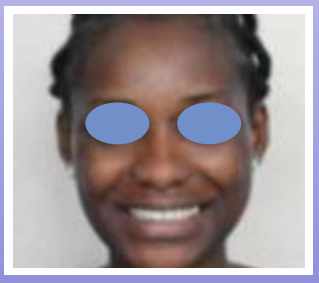
WEST AFRICAN JOURNAL OF ORTHODONTICS

ISSN 2315-9502

VOLUME 9, NUMBER 2

DECEMBER 2020

Space closure with active-tieback and Ni-Ti coil springs



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A Comparative Evaluation of Rates of Space Closure using Nickel-titanium Closed Coil Springs and Active Tiebacks in Premolar Extraction Cases

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Abstract.

Background: Space closure as an important step in orthodontic treatment requires an appropriate force system. Active tiebacks and Nickel titanium closed coil springs are two methods of force systems available. This study aimed to evaluate and compare the rates of space closure using both methods in premolar extraction cases.

Methods: This was a comparative clinical study with a split-mouth design carried out in the Orthodontic Clinics of Lagos University Teaching Hospital (LUTH) and Lagos State University Teaching Hospital (LASUTH), Lagos, Nigeria between July 2018 and July 2019. Patients who required the closure of first premolar extraction spaces as part of their treatment plan, who met the inclusion criteria and gave informed consent, were randomly recruited for the study. Fifteen subjects having forty-two quadrants were recruited in total. The rate of space closure with Nickel titanium [NITI] closed coil springs and Active tiebacks and a comparison between the two rates were evaluated.

Results: The participants in this study were within the age range of 13-39 years with a mean age of 23.13±9.37 years; 12 (80%) of the subjects were females and 3(20%) were males. The mean rate of space closure with NITI closed coil springs was faster at 1 mm/month when compared to 0.75mm/month for active tiebacks.

Conclusion: Space closure with NITI closed coil spring was significantly greater than Active tiebacks by 0.25mm/month. (p = 0.002) with a confidence interval of 95%. Thus, NITI closed coil spring may be considered a preferred option in various clinical scenarios.

Keywords: Rate of space closure, Nickel Titanium closed coil springs, Active tiebacks

ORIGINAL ARTICLE

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Introduction

Correction of malocclusions in orthodontics requires the extractions of premolars to achieve ideal treatment goals such as facial aesthetics, balanced occlusion, and post-treatment stability.[1-3]

The clinician must properly manage these premolar extraction sites with a known force system to ensure a balanced occlusion and avoid relapse at the end of treatment.[1,4]

Active tiebacks and Nickel titanium closed coil springs are examples of force systems used by clinicians to close premolar extraction spaces.[5-12] To the best of my knowledge there is no study to date among Nigerians where the rate and a comparison between the rates of the two force systems have been evaluated.[5-7] Studies previously conducted have indicated Nickel titanium closed coil springs to have a more consistent and significantly higher rate of space closure than Active tiebacks,[6,7,13] however, different rates have been documented.[6,7,13]

Active tiebacks are known to be cheap, easy to clean, and easy to place, thus, it has the advantage of being delegated during busy clinical hours. [14] They also produce lower forces (200g range) which creates less tipping and less archwire deflection and ultimately reduces friction to permit a more effective space closure.[15-17] Although they must be replaced every 4-6 weeks due to their ability to retain plaque[18] and due to a force loss of 50 to 70% in the first 24 hours intraorally followed by a more steady and stable force decay of 10 to 20% in the first 4 weeks.[14,19-21] Despite these variations in force levels they are widely accepted for effective space closure.[5-7,22,23]

Nickel-titanium (NITI) closed coil springs gained popularity in orthodontics after the introduction of nickel-titanium alloy in 1971.[24] They were primarily made of stainless steel (SS) and cobalt-chromium-nickel (Co-Cr-Ni) alloys.[24] The uniqueness of the Nickel Titanium alloy can be seen in its ability to transition between two phases - martensitic (flexible/low temperature) and austenitic (stiff/high temperature) phase [25]and this transition permits for shape memory and super elasticity; properties not found in any other dental materials.[24,26]

