Research Article

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Evaluation of a Modified Nickel Titanium Spring And T Loop In Canine Retraction – A Comparative Clinical Study

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ABSTRACT

Aim: The aim for this study was to evaluate two different types of loop mechanics in canine retraction, namely modified Nickel Titanium (Ni-Ti) retraction spring and the T loop.

Material and Methods: 10 patients were selected, on which a modified Nickel Titanium spring made with 0.016" x 0.022" Ni-Ti wire and T loop made with 0.016" x 0 .022" Titanium molybdenum alloy (TMA) wire, according to the recommendations of the author were made and placed on canine on each of the quadrants of upper arch in the same patient. All the cases were supplemented by study models, photographs and OPG (Orthopantomogram) taken at pre and post retraction stages.Rate of retraction, Rate of tipping and anchorage loss was measured for both Ni-Ti loop and T loop.

Results: Ni- Ti loop showed increased rate of canine retraction when compared to the T loop which was clinically and statistically significant.T loop showed more anchorage control than the Ni-Ti loop although the difference was not statistically significant.The rate and the amount of canine tipping was more with the T loop when compared to the Ni-Ti loop. Equal amount of canine rotation was observed clinically for both the loops.

Conclusion: Ni-Ti loop showed faster retraction rate and lesser amount of tipping than the T loop. T loop showed more anchorage control than the Ni-Ti loop although the difference was not statistically significant. Clinically both the loops showed equal rotation of the canine.

Keywords: Retraction, loop mechanics, Ni-Ti loop, T loop.

INTRODUCTION

Canine retraction is usually carried out by two methods. Retracting canines by sliding along a base wire(Frictional mechanics),Retracting the canine with a specially designed spring attached to it without any base arch wire for the canine to slide on (Frictionless mechanics).Specialized pre-fabricated springs for space closure are an integral part of the frictionless mechanics. New knowledge concerning the biomechanics, spring design and the development of new materials for fabrication has improved the biological response and patient acceptance.[1]To retract a canine into its extraction site without tipping and rotation, a spring must generate not only closing force, but also moments to bring the root apices together at the extraction site and to maintain aproper rotation.[1]

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Fig 1: Ni Ti Loops.

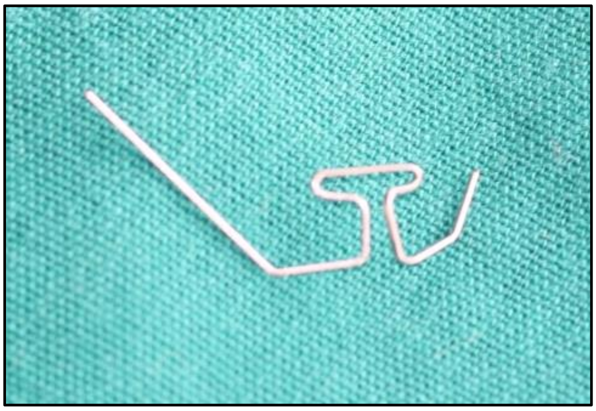


Fig 2: T Loop.

Fig 3a, 3b, 3c: T loop and Ni-Ti loop placed on the upper quadrant for retraction. Posterior segment stabilized with a 0.019" x 0.025" rectangular wire and TPA

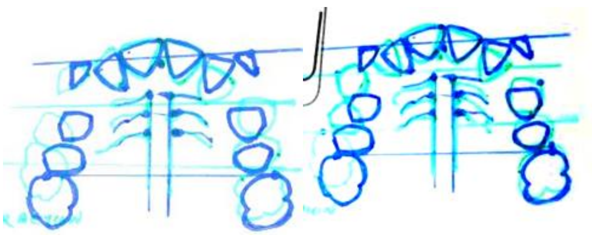


Fig 4a, 4b: Superimposition on the midrugae reference.

Of the entire retraction spring designs available, T loop is considered the most versatile.The advantage of T loop claimed by many authors, over other retraction spring is the production of a higher M/F ratio, low load deflection rate and expression of

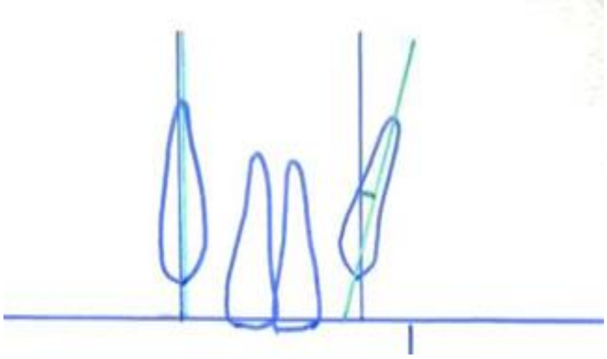


Fig 5: Pretreatment OPG tracing.

