A Nickel Titanium Canine Retraction Spring

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Two methods have been used to move canines distally in premolar extraction cases: sliding mechanics along a continuous archwire and independent retraction with springs.[1-13] When simple closing loops are used to retract the canines independently, friction between the archwire and bracket is eliminated. Stainless steel springs, however, tend to produce too much force and thus to cause undesirable tipping and rotation of the canines and loss of anchorage in the posterior segments.[4-13]

Many types of retraction springs have been developed to overcome these problems, including Ricketts's maxillary canine retractor[5,6] and Gjessing's canine retraction arch.[8,9] Bourauel and colleagues recently described a spring that takes advantage of the superelastic properties of nickel titanium,[12] with a nickel titanium T-segment connected to a stainless steel arm, as in Burstone's T-loop.[7]

Fig. 1 Canine retraction spring made from .016" × .022" Titanal wire, with antitip and antirotation bends incorporated in closing loop.

To retract a canine into an extraction site without tipping and rotation, a spring must generate not only a closing force, but also moments to bring the root apices together at the extraction site and to maintain proper rotation. We have designed a new nickel titanium retraction spring that incorporates a simple vertical closing loop with antitip and antirotation bends (Fig. 1). The major advantage of this spring is the ability to use it without a preliminary leveling stage, because it can simultaneously retract the canines and level the posterior teeth. Its light, continuous force allows an activation of as much as 10mm to complete canine retraction without reactivation of the closing loop.

Canine Retraction Spring Design

Because it is impossible to maintain normal plier bends in a nickel titanium wire, the vertical closing loop and the antitip and antirotation bends were memorized by heat-treating the wire

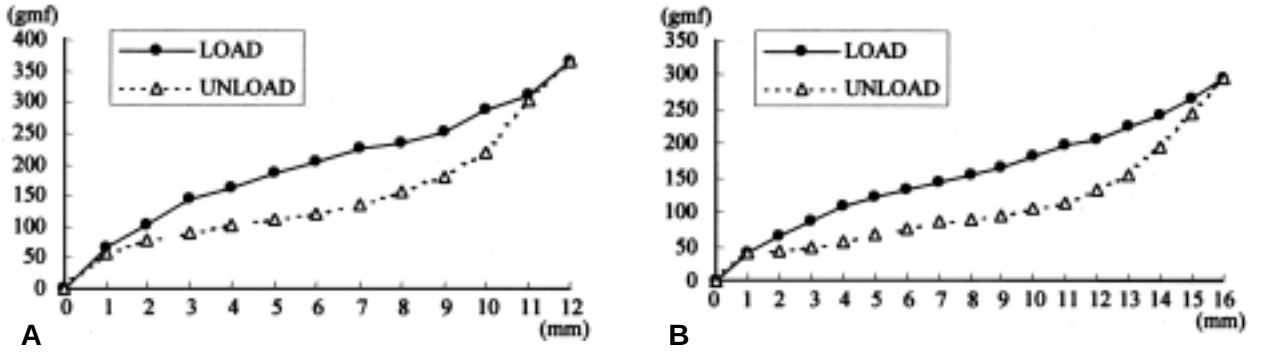

Fig. 2 Force/activation curves of Titanal canine retraction spring. A. 8mm loop. B. 10mm loop.

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in an electric oven. An .016" × .022" Titanal* wire was contoured with a three-prong plier, embedded in a heat-resistant plaster to maintain its shape, and heat-treated for 15 minutes at 550°C, according to Ohura's method.[14]

Uni-axial tensile tests were conducted in 37°C water to establish the force/activation curves of the Titanal canine retraction springs in two loop heights, 8mm and 10mm (Fig. 2). For the 8mm loop, as the divergence between the legs decreased from 10mm to 2mm, the unloading force decreased only from 200gmf to 100gmf. For the 10mm loop, the unloading force stayed between 110gmf and 40gmf. These tests indicate that the spring provides continuous forces and moments over a broad range of activation, and that the closing force can be maintained within normal biological and physiological limits.[3]

Clinical Study

To evaluate the closing rate of extraction sites with the Titanal canine retraction spring, we tested the 10mm loop in 22 female patients who needed individual canine retraction. Thirteen of the patients were under 15 years old, and nine were over 20 years old.

