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Original Research Article

A Comparison between Space Closure by Canine Retraction with Active Tiebacks and Closed Coil Springs: A Clinical Study with the MBT System

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ABSTRACT

Introduction: Space closure is one of the important step in MBT treatment mechanics. It can be achieved either by en masse retraction or canine retraction. The purpose of present study is to compare the rate of space closure by canine retraction between active-tie back and NiTi closed coil spring.

Materials & Methods: This study was conducted using split mouth technique in the department of orthodontics and Dento-facial Orthopaedics, Buddha Institute of Dental Sciences, Patna. It compared the difference in the rate of canine retraction between active tiebacks and Nickel Titanium coil springs. They were sub-divided into upper and lower arch and right and left segment. TPA was used in all patients to prevent anchorage loss.

Results: The rate of canine retraction was faster with Ni- Ti Closed Coil Spring compared to the Active Tieback in the first and second months. In the third month the Active Tieback showed a faster rate of canine retraction than NiTi Closed Coil Spring.

Conclusion: The average rate of canine retraction was greater in the Nickel- Titanium closed coil spring group than the Active Tieback group by 0.5 mm per month.

Key words: Canine Retraction, Active Tie Back, Nickel Titanium Coil Spring.

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INTRODUCTION

The orthodontic treatment often demands extraction of first premolars followed by fixed orthodontic therapy necessary for retraction of upper and lower anterior teeth.

There are different space closure (anterior retraction, posterior protraction, or combination) options which are available today in pre-adjusted mechanotherapy sliding mechanics for en masse retraction;[1,2] has gained a substantial popularity after the evolution of MBT philosophy. In PEA using sliding mechanics the space closure is carried out nowadays with the help of either E-chain, Ni-Ti coil closing spring, or stretched modules with ligatures.

Nickel – Titanium coil springs have been shown to produce a constant force over varying lengths and duration, with no force decay. They may be able to meet all the criteria for an ideal force delivery system.[2] In high anchorage cases, it's better to retract canines first and then go for incisors retractions. This reduces the load of anchorage unit.

Pre-adjusted fixed orthodontic appliances commonly utilize sliding mechanics for space closure with force delivery systems such as elastomeric chain, nickel titanium coil springs, elastomeric modules attached to wire ligatures, or intra-oral elastics. Synthetic elastomeric chain was introduced in the 1960s and has been in widespread use since.[3] When a polymer is stretched and the stress within it increases proportionally to the applied strain, the polymer is described as behaving elastically. In such circumstances, the unloading curve of the resultant stress/strain graph is identical to the loading curve.[4] However, when elastomeric chain is stretched, it does not behave as a perfectly elastic material, because it loses energy and its unloading curve demonstrates less stress for a given stretch compared to the loading curve. This is called a hysteresis curve and is important because it is the unloading curve that is of interest to orthodontists. Indeed, it is well known that elastomeric systems lose force during the duration of their use. This is thought to be due to a combination of water causing the weakening of intermolecular forces and chemical degradation, and tooth movement resulting in decreasing stretch placed upon the elastomeric chain.[5] However, most investigations have been performed under laboratory conditions, which cannot simulate the oral environment. It is not known how much force remains in a length of elastomeric chain at the end of its clinical use or for how long it may remain active. While stainless steel coil springs have been in use since the 1930s, nickel titanium (NiTi) coil springs were introduced more recently. Increasingly, nickel titanium coil springs are used for space closure as they are thought to retain more force over a given time period and also provide a constant force. This may be a more effective tooth moving force than that provided by elastomeric chain. Certainly previous studies have concluded that nickel titanium coil springs are more effective in space closure than either elastomeric modules or intra-oral elastics, although no statistically significant difference has been found between the rate of space closure with elastomeric chain or nickel titanium coil springs. Force delivery from nickel titanium coil springs has been found to vary in response to the amount of activation and temperature. The composition of nickel titanium wires has been found to vary within batches, which has produced variable forces from custom made springs and this may account for batch variation found also within coil springs. Despite their potential superiority, nickel titanium coil springs remain relatively expensive and elastomeric chain remains popular in clinical practice.

In severe crowding cases until, the canines have been distalized to relive the crowding, space to correctly align the incisors will not be available. Correct positioning of the canines after retraction is of great importance for the function, stability, and esthetics.