Nickel-titanium closed coil springs have the advantage of not exhibiting the rapid force decay seen with elastomers (elastic modules), [25,27] nor do they display the extremes in space closing forces of stainless steel coils or closing loops.[28] Their use also does not require reliance on patient cooperation, as does the interarch elastic wear[7] and they produce a faster rate of space closure due to the constant force produced by their super elasticity.[5,6,24]Thus, their use for physiologic orthodontic tooth movement is highly recommended.[7,12,15,24,29-31]

They can also be activated once during space closure because the super elastic character of the nickel-titanium alloy they are made from allows a low, constant force to be delivered and maintained over the distance of a whole extraction site.[32] Thus the advantage of reducing chairside time and conserving anchorage.[32]

This study sought to determine the rates of the two force systems among Nigerians and compare the rates to determine if there was any significant difference between the Nickel-Titanium closed coil springs and Active tiebacks in the closure of first premolar extraction spaces.

The study generated baseline rates for Nigerians and more recent data. It compared the rates generated with previous studies done amongst Caucasians [5-8,10,33]and described in detail the experimental method employed which previous studies lacked.[5-8,10,33]

Materials and Methods

In this split-mouth study, subjects were selected according to the following inclusion criteria

subjects with good general health. [American Society of Anaesthesiologists ASA 1]

(Subjects requiring extraction of first premolars in each arch, as in Angles class I: bimaxillary proclination cases; increased overjet in Angle's class II; mandibular prognathism in Angle's class III, and cases with severe crowding. Subjects who were 10–19 years old at the start of treatment representing the adolescent population and subjects who were 20 years and above - representing the adult population. Subjects with full permanent dentition. Subjects undergoing orthodontic treatment with upper and or lower pre-adjusted edgewise appliance (Roth 0.22 prescription Equilibrium® manufactured by Dentaurum) and subjects of Nigerian descent.

The exclusion criteria included the following: 1. Subjects with extra-oral anchorage. Subjects with severe skeletal discrepancy requiring orthognathic surgery. Presence of craniofacial anomalies, such as cleft lip and palate in subjects. Subjects with

impacted teeth, with or without surgical exposure. Subjects on self-ligating appliances. Subjects with springs that showed permanent deformation at any of the recall visits. Subjects who were allergic to latex and nickel titanium. Subjects on medications such as contraceptives and bisphosphonates. Subjects who took non-steroidal anti-inflammatory drugs (NSAIDs) e.g. aspirin, ibuprofen, and diclofenac for pain, at any of the recall visits. Subjects were encouraged ahead of time and at every recall visit not to take NSAIDs for pain due to the potential confounding effect of slowing down tooth movement. They were advised to take paracetamol instead.

Ethical approval for the study was obtained from the Health Research and Ethics Committee of the Lagos University Teaching Hospital and Lagos State Teaching Hospital, Ikeja Lagos (ADM/DCST/HREC/APP/2024). The protocol for the study was explained in detail to the patient. Written and verbal informed consent regarding the nature of the study was obtained from both adult and adolescent subjects. Informed consent was obtained from the adult subjects and from the parents of the adolescent subjects whereas assent was obtained from the adolescent subjects.

Participants had their first permanent premolars extracted after which their teeth were levelled and aligned. Levelling and alignment were carried out after the initial set-up of both the upper and lower arches, or the upper arch only with Roth 0.022 brackets by Dentaurum, with the use of a sequence of Nickel-titanium wires. The wire sequence included 0.014, 0.016, 0.018-inch nickel titanium, and 0.020-inch stainless steel wires ligated with an elastomeric module into the brackets at six weeks interval. After the levelling and alignment stage was completed, the second stage was commenced by placing working arch wires i.e.0.019 x 0.025-inch stainless steel archwires with a post (G&H Orthodontics) for one month, to allow torque expression to begin. The arch wires were passive, and this was confirmed by sliding the archwire through the slots of the brackets.

After one month, the working archwire - 0.019 x 0.025-inch stainless steel archwires (G & H Orthodontics) were removed to take clinical photographs and alginate impressions with plastic stock trays of the upper and/or lower arch before the commencement of space closure with Active tie back and Nickel titanium closed coil spring on either the right or left halves of the subject's dentition via randomization in the split-mouth study design.