In each case, the vertical loop followed the contour of the alveolar bone without causing any buccal or gingival irritation, even with 10mm of activation (Fig. 3). While distalizing the canines, a 2 × 4 appliance and a lingual arch and/or transpalatal arch were used to incorporate the four incisors into the anchorage unit. No extraoral appliances were used. A single activation was sufficient to close the extraction spaces in every patient.

The distances between the anatomical contact points of the canines and second bicuspids were measured intraorally with a slide caliper before and after canine retraction. The average rates of space closure in the younger patients were .62mm/week in the upper arch and .51mm/week in the lower; in the adult patients, .48mm/week in the upper arch and .43mm/week in the lower (Table 1).

Case Report

In this typical 25-year-old female patient, canine retraction was completed in three months per arch without any reactivation of the closing

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TABLE 1
CANINE RETRACTION USING TITANAL SPRING

	No. Patients	No. Teeth	Extraction Space (mm)	Duration of Retraction (weeks)	Rate of Retraction (mm/week)
Upper first premolar extractions					
Patients under age 15	13	25	5.7 ± 1.5	10.0 ± 3.1	0.62 ± 0.29
Patients over age 20	8	15	5.3 ± 1.0	11.9 ± 3.0	0.48 ± 0.17
Lower first premolar extractions					
Patients under age 15	6	12	4.2 ± 1.3	9.2 ± 3.8	0.51 ± 0.20
Patients over age 20	7	13	4.8 ± 1.7	12.0 ± 3.4	0.43 ± 0.15

Fig. 3 Case 1. A. 25-year-old female patient before treatment. B. Initial appliance for upper canine retraction. C. After three months of upper canine retraction (continued on next page).

