A comparative evaluation of rate of retraction and anchorage loss using nickel titanium closed coil spring and active tiebacks during the en-mass retraction in mandibular arch - an in-vivo study

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Abstract

Objective: To compare clinical effectiveness of Nickel Titanium (Ni-Ti) closed coil spring and active tiebacks during space closure in mandibular arch. To compare rate of anterior retraction by using Ni-Ti closed coil spring and active tiebacks in mandibular arch. To compare amount of anchor loss in mandibular arch with Ni-Ti closed coil spring and active tiebacks.

Materials and Methods: A total of 20 patients with Class 1 bimaxillary proclination undergoing fixed orthontic treatment (MBT 0.022 slot) after first premolar extraction will be randomly selected from depatment of Orthodontics & Dentofacial Orthopaedics of K.D. Dental college, and will be divided into two groups for space closure. Patient will be informed about treatment and thesis procedure and consent regarding was taken. The space closure mechanics was allocated to the left or right side of same arch wire in each patient.

Group 1 consisted of 10 patients in which right quadrant of maxillary arch, the space closure was done by Ni-Ti closed coil springs in 10 patients and by active ligature on left quadrant of the same 10 patients.

Group 2 consisted of same 10 patients in which left quadrant of same arch, the space closure will be done by active ligature in 10 patients and by Ni-Ti closed coil springs on right quadrant of same 10 patients.

The amount of anterior retraction, anchorage loss and rate of space closure was measured before start of retraction and patients will be called at six week interval for evaluation of retraction rate as T0, T1, T2, T3,T4. Results will be assessed on cast and Lateral Cephalogram were repeated at T4 for evaluation of anchorage loss.

Result: Rate of anterior retraction and amount of anchorage loss was found to be slightly more with niti closed coil spring as compared to that of active tie back.

Conclusion: NiTi closed coil springs achieved faster space closure as compared to the active tieback and significant amount of anchorage loss was also noted with NiTi closed coil when compared with active tieback.

Keywords: Rate of Retraction, Anchorage Loss, Nickel Titanium Closed coil spring , Active tie backs, Mandibular arch.

Introduction

Anchorage is the nature and degree of resistance to displacement offered by an anatomic unit when used for the purpose of effecting tooth movement and Anchorage Loss (AL) is a reciprocal reaction that could obstruct the success of orthodontic treatment.

Among the three stages of comprehensive fixed orthodontic treatment, the second stage i.e. space closure[3] is one of the most challenging aspects as it aims to correct the molar and buccal segment relationships to provide normal occlusion, close extraction spaces, and correct excessive or negative overjet. Previous studies[7] specifically considered the relationship between the rate of tooth movement and applied magnitudes of force in humans. Some studies[8-9] stated that super elastic NiTi coil springs resulted in a significantly greater and more consistent rate of space closure than elastic modules.

Materials and Methods

The present study was undertaken at the Department of Orthodontics and Dentofacial Orthopaedics, K.D. Dental College, Mathura. This study was conducted on 20 participants to evaluate Rate of Retraction and Anchorage loss using Nickel-Titanium Closed Coil Spring And Active tiebacks during theen masse retraction in mandibular arch.

Inclusion Criteria

1. Patient undergoing fixed Orthodontic treatment having Class I bimaxillary protrusion with all four first premolar extraction treatment protocol.
2. The patient had normal soft tissues.
3. The patients were nonsmoking.
4. No current use of alcohol or illicit drugs.
5. No history of recurrent mouth ulcers.
6. No diagnosed systemic diseases.
7. No current or past history of chemotherapy or radiation.
8. Initial levelling and alignment stage had been completed.

Informed consents were acquired from each and every patient interested and involved has to be taken.

Materials used

1. Ring (3M Unitek, USA)
2. NiTi Closed Coil Spring (G&H Wire Orthodontics (Franklin, IN, USA)
3. Vernier Calliper.
4. Crimpable hooks
5. 0.019 X 0.025 SS WIRE
6. Jigs made up of 0.017 X 0.025 SS WIRE

Method

This study was conducted to evaluate the clinical effectiveness of NiTi closed coil springs of G&H Wire Orthodontics (Franklin, IN, USA) and active ligature of 3M Unitek (USA), on rate of space closure in terms of en-mass retraction and anchore loss in mandibular arch.