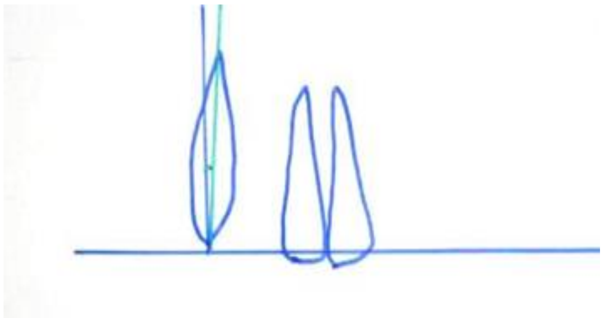


Fig 6: OPG tracing after T loop retraction.

Table 1: Points Identified on the Study Model for Measurement

Cn	Tip of the canine on which Ni-Ti loop is placed (pre-treatment).
Ct	Tip of the canine on which T loop is placed (pre-treatment).
Cn'	Tip of the canine on which Ni-Ti loop is placed (post-retraction).
Ct'	Tip of the canine on which T loop is placed (post-retraction).
Mn	Molar mesial point on the side where Ni- Ti loop is placed (pre-treatment).
Mt	Molar mesial point on the side where T loop is placed (pre-treatment).
Mn'	Molar mesial point on the side where Ni- Ti loop is placed (post-retraction).
Mt'	Molar mesial point on the side where T loop is placed (post-retraction).
R1M	Right first rugae medial point.
R2M	Right second rugae medial point.
R3M	Right third rugae medial point.
L1M	Left first rugae medial point.
L2M	Left second rugae medial point.
L3M	Left third rugae medial point.

Table 2: Pre and post retraction linear and angular measurements.

Linear measurements	**Angular measurements**
Cn-Cn'	Tip value of the canine at T0,T1,T2
Ct-Ct'	
Mn-Mn'	
Mt-Mt'	

constant level of force.[2]Yasoo Watanabe and Keisuke Miyamoto developed the Nickel Titanium canine retraction spring in .According to the author Ni-Ti retraction spring has the advantages of quick retraction rate, continuous forces and less frequency of activation.[2]

No studies have been done to assess the efficiency of these springs. It was our interest to compare the effectiveness of both these springs, T loop being the commonly used spring and Ni-Ti since it is relatively new and made from a material which is used widely in orthodontics because of its properties.

The aim of this study is to compare the efficiency of two different types of loops used for canine retraction namely, the T loop and the Ni-Ti retraction spring.

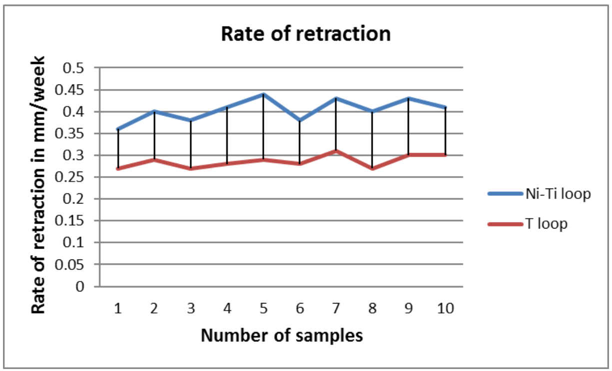
Table 3: Pre and Post retraction values with Ni-Ti and T loop retraction.

		Mean	Std. Deviation
Time taken for Ni-Ti and T loop retraction	Ni-Ti loop	13.7000 weeks	5.49848
	T loop	18.9000 weeks	4.93176
Anchorage loss for Ni-Ti and T loop retraction	Ni-Ti loop	2.0000 mm	.81650
	T loop	1.5000 mm	.52705
Rate of retraction with Ni-Ti and T loop	Ni-Ti loop	.4040 mm/week	.02547
	T loop	.2860mm/week	.01430
Amount of canine tipping with Ni-Ti and T loop retraction	Ni-Ti loop	-5.7000 degree	2.79086
	T loop	-9.8500 degree	4.95003
Rate of canine tipping with Ni-Ti and T loop	Ni-Ti loop	.4210 degree/week	.18126
	T loop	.5010 degree/week	.19913