Canines can be retracted in two ways:[5]

1. Frictional (sliding) mechanics.
2. Non-frictional (non-sliding) mechanics.

Frictional mechanics is the sliding of a tooth along an arch wire by application of force. Non-frictional mechanics uses loops for tooth movement (non-sliding). Canines can be retracted individually or can be retracted along with the incisors. Retraction of the canines along with the anterior teeth as one unit is known as an en masse retraction. Both techniques depend on the type of malocclusion and operator's skill and preference. To date, several studies have been published concerning different techniques of canine retraction with the aspect of the application, mechanics, or effectiveness.

AIMS & OBJECTIVES

1. To compare the rate of canine retraction between Ni-Ti closed coil spring and active tieback.
2. To compare the rate of space closure between vertical grower and average grower and between upper and lower arch and right and left segment.

MATERIALS & METHODS

This study was conducted using split mouth technique in the department of orthodontics and Dento-facial Orthopaedics, Buddha Institute of Dental Sciences, Patna. It compared the difference in the rate of canine retraction between active tiebacks and Nickel Titanium coil springs. They were sub-divided into upper and lower arch and right and left segment. TPA was used in all patients to prevent anchorage loss.

The purpose and methodology of the study was explained to the subjects and written consent was taken. 15 patients satisfying the above criteria were selected irrespective of their sex. The treatment plan included bilateral extraction of the first premolars with maximum anchorage and fixed mechanotherapy using an MBT prescription. Initial leveling and aligning was carried out and 0.019"×0.025" stainless steel archwire was left in place for at least 4 weeks. After which, canine retraction was carried out using Active tiebacks and Nickel titanium closed coil springs. A split mouth study design was used in which Active tiebacks and Nickel titanium closed springs was affixed in opposing quadrants to achieve canine retraction; type I active tie back was used with module (GAC) attached to the molar hook and ligature attached to canine hook (fig: 1). The elastic module was changed once in a month and was stretched twice its diameter before being ligated.

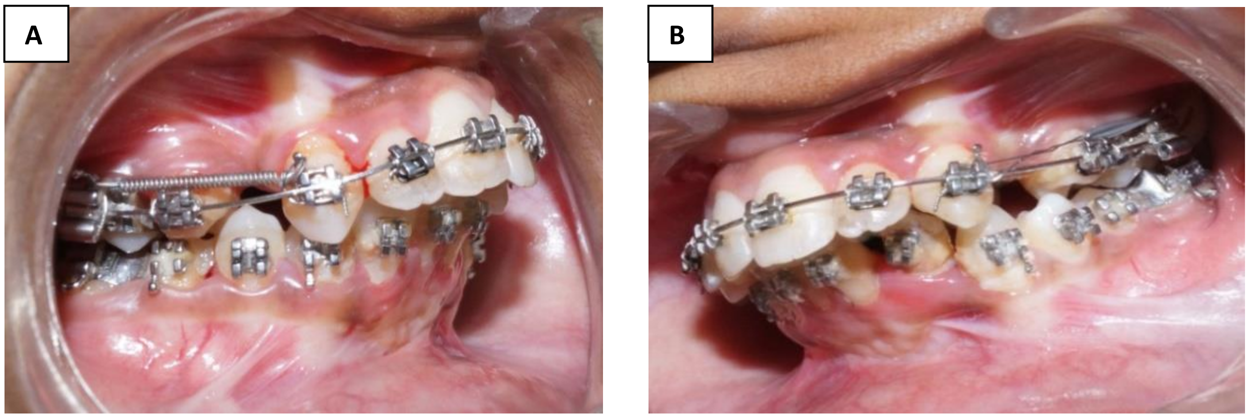


Fig 1: (A) Nickel Titanium Coil Spring. (B) Active Tieback

A total of 30 test quadrants were created for closure of first premolar extraction spaces in both arches. The quadrants were allocated into two groups for treatment. The quadrants was affixed with Nickel titanium closed coil spring and with Active tie back one on each side of the patient randomly.

The NiTi closed coil spring No. 302 nine millimeters in length (manufactured by GAC, Neo-Sentalloy) is used. It exerts a force delivery of 150 grams, when stretched up to 21 mm, which is deemed ideal for canine retraction. The Tooth movement was determined by means of direct measurement from the cusp tip of the canine to the mesiobuccal cusp tip of the 1st molar (fig: 3) with Vernier Calipers with 0.02 mm accuracy (fig: 2), after the initial alignment of the teeth.