Randomization was done by balloting once at the beginning of space closure by the subject. The papers were rolled before the arrival of the subject. The random selection of Nickel Titanium closed coil springs or active tiebacks was done to achieve within patient control with the help of a research assistant. Nickel-titanium springs [Medium grade Sentalloy (Superelastic Nickel Titanium Alloy) –GAC International Inc., Central Islip, N.Y.] or active tiebacks with elastomeric modules from [Masel® 0.120 unicycle] were allocated to either the right or left half of each patient's dentition [Split Mouth] via balloting. The patient picked once from a cup of rolled papers containing an equal number of NR and AR and NL and AL with NR representing Nickel Titanium closed coil springs on the right half of the subject's dentition; AR representing active tiebacks on the right half of the subject's dentition; NL representing Nickel Titanium closed coil springs on the left half of the subject's dentition; AL representing active tiebacks on the left half of the subject's dentition. Thus, a subject picking NR signified Nickel-titanium closed coil springs on the right half and automatically active tiebacks on the left half of the subject's dentition. The subject picking AR signified Active tie back on the right and automatically Nickel Titanium closed coil spring on the left half of the subject's dentition. The lettered rolled paper selected by the subject

determined the intervention allocated to the right or left half of the subject's dentition; this was applicable for all subjects, regardless of the involvement of one or both arches.

This study was a single-blinded study for only the subjects were blinded. Each subject was unaware of the side to which each intervention was applied.

Before the impression was taken, the brackets were smeared with Vaseline® petroleum jelly to act as a separating medium in order not to dislodge the brackets while the impression was being taken. The impressions were taken using appropriately sized plastic stock trays under universal infection control measures. The alginate impression was gently rinsed under running tap water at room temperature to remove residual saliva and blood and then shaken gently to remove excess water. The impression was disinfected by spraying a solution of 0.05% sodium hypochlorite prepared with a ratio of 1 in 7 parts dilution and stored in a plastic bag for ten minutes. The disinfectant was rinsed out after 10 minutes with running tap water at room temperature.

The alginate impressions were cast using Gypstone® model stone immediately to prevent dimensional changes due to water gain and stored securely for measurement. The premolar extraction site on the baseline maxillary or mandibular arch casts obtained from the impressions taken was measured with Tresna digital calliper. This was measured from the cusp tip of the canine to the buccal groove of the first molar in all quadrants with the Digital Vernier Calliper with 0.02 mm accuracy and recorded as T0. All measurements on study models were repeated by the same operator (the researcher) three times and the mean was recorded to eliminate intra-examiner variability and measurement error.

The six anterior teeth were tied with a 0.010-inch stainless steel wire (G & H Orthodontics) i.e. [figure of eight]; the two posterior teeth [first molar and second premolar] were also tied with stainless steel ligature made of 0.010-inch stainless steel (G & H Orthodontics) to reinforce anchorage. Anchorage was reinforced to prevent the mesial drift of the first molar, which may alter the results obtained during space closure by the different interventions.

The archwire was then replaced and ligated with elastic modules using straight artery forceps to commence space-closing mechanics.

The Nickel Titanium closed coil springs were 9mm in length with 0.010 x 0.030-inch in diameters. The 9mm coil springs were used to provide a force of 200g. Forces were measured with a TECLOCK® force gauge (YDM Corporation Japan).

The Nickel titanium closed coil spring had two eyelets at either end. One eyelet was inserted into the first molar hook posteriorly whereas the other eyelet with a 25mm length of ligature wire (0.010 stainless steel ligature) in it was stretched mesially and tied anteriorly on the post on the archwire (G & H Orthodontics) just distal to the lateral incisor using straight artery forceps. A force of 200g was ensured with a TECLOCK® Force gauge [YDM Corporation Japan].

The Nickel Titanium closed coil springs were not replaced during treatment, but the force gauge was used to ensure a force of 200g at every recall visit and it was also ensured there was no kinking or deformation of the spring.