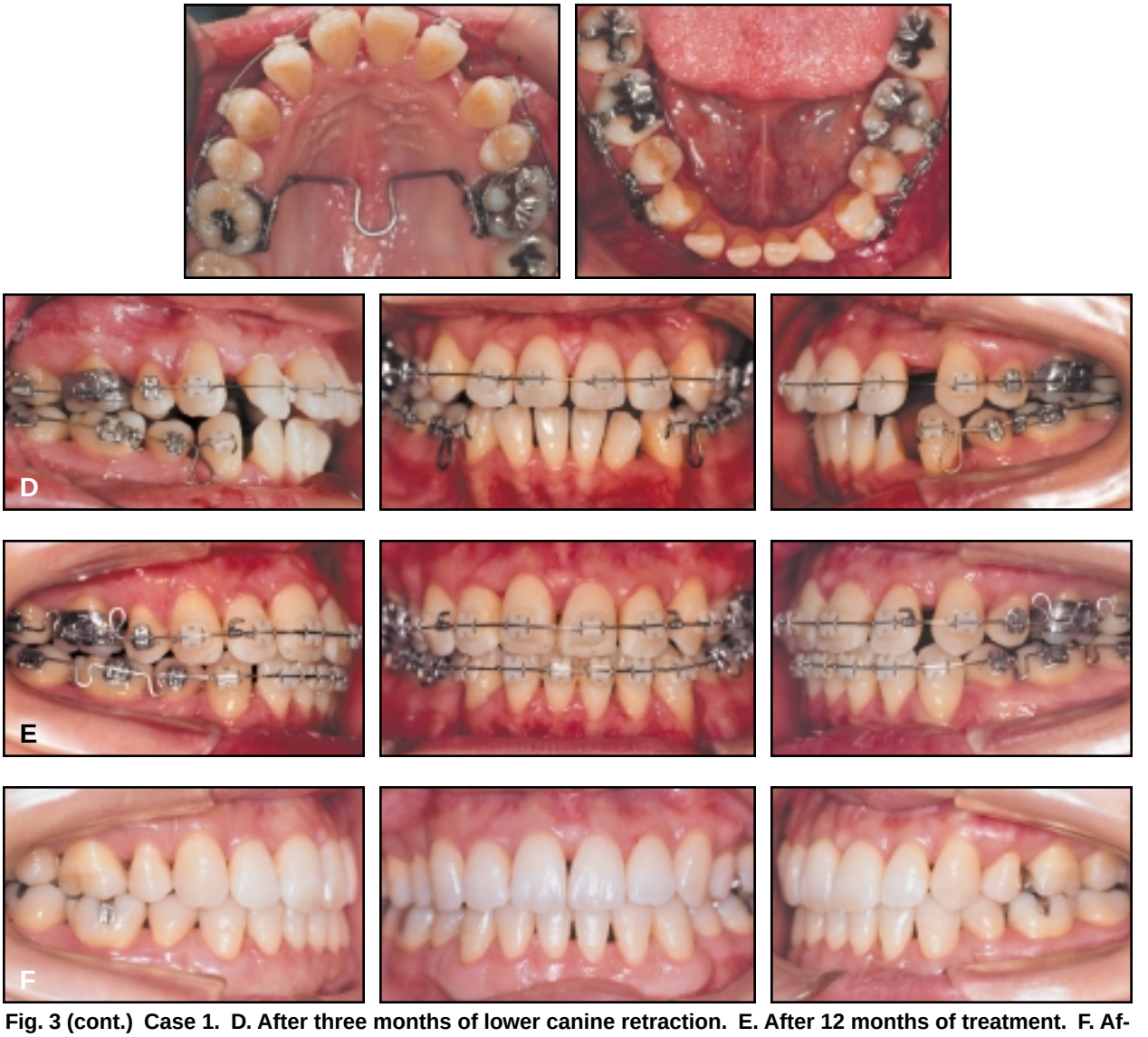

Fig. 3 (cont.) Case 1. D. After three months of lower canine retraction. E. After 12 months of treatment. F. After 18 months of treatment.

loops (Fig. 3). The distal canine movement exposed the interincisal spaces so we could counteract the early stages of decalcification by scaling or root planing. Maxillary lingual and transpalatal arches were used to preserve posterior anchorage. Mandibular posterior anchorage with this system is usually strong enough without reinforcement. Minor tipping and rotation of the incisors were evident after the canine retraction.

Discussion

The canine retraction force produced by the Titanal spring (Fig. 2) is consistent with the magnitude recommended by most authors,[4,5,7-9,11,13] but slightly greater than the force advocated by Iwasaki.[15] The closing rate is equivalent to Ziegler's[4] and Boester's[5] and faster than that reported by Dinçer,[10] Bauer,[11] and Häsler.[13]

This canine retraction spring produces not only a well-maintained, light, continuous closing force, but also a constant antitip and antirotation force. The superelastic nickel titanium wire resists permanent deformation, even if the canines are rotated or distally tipped. Leveling of the posterior teeth and canine retraction can proceed simultaneously, and even faster in growing children than in adult patients.

Another advantage of the Titanal spring is the avoidance of friction between the archwire and the bracket slot. In sliding mechanics, the moments preventing tipping and rotation are created by contact between the archwire and the bracket slot. This contact, however, creates frictional binding that can inhibit tooth movement. Because of the risk of friction, the archwire cannot be tightly ligated to the canine bracket slot, which means the distalizing force is not applied through the center of rotation, increasing the likelihood of canine rotation. A "friction-free" system makes it possible to apply predetermined and precise forces for planned tooth movements. If anchorage needs to be reinforced, the incisors can be incorporated into the anchor unit, or a lingual arch can be added.

Finally, the most important benefit of this canine retraction spring is its ability to deliver continuous forces and moments over a broad range of activation. Without the need for reactivation of the closing loops, patient discomfort, chairtime, and appointment frequency can all be reduced.

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