Each measurement was taken three times, and the mean of the three were recorded. The subjects were recalled at a time interval of 4 weeks and measurements were taken until the canine was retracted. All the different measurements at each monthly interval were tabulated and compared for the two different force delivery systems. Then they were subjected to standard accepted statistical analysis.

Fig 2:Vernier Calliper

Fig 3:Measurement from cuspal tip of mesiobuccal cusp of permanent first molar to cuspal tip of permanent canine

Table 1: Rate of canine retraction

	N	Mean	Std. Deviation	Minimum	Maximum
NiTi Closed Coil Spring					
Active Tieback	30	1.61	0.32	1.05	2.65

Table 2: Comparison of monthly rate of canine retraction between NiTi closed coil spring and Active Tieback

Month		Mean	N	Std. Deviation	Mean Difference	t-value	p-value
T1	**NiTi closed coil spring (mm)**	2.114	15	0.1266	-0.0179	-0.932	0.367
	Active tie back (mm)	2.132	15	0.1289			
T2	**NiTi closed coil spring (mm)**	1.990	15	0.1373	-0.0574	-2.426	0.029
	Active tie back (mm)	2.047	15	0.1196			
T3	**NiTi closed coil spring (mm)**	1.878	15	0.1335	-0.0697	-3.434	0.004
	Active tie back (mm)	1.948	15	0.1113			
T4	**NiTi closed coil spring (mm)**	1.756	15	0.1326	-0.0793	-5.249	<0.001
	Active tie back (mm)	1.835	15	0.1076			
T5	**NiTi closed coil spring (mm)**	1.640	15	0.1176	-0.0773	-7.592	<0.001
	Active tie back (mm)	1.717	15	0.1087			
T6	**NiTi closed coil spring (mm)**	1.519	15	0.0970	-0.0848	-5.998	<0.001
	Active tie back (mm)	1.604	15	0.1192			
T7	**NiTi closed coil spring (mm)**	1.446	13	0.0622	-0.1029	-6.037	<0.001
	Active tie back (mm)	1.549	13	0.1041			
T8	**NiTi closed coil spring (mm)**	1.427	10	0.0503	-0.0506	-4.231	0.002
	Active tie back (mm)	1.477	10	0.0791			
T9	**NiTi closed coil spring (mm)**	1.524	1	-	-	NA	NA
	Active tie back (mm)	1.500	1	-			

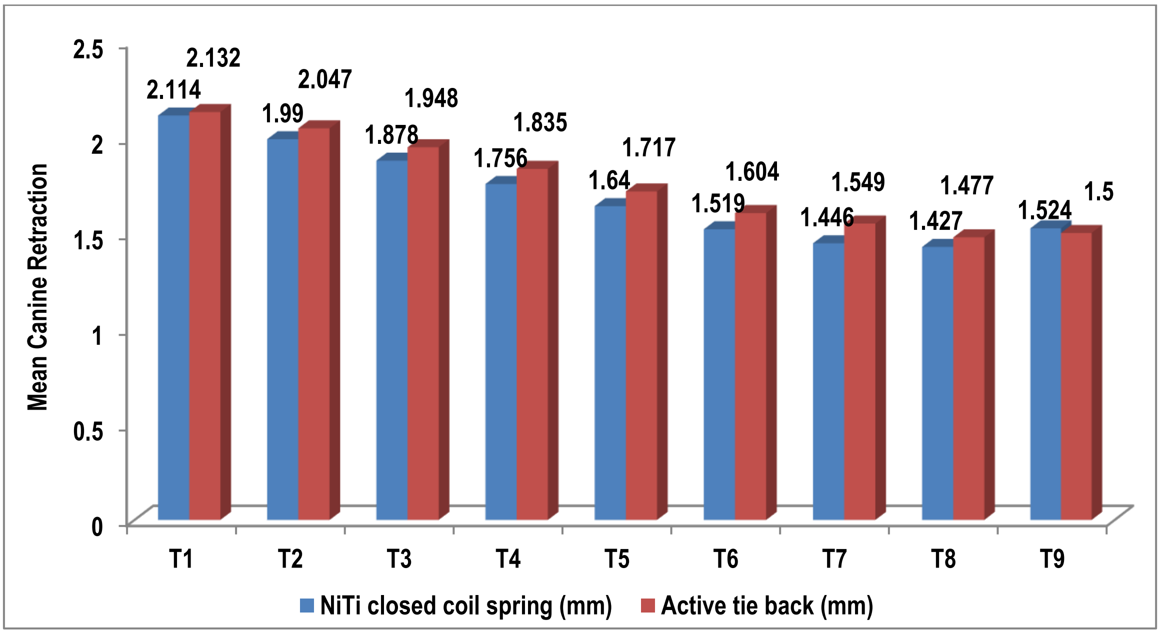
RESULTS

Comparison of Average rate of canine retraction between Nickel-Titanium closed coil spring and Active Tieback. (Table 1)