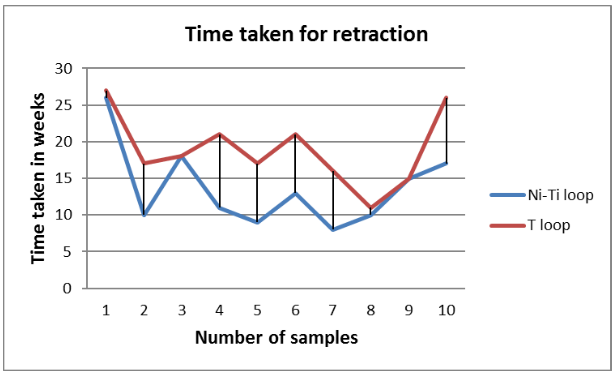
MATERIALS AND METHODS

The sample size consisted of 10 patients in which T loop and Ni-Ti loop were placed in the maxillary arch for canine retraction and the efficiency of both determined. Ethical clearance was obtained from the ethical clearance committee working in the institution prior to the start of the clinical study. The inclusion criteria included patients withcanines in the same position with respect to the midline on the upper arch, patient with generalized crowding in the upper arch and patient on which extraction of the upper first premolar were indicated for space gaining. We excluded patients with impacted canines, cleft palate cases and patients who had gross difference in the position of canines on the upper arch.

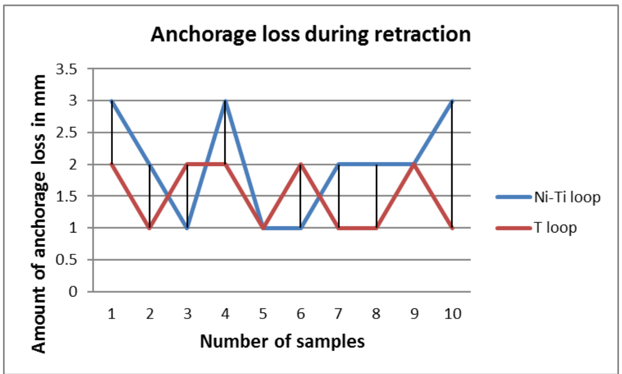
In the present clinical study all the patients were treated with preadjusted edgewise fixed appliance mechanotherapy with 0.022" slot (MBT prescription). A modified Nickel Titanium spring made with 0.016" x 0.022" Ni-Ti wire and T loop made with 0.016" x 0 .022" TMA wire (Fig.1, Fig.2) according to the recommendations of the author was made and placed on canine on each of the quadrants of upper arch in the same patient.[2] A Transpalatal arch (TPA), was inserted to prevent the rotation of the molars and also to know the exact amount of canine distalization (Fig.3). All the cases were supplemented by study models and OPG taken prior to the placement of the spring and on finishing of canine retraction in each of the quadrants. All radiographs were taken with Sirona Orthophos xg5 radiographic machine using standardized protocols and printed out using Konica, Minolta dry pro Model no. 832. Impressions were made with alginate impression material and



Graph 1: Comparison of rate of retraction for Ni-Ti and T loop.



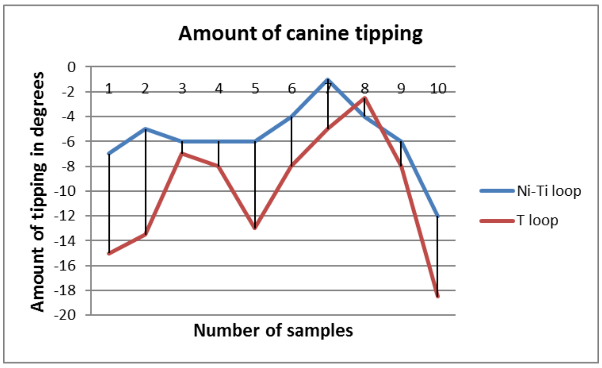
Graph 2: Comparison of time taken for Ni-Ti and T loop retraction.



Graph 3: Comparison of anchorage loss values for Ni-TI and T loop retraction.

the cast was poured with Orthokal (Orthodontic dental stone Type – III).

