Research Article

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Clinical Comparative Assessment of Space Closure Using Various Force Delivery Systems in Orthodontics

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ABSTRACT

Aim: To clinically compare the space closure using various systems of force delivery in orthodontics.

Material & Method: Forty patients from the 17-25 age group were divided into four groups based on mode of space closure as Group I by active ligature, Group II by power e-chain, Group III by Nickel-Titanium closed coil spring and Group IV by Stainless Steel closed coil spring. After every four weeks, the quantity of space closure was measured using the automated Vernier calliper.

Result: The mean (mm) of retraction achieved at the end of the 1stmonth was 0.597 in Group I with a SD of 0.208 and 0.815 in Group II with a SD of 0.146. Whereas, the mean was 1.165 with SD of 0.198 in Group III, and 0.928 with SD of 0.451 in Group IV.

Conclusion: The order of force distribution systems according to the retraction rate for both Ni-Ti closed coil spring and Stainless-Steel closed coil spring was equal and more than both Power E-chain and Active ligatures.

Keywords: Space Closure;Ni-Ti closed coil spring; Stainless Steel closed coil spring; Power E-chain and Active ligatures.

INTRODUCTION

Orthodontic tooth movement involves the utilization of a method of force distribution capable of inducing the appropriate output of individual dental units within the biological environment. Ideally, a force delivery system should have an optimal and constant force delivery system.[1]In fixed orthodontic procedure, there are 3 stages - initial leveling & alignment, space closure and finishing & detailing, one of the most difficult aspects of space closure.[1-6] Either friction mechanics or frictionless mechanics are the types of biomechanics involved in the space closure.[6]Sliding en-mass for correction mechanics have gained significant popularity, especially after the evolution of MBT philosophy.[7-10]Sliding mechanics need less wire bending but provide outstanding root parallelism and arch shape control.[11] Sliding mechanics for space closure with force delivery systems are commonly used by pre-adjusted fixed orthodontic appliances, such as elastomeric chains, elastomeric modules attached to ligature wire or intraoral elastics, and coil springs such as Ni-Ti closed coil springs and Stainless Steel closed coil springs.[12]In various studies, the rate of space closure by Closed coil springs and

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Elastomeric chain was compared but nevertheless, several studies are being carried out in search of the ideal space closure system. [12]Since the comparative clinical performance of the power chain, active ligatures, NiTi closed coil spring and Stainless Steel closed coil spring were not previously reported, the objective of the study was to compare the clinical performance of these orthodontic space closure force delivery systems.

AIM & OBJECTIVES

To assess and compare the clinical performance of multiple systems of force delivery for space closure in fixed mechanotherapy over a period of 4 months.

MATERIALS & METHODS

This study included a total of 40 patients aged 17-25 years who underwent orthodontic care at the Department of Orthodontics & Dentofacial Orthopedics. An informed signed consent was obtained from the participants. Patient with age group of 17-25 years with premolar extraction in all the quadrants, 0.022"x0.028" MBT appliance was planned for them to treat and stainless steel working arch wire was used after 1 month of initial alignment were included in the study. Patient other than premolar extraction and does not planned for MBT were excluded for the study.

In Group I- Active ligatures prepared from one grey elastic module and a long ligature, in Group II- Power E-chain, in Group III- Nickel-Titanium closed coil springs (G&H) and in Group IV- Stainless Steel closed coil springs (G&H) were used for space closure. These were customized according to the manufacturer's instructions to deliver the force value of approximately 200 gm from the hook on the molar tube to the hook on the main arch wire. Except the springs all were replaced on next visit, the springs were reactivated on each visit as per requirement.

Stainless Steel 0.017"x0.025" arch wires with soldered J-hooks between lateral & canine and bite opening curves were engaged at the end of levelling and alignment. After one month, the patients were recalled to ensure the archwires were passive, checked by sliding the archwire through the bracket slots and 0.017"x0.025"SS retraction archwires were then removed and impressions were obtained before retraction was started for the creation of study casts (T_0). Then, retraction archwires were re-established and retraction using different systems of force delivery was started.

Fig 1: Overall comparison among all the four groups using Tukey's HSD test.

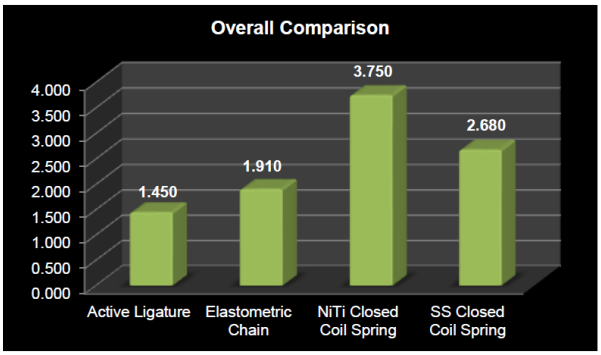

Table 1: The mean (mm) of retraction completed at the end of 1st month.