The rate of canine retraction for Nickel-Titanium Closed Coil Spring and Active Tieback was 2.304 mm and 1.804 mm per month respectively. The average rate of canine retraction was greater in the Nickel- Titanium closed coil spring group than the Active Tieback group by 0.5 mm per month. This difference was statically significant with a ‘p’ value of < 0.001.

The rate of canine retraction for Nickel-Titanium Closed Coil Spring was 2.14 mm, 1.99 mm and 1.87 mm at the end of first, second and third months respectively. In all the quadrants (except one) in the Nickel-Titanium Closed Coil Spring group the canine retraction was complete by the end of the third month. The rate of canine retraction for the Active Tieback was 2.13 mm, 2.047 mm, 1.948 mm, 1.83 mm and 1.717 mm at the end of first, second, third, fourth and fifth months respectively. This indicates that the rate of canine retraction was faster with Ni- Ti Closed Coil Spring compared to the Active Tieback in the first and second months. In the third month the Active Tieback showed a faster rate of canine retraction than NiTi Closed Coil Spring. This may be due to the fact that the elastic module of the active tieback was changed every month, whereas the NiTi closed coil springs were not changed. Month wise comparison of the rate of canine retraction between Nickel-Titanium Closed Coil Spring and Active Tieback showed that in the first month the rate was 2.14 mm and 2.04 mm for Nickel- Titanium Closed Coil Spring and Active Tieback respectively. This indicates that the rate of canine retraction was faster in the Nickel-Titanium Closed Coil Spring group compared to the Active Tieback group in the first month. This difference in the rate of canine retraction for the first month was statistically significant ($p < 0.001$). In the second month the rate of canine retraction was 1.99 mm and 1.94 mm for Nickel Titanium Closed Coil Spring and Active Tieback respectively. This indicates that the canine retraction was marginally faster in the Nickel Titanium Closed Coil Spring group compared to the Active Tieback group in the second month. But this difference in the rate was not statistically significant. In the third month the rate of canine retraction was 1.878 mm and 1.948 mm for Nickel Titanium Closed Coil Spring and Active Tieback respectively.

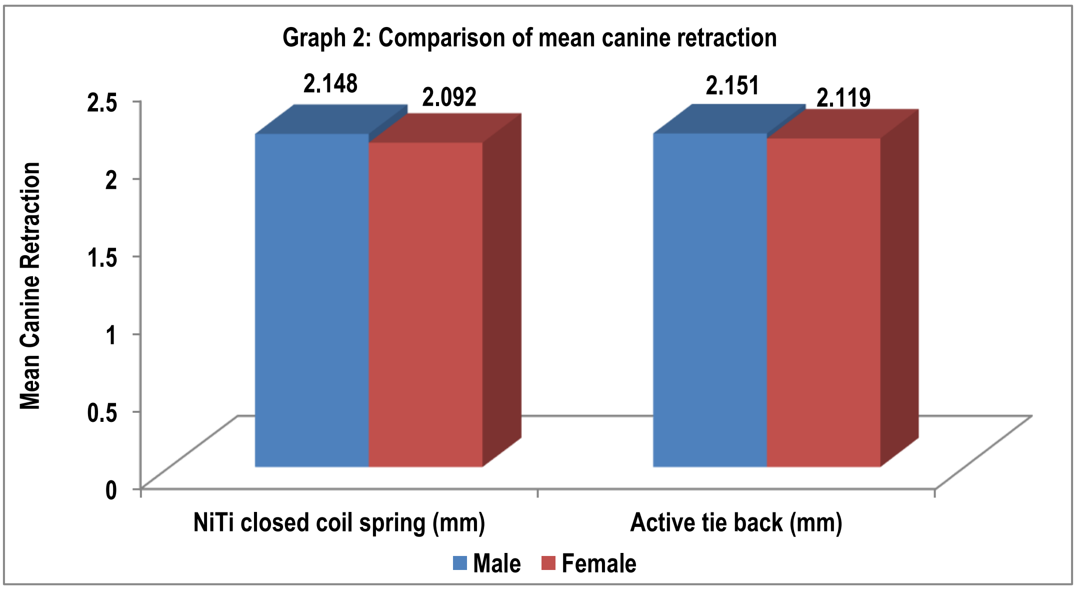
This indicates that the rate of canine retraction was faster in the Active Tieback group compared to the Nickel Titanium Closed Coil Spring group in the third month. This difference in the rate of canine retraction for the third month was statistically significant ($p < 0.05$)