The Active tieback was a force of 200g. This was measured with a Teclock® Force Gauge [YDM Corporation Japan]. The active tiebacks consisted of an elastomeric module (Masel®0.120) unicycle and a 25mm length of ligature wire (0.010 stainless steel ligature). The module was held with straight artery forceps (Orthopli) and inserted into the first molar hook, the 0.010 stainless steel ligature has two arms, and one arm was placed beneath the 0.019 by 0.025 stainless steel archwire – (G & H Orthodontics) this ensured the stability of the active tiebacks and kept

the ligature away from the gingival tissues and helped prevent gingival irritation whereas the other arm was held straight and was tied around the brass post of the archwire with the other arm. The two arms were held together around the brass post and the module was stretched to twice its original size. The force was measured using a Teclock® Force Gauge to provide a force of 200g force.

During space closure, subjects were recalled for routine reviews at regular intervals with a mean time interval of one month, up to a maximum of four visits, and alginate impressions were taken at every visit.

At each monthly recall, the active tieback was replaced. Oral hygiene maintenance was reinforced at each appointment by asking the subject to brush after every meal, and the appliances were also checked, and subjects were also encouraged not to use Non-Steroidal Anti-inflammatory Drugs for pain rather encouraged to use paracetamol instead. Arch wires were inspected for any damage; the ends were trimmed using a distal-end wire cutter (Orthopli) to prevent any interference by the second molars from sliding.

No other form of force application (Elastics) was used at any time in the course of the study.

At routine reviews, the amount of space closure was determined from measurements on the study model from the canine cusp tip to the buccal groove of the first permanent molar with a Tresnar® Digital Vernier calliper with a 0.02mm accuracy. Space between the contact points of the canine and second premolar was not used because by 4 months the space was too small for a Vernier calliper to fit into. The study models were obtained from alginate impressions (PRO ALGIN®) taken with appropriate plastic stock trays under universal infection control measures. The study models obtained at each visit were measured three times and the mean was recorded. Baseline measurement (T0) was the measurement taken one month after placement of working archwire (0.019 by 0.025inch) before the application of intervention; T1is the first measurement taken after the commencement of space closure [at 2 months]; T2 is the second measurement [at 3months]; T3 is the third and final measurement (at 4months). The maximum duration of recording was four months. All the different measurements at each monthly interval were tabulated and compared for the two different force delivery systems. A rate of space closure in millimeters per month for each quadrant, and overall for each subject was calculated. The distance moved by the named intervention at every recall visit was calculated by subtracting the final measurement from the initial measurement. Distance moved at each visit = T0 – T1/T2/T3. T0 was the initial measurement taken before any named intervention at 1 month i.e. baseline; T1 was the measurement taken at the first recall visit at 1 month post-intervention; T2 was the measurement taken at the second recall visit at 2 months post-intervention; T3 was the final measurement taken at the third recall visit at 3 months post-intervention.

Rate = Distance/Time

Distance is the measurement from the canine tip to the buccal groove of the first permanent molar recorded at T1/T2/T3

Time is 1month/2months/3months [Post intervention]

The rate of space closure in mm per month (1 month) was calculated by dividing the distance moved with time (1/2/3months).

All measurements were done by a calibrated examiner (researcher). Then they were subjected to analysis by SPSS (Statistical Package for the Social Sciences) version 23.0.0.0.

Measuring the space available on the study model three times and calculating a mean assessed random error. The space available is the space between the canine tip and the mesiobuccal groove of the first permanent molar.

Figure 1A. Intraoral (Right buccal) photograph during space closure with Nickel titanium closed coil spring

Figure 1B. Intraoral (Left buccal) photograph during space closure with Active tie backs

Data was collected using the methods below namely questionnaire-based method and a clinically based method. The questionnaire was an interviewer-administered questionnaire designed for the study. It had two sections; each subject filled the first section while the second section was filled by the researcher after assessing the subject clinically.

The first section of the questionnaire contained the sociodemographic data of the subject while the second section contained the orthodontic summary of the subject. This included type of malocclusion [Angles I/II/III]; arches involved [Lower/Upper/Both]; site of force delivery system [Upper right or Upper left/Lower right or Lower left].

Statistical analysis

Microsoft Office Excel 2016 16.0.6741.2048 (Microsoft, Redmond Washington) was used to organize the data collected. All the statistical analysis was carried out through the Statistical Package for the Social Sciences (SPSS) version 23.0.0.0 [SPSS Inc., Chicago IL, USA], IBM Corp. [International Business Machines Corporation, Armonk, New York, USA].