Prior to the placement of the spring, the posterior segments (molars and the premolars) were aligned with a 0.017” x 0.025” rectangular Ni-Ti wire and stabilized with a 0.019” x 0.025” rectangular stainless steel wire. The spring was



Graph 4: Comparison of amount of canine tipping for Ni-Ti and T loop.

delivered on the same day as the posterior segments were stabilized with a rectangular wire and TPA.The T loop was fabricated and placed on one of the canines in the maxillary segment, centered on the extraction space (Fig.3) The posterior segment was inserted to the auxiliary tube of the upper molars. Proper pre-activation and anti-rotation bends were placed on the spring to enhance anchorage control and prevent tooth rotation to the extraction space.The Ni-Ti loop was fabricated with the help of a Ni-Ti bender as per the recommendation of the author.[2] The anterior segment of the loop was inserted onto the contralateral canine and the posterior segment was inserted to the auxiliary molar tube.

Initially patients were recalled after 2 weeks and then after every 4 weeks interval and the progress was recorded. The springs were not activated on delivery and 2mm activation was made after 2 weeks. On every subsequent visit both the springs were activated uniformly by 2mm. The patients were frequently monitored till the retraction of canines on both the quadrants were completed. On completion of retraction a new set of study models and OPG were made.

Reference points were identified on the pre and post retraction cast for easy measurement (Table 1) The pre and the post retraction changes including the rate of canine retraction and the anchor loss was measured directly from study cast taken at T0, T1, T2. The palatal rugae was taken as a standard for all pre and post retraction models[3,4,5]. An occlusogram was made on the cast with the help of an acetate paper for T0, T1, T2 and points were identified for measurement. The occlusogram was superimposed on the mid palatal rugae for comparison (Fig.4). The amount of retraction and the anchor loss were directly recorded from the occlusogram and analyzed for each of the springs. The rate of canine retraction was calculated by dividing the amount of canine retraction and the time taken for complete canine retraction.

The amount of tipping was measured from the OPG taken at T0, T1, and T2 (Fig.5, Fig.6,Fig.7). A line tangent to the most superior part of the condylar head was taken as a standard for all OPG measurements. This line was drawn down to the lower premolars and molars and was taken as a reference line. The long axis of the canine and the reference line was traced onto an acetate sheet. The angle made by the long axis of canine and the reference line was noted in T0, T1, and T2, by measuring it directly from the tracing and was analysed.

The statistical methods used for the study were descriptive statistics and independent sample t test.All the statistical methods were carried out through the SPSS for Windows (version 16.0).

RESULTS

The measurements were made directly from the study models by superimposing the occlusograms at the palatal rugae. The tip value of the canine was measured from the OPG.Three linear and one angular measurement were made (Table 2). After calculation of the linear and angular measurements the rate of canine retraction and the rate of tipping were measured by dividing the total time taken for retraction of the individual canine.

As summarized in Table 3 the mean rate of retraction in Ni-Ti group was 0.4040 (+/- 0.02547) mm/week, whereas in the T loop it was 0.2860(+/- 0.01430) mm/week. These values were clinically and statistically significant with a t value of 12.774(P = 0.000) (Graph 1).Mean time of canine retraction with the Ni-Ti loop was 13.7000(+/- 5.49848) weeks, whereas the T loop retraction time was 18.9000(+/- 4.93176) weeks(Graph 2).In contrast the anchorage loss was seen greater with a Ni-Ti spring, showing a mean value of 2.0000(+/- 0.81650) mm, whereas in the T loop it was 1.5000(+/-0.52705)mm. These values were not significant on statistical testing with a t value of 1.627(P = 0.121) (Graph 3). It was also observed from that the mean rate of tipping in Ni-Ti group was 0.4210 (+/- 0.18126) degrees/week, whereas in the T loop it was 0.5010(+/- 0.19913) degrees/week. (P = 0.360) (Graph 4).

The results for the study were as follows:

1. Ni-Ti loop showed increased rate of canine retraction when compared to the T loop which was clinically and statistically significant.

2. T loop showed more anchorage control than the Ni-Ti loop although the difference was not statistically significant.

3. The rate and the amount of canine tipping was more with the T loop when compared to the Ni-Ti loop, equal amount of canine rotation was observed for both the loops.

DISCUSSION

In our study we evaluated 10 individuals, who underwent extraction of their upper first premolars for orthodontic purpose. The Ni-Ti and T loop were fabricated with 016” x 0.22” Ni-Ti and TMA wires respectively. The wire dimension and the activation of the spring were kept constant to minimize errors caused by unequal force levels. The upper canine was ligated with a 0.010” steel ligature wire to counter any effect of rotation. The preactivation bends on each of the loops were kept constant as per recommendations by the authors so as to avoid any error caused by unequal alpha and beta moment. The posterior segment was stabilized with the help of a 0.019” x 0.025” stainless steel wire and a transpalatal arch, which minimized the amount of anchorage loss and also prevented the rotation of the molars.