Graph 1: Comparison of monthly rate of canine retraction b/w NiTi closed coil spring and Active Tieback

Table 3: Independent T-Test results

	Sex	N	Mean	Std. Deviation	t-value	p-value
NiTi closed coil spring (mm)	**Male**	6	2.148	0.140	0.825	0.424
	Female	9	2.092	0.120		
Active tie back (mm)	**Male**	6	2.151	0.119	0.456	0.656
	Female	9	2.119	0.141		



DISCUSSION

It has been suggested that forces of approximately 150 gm may be the ideal physiologic force for bodily movement of canines in humans. The results of previous studies anticipated that the 200 gm springs might produce faster space closure than the 150 gram springs. A study by manhartsberger and seidenbusch which investigated the properties of open and closed Sentalloy springs, found that there was little difference between the force delivery curves for the 150 and 200 gm closed coil springs when stretched between 1 and 10 mm .

According to the review done by kulshresthra et.al in 2015 different types of forces are applied within the same archwire, it is believed the arch wire may twist under the influence[6], this might affect the results of rate of retraction in these studies. In such trials, it is difficult to keep the variables of individual response, fluctuation of oral environment, lapses between appointments, precise and repeatable method of measurement of the rate of canine retraction, the force systems, could not be compared accurately.[7] Some believe that the varied response to different methods of canine retraction was not dependent on the type of force; rather it was due to individual metabolic response.[7] Sample size generally applied for these clinical trials was considered conclusive in a few researches.[8] A range of 100-200 g is suggested sufficient by Quinn and Yoshikawa[9] and this was the force range observed in the review. It is not the magnitude of force applied rather its duration that is considered important for good biologic tooth response. Light continuous force up to a threshold can provide an optimum force.[10] High initial forces did not achieve greater space closure but resulted in the greater percentage of force decay. NiTi coil springs are believed to provide this constant force[4], however, one study contradicted this. In sliding mechanics, the force of friction is encountered, which tends to reduce the force available eventually for effective tooth movement. The data so far reviewed proved that elastomeric power chains, elastic threads, magnets, NiTi coil springs, corticotomies[11], distraction osteogenesis[12] and laser therapy all are able to provide optimum rate of tooth movements. All the methods were nearly similar to each other for retraction of canines.

Different measurement methods were used to analyze the retraction, which caused difficulties in comparing the results of the studies. From a methodological point of view, it was notable that only 2 of the 22 studies declared the use of blinding in measurements. It is known that nonrandomized trials or RCT without blinding design are more likely to show the advantage an innovation has over a standard treatment method.[12] This implies that the measurement can be affected by the researcher. An RCT is our most powerful tool to evaluate therapy, and the quality of the trial significantly affects the validity of the conclusions.

Similarly, Samuels et.al (AJO-DO JULY 1998) have anticipated that the 200 gram springs produce a faster space closure than the 150 gram springs. Studies by Manhartsberger and Seidenbusch[12], investigated the properties of open and closed sentalloy springs and found that there is little difference between the force delivery curves for 150 and 200 gram closed coil springs when stretched between the 1and 10 mm. A greater difference appeared to exists, between the 100 and 150 gram springs. The Sentalloy nickel – titanium closed coil springs appear to provide light continuous forces and have superelastic properties, but the clinician needs to be aware that some variation will exist in the force provided by same batch of springs. The medium (150 gm) and heavy (200 gm) springs give a more consistent and faster rate of space closure than the elastic modules or the light (100 gm) spring.

Smillarly Samuels et.al also anticipated grater rate of closure of premolar extraction spaces by super-elastic nickel-titanium coil springs were more linear compared with an elastic modules indicating the rate of space closure was more consistent than with the modules where it decreased with time.