Space closure was carried out on 0.019 x 0.025 -inch stainless steel arch wires. with anchorage balance between the six anterior teeth against the second premolar and first molar. Space closure involved both incisor retraction and molar protraction, to varying degrees, in all patients with anchorage balance controlled by anterior torque adjustments in the arch wire.

After the initial leveling and alignment (Figure 1) with round NiTi wires upto rectangular SS wire i.e 0.019×0.025 SS. with crimpable hook of 8 mm in height distal to lateral incisors on 0.019×0.025 SS wire was placed , and was left for 4 weeks in all subjects for space closure.

Fig. 1: Intra oral pictures after Leveling and alignment has been finished

The space closure mechanics were allocated to the left or right side of same arch wire in each patient by random selection, to achieve within patient control.

Patients were randomly divided into two groups:-

Group A consisted of 20 patients, in whom any one quadrant of mandibular arch space closure was done with Ni-Ti closed coil springs.

Group B consisted of same 20 patients in whom other quadrant of same arch space closure was done with active tiebacks (O-ring with 0.010" ss ligature wire.

Fig. 2: NiTi Closed Coil Spring for (Group-A)

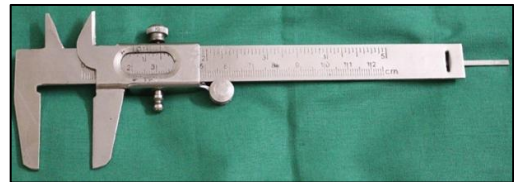**Fig. 3:** O-Ring for (Group-B)

Fig. 4: Vernier Calliper used for the study

Fig. 5: Crimpable Hooks used for the study

Fig. 6: Intra oral pictures with Niti Closed coil spring and Active Ligature in place at T0

After 4 weeks en-masse the retraction (Figure 7) was carried out in both the groups.In 20 patients belonging to group 1 retraction was done using a NiTi closed coil springs of 9 mm in length (G & H NiTi closed coil springs with eyelets, USA). The springs were not stretched to more than 12 mm (as suggested by Manhartsberger and Seidenbusch).

In 20 patients belonging to group 2, retraction was done with active tiebacks (O-ring(3M Unitek, USA) with 0.010" ss ligature wire); which was placed from the first molar hook to the crimpable hook welded on the archwire. The active tiebacks was prestretched to approximately twice its resting length to reduce the force decay[18] and changed at each subsequent visit.

Fig. 7: Intra oral pictures with Niti Closed coil spring and Active Ligature in place at T4 (After 4 months of retraction)

Assessment of outcomes

The amount of anterior retraction, anchorage loss and rate of space closure were measured before start of retraction and patients were called at six week interval for evaluation of retraction rate as T0, T1, T2, T3, T4. Results were assessed on cast and Lateral Cephalogram was repeated at T4 for evaluation of anchorage loss.

In all four visits measurements were taken with the help of verniercalipers and clinical photographs were taken (Figure 8).

Space closure was assessed by measuring the study models the distance from the cusp tip of the mandibular canine to the mesiobuccal groove of the first mandibular molar on both sides with the Vernier Calliper.
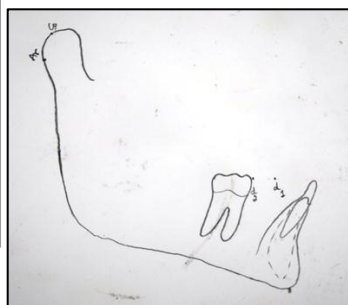

Fig. 8: Measurement of space on study model

Measurement of anchorage loss were by tracing a cephalogram taken just before the commencement of space closure (T0) (Figure 10) and after 4 months of space closure (T4) (Figure 11).