Repeated ANOVA was used to determine the mean rates of space closure with NITI closed coil springs and Active tiebacks at different time intervals [T1/T2/T3]. Paired t-test was used to compare the mean rates of space closure between the NITI closed coil springs and Active tiebacks. A Bar chart was used to represent the interventions in the different quadrants.

Dahlberg formula was used to determine random errors and the intra-class correlation coefficient of reliability (ICC) was used to determine systematic errors between the two methods.

Results

A total of 19 subjects were recruited, and 4 were lost to follow-up. Fifteen subjects having 42 quadrants in total were analyzed for the study. These subjects satisfied the inclusion criteria with twenty-one quadrants for each intervention. There were 3 (20%) males and 12 (80%) females with a male-to-female ratio of 1:4. The 3 males recruited were adolescents whereas 4 of the 12 females were adolescents and the remaining 8 were adults. The age range of subjects was 13 – 39 years in the study with a mean age of 13.67±0.58 years for males and 25.50±9.01 years for females with an overall mean age of 23.13±9.37 years. (Table 1)

Table 1: Age and Gender distribution of subjects

Variable	Gender		
Age (Years)	Male	Female	Total
10-19	3 (20.0%)	4 (26.7%)	7 (46.7%)
20-29	0 (0.0%)	5 (33.3%)	5 (33.3%)
30-40	0 (0.0%)	3 (20.0%)	3 (20.0%)
Total	**3 (20.0%)**	**12 (80.0%)**	**15 (100.0%)**
(Mean±SD)	**13.67±0.58**	**25.50±9.01**	**23.13±9.37**

Active tiebacks were applied in nine upper right quadrants and six upper left quadrants; NITI closed coil springs were applied in six upper right quadrants and nine upper left quadrants whereas both interventions in the lower arch were equally distributed i.e. three in both lower left and right quadrants. Active tiebacks were placed more in the upper right quadrant than in any other quadrant whereas NITI closed coil springs were placed more in the upper left quadrants. Figure 2

