into the correct position as the main arch wire takes effect.

CONCLUSIONS

- Laceback ligatures proved to be effective for canine distalization.
- When compared to superelastic NiTi closed coil springs, the amount and rate of canine movement were less. However, a more controlled canine movement was obtained for the sagittal, vertical, and transverse planes.

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