Fig. 11: Cephalometric reading for T4 (After 4 months of space closure)

Anterior retraction = total retraction space closure − anchorage loss

Statistical Analysis

The observations obtained in the study were subjected to statistical analysis, so as to get their interpretation. All quantitative variables, e.g., space closure, anchor loss, anterior retraction were described using mean ± standard deviation (SD) and compared using students unpaired t-test. $P < 0.05$ was considered as significant.

The force values on the first and fourth month of retraction were tabulated and were subjected to: UnPaired sample T-test

Discussion

In case of bimaxillary protrusion, extraction of 1st premolar is needed. Orthodontic treatment involving extraction of teeth, often there is a need to close extraction space, after the initial levelling and alignment.

The present study was designed to compare the rates of space closure, molar anchorage loss and rate of anterior retraction when using standard NiTi closed coil springs and active tiebacks.

Rate of Space closure

The rate of space closure was measured and calculated for both the groups (Table1). In this study, the NiTi closed coil springs produced rapid rate of tooth movement(0.92mm) as compared with conventional active tieback(0.49mm) which was statistically highly significant(p value 0.000). Our findings are also in accordance to the findings of Al-Sayagh[35] and Ismael and von Fraunhofer.[19]
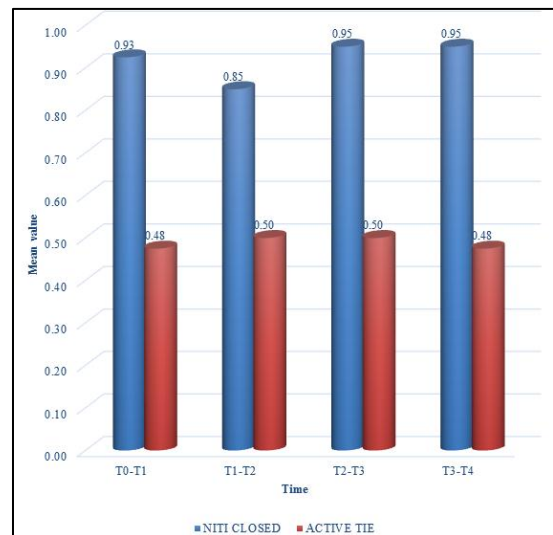

Fig. 12: Anchorage Loss

It was observed that the use of NiTi closed coil springs lead to more anchor loss(1.80 mm) as compared to active tieback(1.03 mm),which was found to be highly significant (P = 0.000) as shown in Table 2.
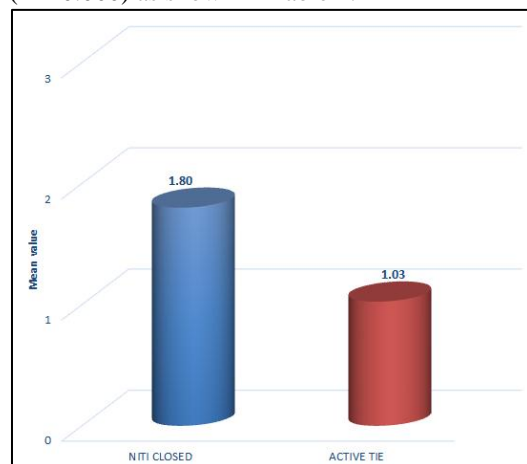

Fig.13 : Anchor loss

Fig. 14: Anterior retraction

Rate of Anterior Retraction

The total amount of anterior retraction was calculated by deducting the anchor loss from the total retraction space. This was calculated for both the groups and the mean was found. This shows that the anterior retraction was comparatively more in NiTi closed coil groups(1.98 mm) when compared to active tieback(0.98 mm) and statistically revealed that this difference washighly significant (P = 0.001) as shown in Table 2.