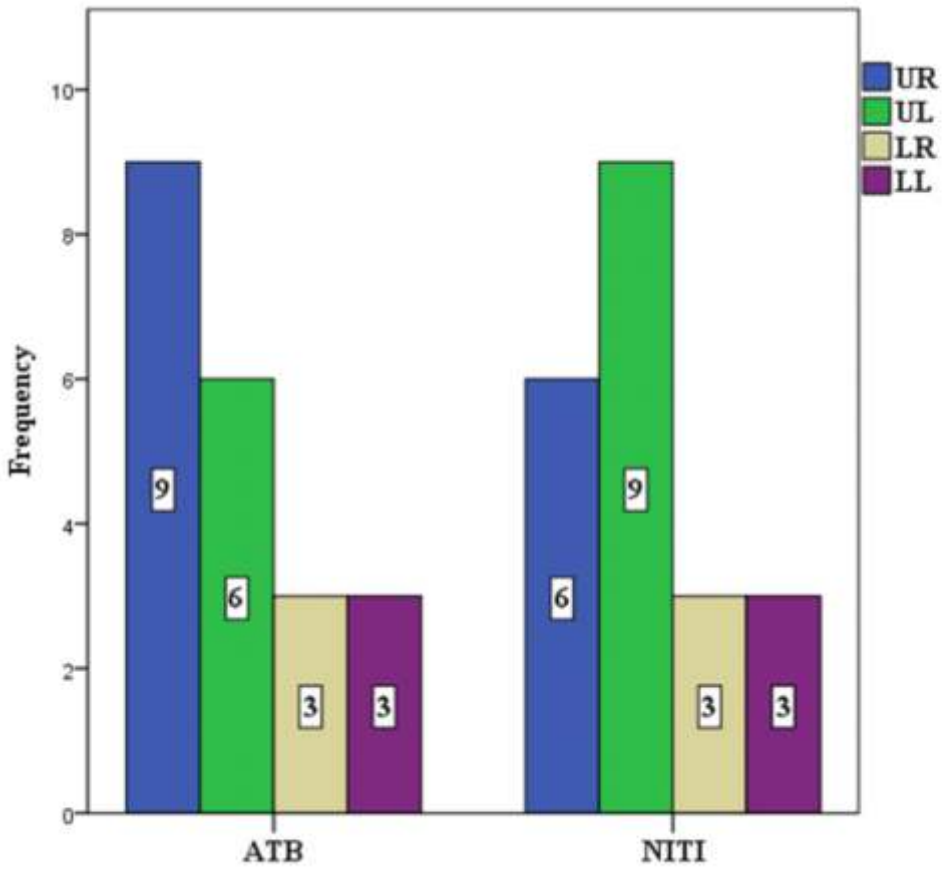

Figure 2: Quadrants in which interventions were applied

The mean rate of space closure using NITI closed coil springs at T1 was observed to be 1.18mm/month. This reduced at T2 and T3 to 0.93mm/month and 0.90mm/month respectively. However, these differences in the rate at the different time intervals were not significant, ($p > 0.05$). Figure 3.

The mean rate of space closure using ATB was measured at one-month post-intervention (T1), two months post-intervention (T2), and 3 months post-intervention (T3). The rate of space closure was highest at T1 (0.87mm/month) and lowest at T3 (0.68mm/month) whereas the rate at T2 was recorded to be 0.72mm/month.

The differences recorded at the different time intervals were not significant statistically,

P-value> 0.05. Fig 3.