In this study the measurements weredirectly made from the dental cast and OPG and compared. Many studies are made on the accuracy of palatal rugae as a stable landmark for cast studies.[3, 4, 5] All these studies have concluded that anteroposterior molar and incisor movement can be assessed as accurately with dental cast as with maxillary occlusal superimposition or any other comparisons methods. According to many authors the medial end of the third palatal rugae is a suitable landmark for serial model analysis of molars and incisors,[5] in this study we have taken the medial end of the first, second and third palatal rugae for maintaining the accuracy of superimpositions. Tip value of each canine, pre and post retraction was measured from the OPG. The accuracy of the measurement was maintained by keeping the standard reference occlusal plane for all measurements.

Uniformity was noted in the rate of retraction with both Ni-Ti and T loop cases with Ni-Ti showing a minimum rate of retraction of 0.36mm/week and a maximum rate of retraction of 0.44mm/week, whereas the T loop showed a minimum rate of retraction of 0.27mm/week and a maximum rate of 0.31mm/week. The possible reasons for the improved performance of a Ni-Ti retraction spring[6] may be due to

1. Light continuous force exerted by the Ni-Ti loop
2. Super elasticity and shape memory property of the Ni-Ti wire.
3. Distortion of Ni-Ti loop was less when compared to a T loop.
4. High spring back of the Ni-Ti wire.

Intra individual variation was noted in the amount of canine tipping, with one of the cases showing a total tip loss of -5 degree in the Ni-Ti side to a -13.5 degree tip loss in the T loop side. This could have arisen as a result of constant change in the center of rotation during retraction due to different moment generated by the loop design[7] .It was observed that the anchorage loss of Ni Ti loop is slightly greater than the T loop with the Mean anchorage loss of 2.0 mm in Ni-Ti loop compared to the loss of 1.5 mm in T loop. Although the preactivation bends were kept constant in both the loops, our study suggest that the beta moment in a Ni-Ti loop should be marginally increased to counter the anchorage lost during retraction.

It was also observed that there was significant rotation of the canine in both Ni-Ti and T loop during retraction stages. 120 degrees of anti-rotation bends were incorporated into both Ni-Ti and T loop, but this proved to be insufficient for the standard activation of 2 mm.[7]The rate of space closure for both the loops approximated 1 mm/month. This was in agreement with suggested rate of tooth movement.[7] The decision to use a passive stainless steel base archwire was intended to control the rotational and vertical effects of the sectional closing loops during canine retraction. Both the loops had preactivation bends which in theory would enhance the tendency towards bodily movement and thus reduce the tendency for the bracket to bind on the base arch wire. The rate of canine retraction was clinically and statistically significant for Ni-Ti loop when compared with T loop which suggest that the promising properties of the Ni-Ti loop with its high spring back and ability to deliver a constant low force during deactivation can make it a definite substitute for the commonly used T loop[6].

It was observed that the anchorage loss of Ni Ti loop is slightly greater than the T loop .Although the preactivation bends were kept constant in both the loops, our study suggest that the beta moment in a Ni-Ti loop should be marginally increased to counter the anchorage lost during retraction. The anchorage value of the loop can be also increased by off-centre positioning of the loop ie, placing the loop closer to the posterior segment. Placing the preactivation beta bend closer to the molar also enhances the anchorage[7].

It was also observed that there was significant rotation of the canine in both Ni-Ti and T loop during retraction stages. 120 degrees of anti-rotation bends were incorporated into both Ni-Ti and T loop,[2] but this proved to be insufficient for the standard activation of 2mm.Thus the anti-rotation bend should be progressively increased from the recommended values if a rotation tendency for the canine is noted. Loop mechanics has many disadvantages including the tipping and rotation of the canines, but this can be effectively reduced by the use of improved loop designs and optimum force levels[8].

CONCLUSION

The present study was conducted to evaluate the efficiency of Ni-Ti and T loop in canine retraction. It was concluded from the study that Ni-Ti loop showed faster retraction rate than the T loop which was clinically and statistically significant. On comparing the rate of tipping it was found that there was an increased amount of tipping associated with T loop when compared to the Ni-Ti loop.T loop showed more anchorage control than the Ni-Ti loop although the difference was not statistically significant. Thus it was concluded from the study that Ni-Ti loop was better than T loop in terms of rate of retraction and the amount of tipping, but the anchorage loss was marginally better for a T loop.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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