In spite of more anchorage loss the effective anterior retraction was more in NiTi closed coil springs.
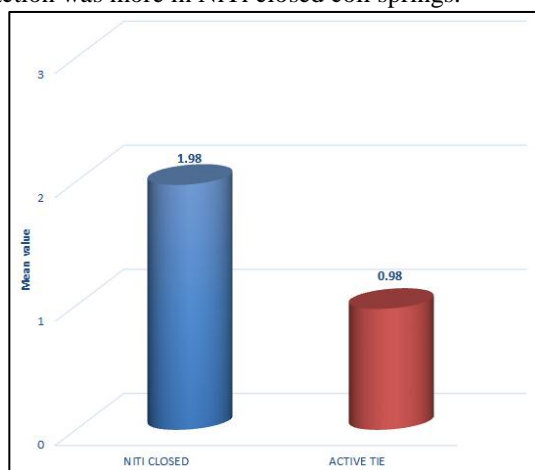
However, actual force application is difficult to be determined in-vivo, due to biological and mechanical reasons (tooth morphology, root length and periodontal architecture, chewing etc.). In this study, these variations were not considered.

Results

When space closure was compared between NiTi closed coil group and active tie back group at T1, T2, T3 and T4, the mean value for group 1 was 0.93 mm, 0.85 mm, 0.95 and 0.95 mm whereas for group 2 was 0.48 mm, 0.50 mm, 0.50 mm and 0.48 mm respectively as shown in Table 1.

Table 1: Comparison of mean values of the distance from cusp tip of mandibular canine to mesiobuccal groove of first mandibular molar between NiTi closed coil group and active tiebacks group at different months of observation, that is, at T0, T1, T2,T3, T4 (unpaired t-test).

Observation	Readings	N	Mean(mm)	S.D.	T-test	P-Value	Inferences
T1 (6th week)	NITI CLOSED COIL SPRING	20	0.93	0.24	6.406	0.000	HS
	ACTIVE TIE BACK	20	0.48	0.20			
T2 (12th week)	NITI CLOSED COIL SPRING	20	0.85	0.24	6.658	0.000	HS
	ACTIVE TIE BACK	20	0.50	0.00			
T3 (18th week)	NITI CLOSED COIL SPRING	20	0.95	0.15	13.077	0.000	HS
	ACTIVE TIE BACK	20	0.50	0.00			
T4 (24th week)	NITI CLOSED COIL SPRING	20	0.95	0.15	11.167	0.000	HS
	ACTIVE TIE BACK	20	0.48	0.11			

The unpaired t-test, when applied, revealed that this difference was statistically highly significant (P = 0.000) at T1, T2, T3 and T4. This showed that there was a faster rate of space closure by NiTi closed coil springs as compared to active tieback.
For NiTi closed coil group the average anchorage loss in 6 months was 1.80 mm while for active tieback group it was 1.03 mm as shown in Table 2

Table 2: The inter group comparison of mean values of anchorage loss and anterior retraction between NiTi closed coil group and active tie back group at 4 months of observation using unpaired t-test.

Variable	Readings	N	Mean(mm)	S.D.	T-test	P-Value	Inferences
Anchor Loss (mm)	NITI CLOSED COIL SPRING	20	1.08	0.25	10.854	0.000	HS
	ACTIVE TIE BACK	20	1.03	0.20			
Anterior Retraction (mm)	NITI CLOSED COIL SPRING	20	1.98	0.26	13.871	0.000	HS
	ACTIVE TIE BACK	20	0.98	0.20			

For NiTi closed coil group the average anterior retraction in 6 months was 1.98 mm while for active tieback group it was 0.98 mm as shown in Table 2. The unpaired t-test when applied revealed that this difference was statistically highly significant (P = 0.000). This shows that the anterior retraction was comparatively more in NiTi closed coil groups when compared to active tieback.

Conclusion

In this study we have used NiTi closed coil spring and active tie backs for space closure. The prospective observation of 20 patients and evaluating the results, the following conclusion would be drawn:-

NiTi closed coil springs achieved faster space closure as compared to the active tieback.

Significant anchorage loss was also noted with NiTi closed coil when compared with active tieback.

In mild to moderate anchorage cases, space closure with NiTi closed coil springs with an increased rate of anterior retraction and anchor loss can be recommended.

However, in critical anchorage cases, reinforcement of anchorage, while using NiTi closed coil springs for space closure, is recommended.

This study also recommended further research in controlling anchorage loss and effective tooth retraction without causing any undesired biologically and physiological reaction and stable anchorage control.

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