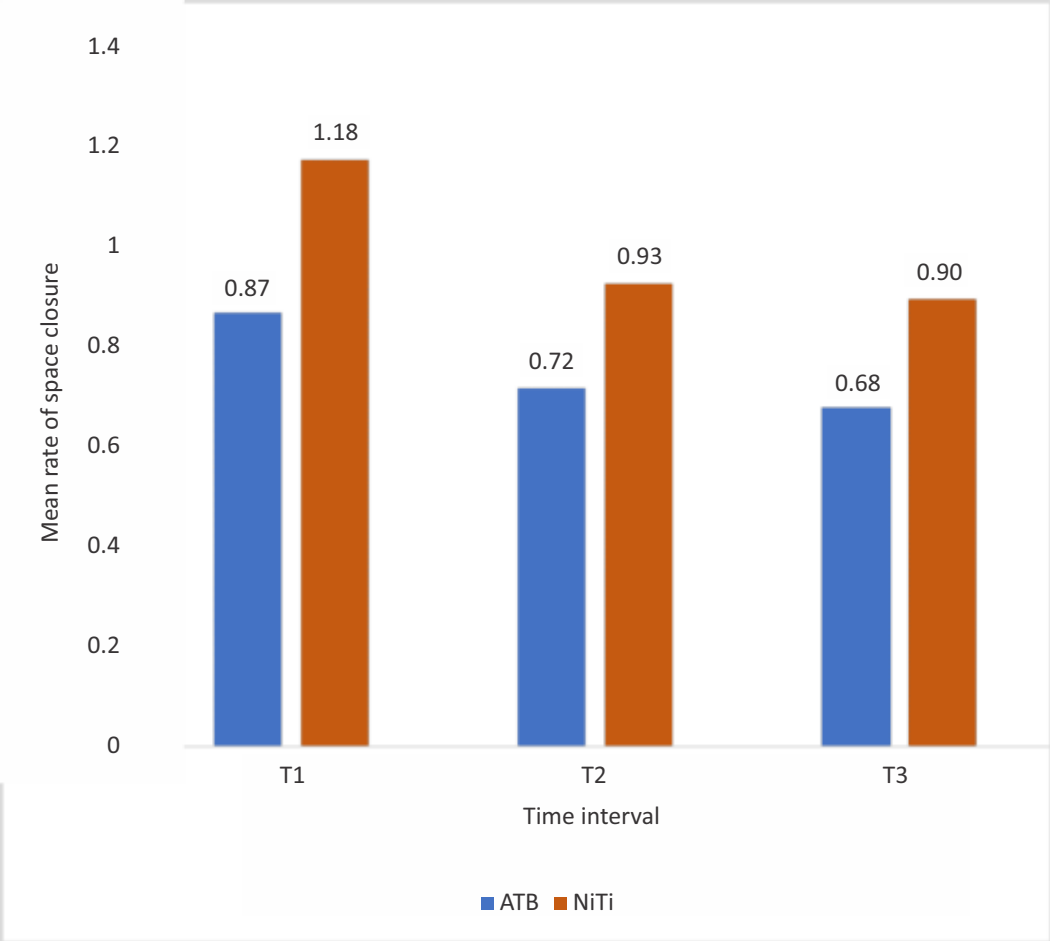

Figure 3: Rates of space closure at different time intervals using NITI and ATB

The differences between the mean rates at different time intervals and the overall mean using ATB and NITI closed coil springs were evaluated. The rate of space closure was faster using NITI closed coil springs when compared with ATB at every time interval [T, T2, T3] Fig 3.

The overall mean rate of space closure with Active tiebacks was 0.75±0.44 while that of NITI closed coil springs was 1.00±0.57mm/month. The overall mean rate of closure throughout the time of intervention was faster with NITI closed coil spring compared to ATB. Fig 4.

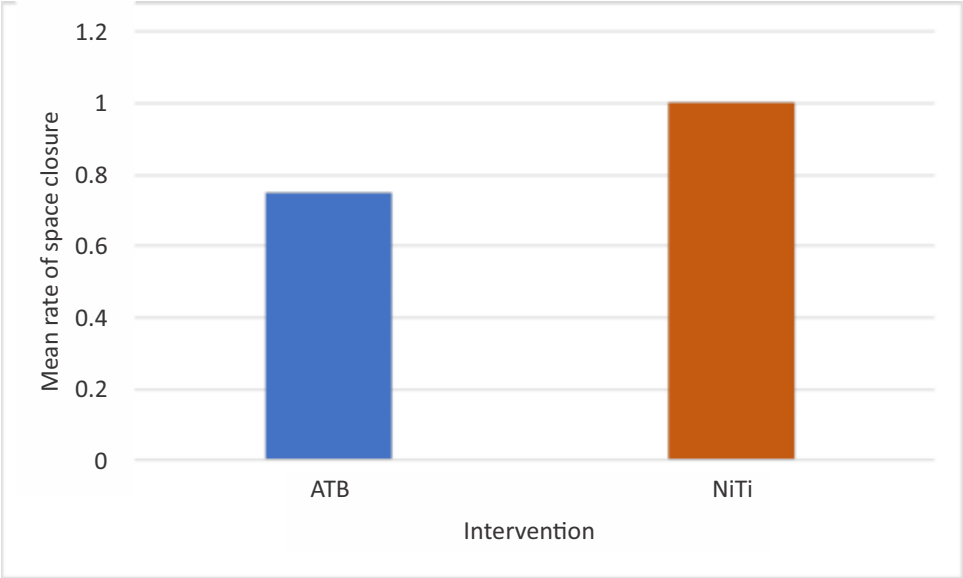

Figure 4: Comparison of the rates of space closure using NITI and ATB

Discussion

The choice of an appropriate force system in the closure of spaces following the extraction of premolars is vital in orthodontics.[1,4,34,35] The force component required to close the premolar extraction spaces may be delivered by applying Nickel-titanium (NITI) closed coil springs, Active tiebacks (ATB), or Elastomeric chains.[7,8,11,36,37]

This split-mouth comparative prospective clinical study was designed to evaluate and compare the rates of premolar extraction space closure using NITI closed coil springs and Active tiebacks amongst adolescents and adults attending the Orthodontic clinics of Lagos University Teaching Hospital, Idi Araba and Lagos State University Teaching Hospital, Ikeja, Lagos.

The overall mean rate of space closure recorded with NITI closed coil spring was 1mm/month. This is similar to the rate recorded by Samuels et al[5] with a rate of 0.96mm/month. The similarity in rates with Samuels et al[5] may be attributed to the superelastic and shape memory property of NITI closed coil springs which ensures light continuous forces are provided over a considerable range of activation and working times.[19,32,38] These light forces are highly recommended for biological tooth movement.[39]

However, a higher rate of 1.85mm/month was recorded by Bokas et al 11; Khanemasjedi et al [40] recorded 1.67mm/month while Aditya 41 recorded 1.62mm/month. This difference in rates with Bokas and Woods[11] may be attributed to the difference in the dimension of the archwires used. A two-step retraction on thinner archwires was employed by Bokas and Woods[11], whereas, an en-masse retraction on an 0.019 by 0.025-inch stainless steel archwire was carried out in this study even though en masse retraction has been documented by Schneider et al[42] to be faster than the two-step retraction.