In another study by Andrew L. Sonis comparing elastics vs NiTi coil springs for canine retraction, nickel titanium produced nearly twice as rapid a rate of tooth movement as conventional elastics rated at about the same force level. This discrepancy is probable due to two factors: the ability of the springs to maintain a relatively constant force level compared to the elastics, and the elimination of the need for patient cooperation. A recent study comparing nickel titanium coil springs with elastic modules in space closure was able to eliminate patient cooperation as a variable, and the nickel titanium springs still produced significantly higher closure rates.[13]

Padmaraj V. Angolkar et al designed an in vitro study to determine the force degradation of closed coil springs made of stainless steel, cobalt-chromium-nickel and nickel-titanium alloys, when they were extended to generate an initial force value in the range of 150 to 160 gm. The results of the study indicated that all springs lost force over time to varying degrees. Most of the springs showed a major force reduction in the first 24 hours to 3 days. After that there was gradual but small force decay until 21 days. Between 21 and 28 days, a sharp increase in force loss was noted in most of the springs.

CONCLUSION

1. Sentalloy nickel-titanium closed coil springs produce more consistent space closure than active tie backs.
2. 150-200 gram springs produce a faster rate of canine retraction.

The particular property of super – elastic nickel titanium in producing a light continuous force over a long range of action, compared with previously available materials, has been well documented. The possibility that a nickel – titanium closed coil spring, with a continuous action, might have some advantages in fixed appliance space closure mechanics was investigated and compared with a currently used elastic retraction module, providing an intermittent force. However, concern has previously been expressed that excessively rapid space closure may also lead to unwanted effects, such as loss of tooth control and blanching of soft tissues in the extraction site, with the consequent reopening of the space later.

REFERENCES

1. The Active- Tieback group showed a greater number of quadrants with favorable parallelism, as Dixon V, Read MJ, O'Brien KD, Worthington HV, Mandall NA. A randomized clinical trial to compare three methods of orthodontic space closure. J Orthod. 2002 Mar; 29(1):31-6.

2. Nightingale C, Jones SP. A clinical investigation of force delivery systems for orthodontic space closure. J Orthod. 2003 Sep; 30(3):229-36.

3. Sonis AL. Comparison of NiTi coil springs vs. elastics in canine retraction. J Clin Orthod. 1994 May; 28(5):293-5.

4. Padmaraj V. Anglokar, Janet V. Arnold, Ram S. Nanda and Manvilla G. Duncanson Jr. Force degradation of closed coil springs: An in vitro evaluation Am J Orthod Dentofacial Orthop, 1992; 102: 127-33.
5. Samuels RH, Rudge SJ, Mair LH. A clinical study of space closure with nickel-titanium closed coil springs and an elastic module. Am J Orthod Dentofacial Orthop. 1998 Jul; 114(1):73-9.
6.Richard P Mclaughlin, John C Bennet, HugoTrevisi 2002, Systemised Orthodontic treatment mechanics, Mosby, London.
7. Watanabe Y, Miyamoto K. A nickel titanium canine retraction spring. J Clin Orthod. 2002 Jul; 36(7):384-8.
8. Mayoral .G Treatment results with light wires studied by panoramic radiography. Am J Orthod. 1982 Jun; 489-497.
9. Wong AK. Orthodontic elastic materials. Angle Orthod. 1976 Apr; 46(2):196-205.
10. Webb RI, Caputo AA, Chaconas SJ. Orthodontic force production by closed coil springs. Am J Orthod. 1978 Oct; 74(4):405-9.
11. Miura F, Mogi M, Ohura Y, Karibe M. The super-elastic Japanese NiTi alloy wire for use in orthodontics. Part III. Studies on the Japanese NiTi alloy coil springs. Am J Orthod Dentofacial Orthop. 1988 Aug; 94(2):89-96.
12. Boshart BF, Currier GF, Nanda RS, Duncanson MG Jr. Load-deflection rate measurements of activated open and closed coil springs. Angle Orthod. 1990 Spring; 60(1):27-32.
13. Von Fraunhofer JA, Bonds PW, Johnson BE. Force generation by orthodontic coil springs. Angle Orthod. 1993; 63(2):145-8.
14. Samuels RH, Rudge SJ, Mair LH. A comparison of the rate of space closure using a nickel-titanium spring and an elastic module: a clinical study. Am J Orthod Dentofacial Orthop. 1993 May; 103(5):464-7.
15. Han S, Quick DC. Nickel-titanium spring properties in a simulated oral environment. AngleOrthod.1993Spring;63(1):67-72.

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