Groups	Mean	SD
Group I	0.597	0.208
Group II	0.815	0.146
Group III	1.165	0.198
Group IV	0.928	0.451

Table 2: The difference in retraction between groups (Tukey's HSD test)

Groups	Mean
Group I & Group III	0.001
Group I & Group IV	0.001
Group II & Group III	0.001
Group II & Group IV	0.008
Group I & Group II	0.190
Group III & Group IV	0.668

On research casts, space was determined by calculating the maximum distance between the canine's cusp tip and the buccal groove of the first permanent molar in all four quadrants in millimeters before the beginning of retraction with the aid of digital Vernier calliper (T_0). The amount of space closure was recorded after every weekly visit by using digital Vernier caliper within the oral cavity. After four months, the research casts were produced again to assess the closed space during retraction (T_1). The space closure mechanics were inspected during each visit and distortions of the springs or arch wires were examined.

All the data were statistically analysed by applying ANOVA, Tukey's HSD test and t-test to compare the different force delivery system.

RESULT

The mean (mm) of retraction achieved at the end of the 1st month was 0.597 in Group I with a SD of 0.208 and 0.815 in Group II with a SD of 0.146. Whereas, the mean was 1.165 with SD of 0.198 in Group III, and 0.928 with SD of 0.451 in Group IV.

The difference in retraction between Group I and Group III, Group I and Group IV, Group II and Group III and Group III and Group IV as the 'P' value was 0.001, 0.001, 0.001 & 0.008 respectively (i.e. 'P'<0.05) was highly significant when comparing all four groups using Tukey's HSD test for a total of four months of retraction. Whereas the 'p' value between Group I and Group II (0.190) and Group III and Group IV (0.668) was not significant. No statistically significant difference was observed between the retraction of the upper and lower arches in the right and left quadrants and between the upper and lower arches.

DISCUSSION

The rate of Ni-Ti closed coil spring, Elastomeric chain and Active ligatures were compared and evaluated by various studies, but very few studies evaluated the rate of space closure using Stainless Steel closed coil spring and for all force delivery systems with the same force magnitudes. The present study was an attempt to compare and evaluate the closure of space using distinct systems of force delivery, i.e. Active ligatures, Power E-chain, Ni-Ti closed coil spring and Stainless Steel closed coil spring in the process of orthodontic space closure.

Ni-Ti closed coil springs have revealed greater and more stable space closure than with the Elastic modules and elastomeric power chain. These findings are consistent with the research performed by various authors.[6-9,11,14]

Cox et al., in 2014 proposed that the possible reason for better Nickel-Titanium closed coil spring performance is that Nickel-Titanium alloys have the special properties of shape memory and super elasticity. Unlike the elastic chain, the Ni-Ti closed coil spring provides constant force that rapidly loses its force, characterized by an initial exponential decrease of 50% due to stress relaxation (Al-Sayagh& Ismael 2011)[3]. In comparison to the current research, multiple studies have shown that Ni-Ti closes the space at a pace comparable to that of other force delivery systems.[5,12]

The results of the research showed that no statistically significant difference was found between the retraction rate of the closed coil spring of Stainless Steel and the closed coil spring of Ni-Ti.To date, there has been only one report that contrasts Ni-Ti coil springs directly with Stainless Steel springs by Norman et al (2016)[13], which definitely complemented the previous space closure research and probably provided an alternate approach. The Stainless Steel springs were observed to be as good as the costlier Ni-Ti coil springs, gave the fastest rate of space closure throughout the phase, and were found to be the most cost-effective method of closing space.

The present research used 0.017"x0.025" SS as a functioning archwire instead of 0.019"x0.025" SS archwire in the support, minimizing the friction and contact point between the bracket & wire and closing the space faster as supported by Awni's study (2012)[4].

The present study chose an inter-individual, parallel group design which, since they involved the same archwire, considered the two sides of space closure to be mutually dependent on each other. Which was supported by Chaudhary et al., (2015)[6] Dixon et al., (2002)[7] and conflicted with Bokas et al., (2006)[5] and Nightingale et al., (2003)[12].

The premolar extraction samples were selected and treated with sliding mechanics and en-mass retraction in the current research. Various studies also used the sliding mechanics and en-mass retraction.[7,8,10-12]

CONCLUSION

The study concluded that-

- The order of force distribution systems according to the retraction rate for both Ni-Ti closed coil spring and Stainless Steel closed coil spring was equal and more than both Power E-chain and Active ligatures.

- In all the quadrants, retraction occurred at the same rate, despite the type of force delivery used.
- Clinically, no significant difference was reported during retraction between upper and lower arches.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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