Previous studies,[41,43,44] recorded a faster rate of space closure with thinner archwires than with large rectangular archwires due to the line contact of the bigger rectangular wire with the bracket. This is said to cause more friction and reduce the rate of tooth movement. [41,43,44] However the 0.019 by 0.025inch stainless steel archwire used in this study has the advantage of allowing full torque expression and allows for bodily movement which ensures the least tissue damage.[45]

Nickel Titanium closed coil spring used in this study at different time intervals recorded the fastest rates of space closure at T1 which is the first month following the application of the Nickel Titanium closed coil spring with a gradual reduction subsequently at the second and third months. These rates are in agreement with Khanemasjedi et al [40] and Chaudhari et al [10] who also recorded the fastest rate at T1 which is the first month following the application of the NITI closed coil spring.

This is in concordance with the phases of orthodontic tooth movement with a rapid rate of tooth movement following the application of force at the initial phase followed by a lag phase where there is a reduction in tooth movement and the final phase in which tooth movement occurs gradually.[46]

The gradual reduction recorded in the rates with the NITI closed coil springs at T2 and T3 compare well with Chaudhari et al 10 who recorded rates of 1.91,0.91,0.86,0.81mm/month at T1, T2, T3, T4. This could be attributed to the close similarity in the methodology of en masse retraction on 0.19 by 0.25-inch stainless steel archwires. However, the rates obtained at the different time intervals in this study are lower than those recorded by Khanemasjedi et al, [40] who compared the efficacy of elastic chains versus nickel titanium coil springs in canine retraction with rates such as 1.93,1.71, and 1.36 mm /month at T1/T2/T3. This difference could be a result of the denser bone density amongst Blacks.[47,48]

Previous studies [49,50] have indicated tooth movement to be affected by bone density. There is a slower rate of orthodontic tooth movement in denser bone.[49,50]

The overall mean rate of space closure using ATB was 0.75mm/month. These results are comparable with previous studies.[58,11] However, in this study a faster rate of space closure with Active tiebacks was recorded than that recorded by Dixon et al[7] and this differed by 0.40mm/month. Dixon et al[7] recorded an Active tieback rate of 0.35mm/month.

Although a faster rate of space closure using ATB was recorded by Shankar et al.[8] This may be due to single canine retraction with the MBT system rather than the en masse retraction carried out in this study with the Roth 0.22 system. Nevertheless, the results of this study compare well with the results by Sonis [12] who also carried out single canine retractions. This may be a result of the similarity in the bracket system of Roth 0.22 with the current study.

In a previous study by Mitra et al.[33], the rate recorded for active tiebacks was faster than the elastomeric chain it was compared with, this is among the few studies of note to have a faster rate for Active tiebacks,[33] even though the rate was not clearly stated as to whether it was rate per week or month thus we cannot truly compare this study with theirs.

Space closure rates with Active tiebacks at different time intervals were fastest at T1 and slowest at T3 but the difference in these rates was not significant. This is in agreement with previous studies [58,11] which could be a result of the force decay experienced by the elastic module of the active tieback in the oral cavity.[11,14] ATB being an elastomer experiences force decay in the first 24 hours of its use; loses 50% of its force after four weeks and is affected intraorally by plaque accumulation and temperature. [14,18]

In comparing the overall mean rates of space closure between NITI closed coil springs and Active tiebacks, NITI was seen to be faster than ATB and these results compare well with previous studies.[57] The faster rate of space closure with NITI closed coil springs in this study can be attributed to the fact that they perform better than ATB in an oral environment [17,27] and they also have a better load deflection than

ATB.38 Maganzini et al[25] also reported NITI to have "constant" unload forces within its designated deactivation range.

The faster rate with NITI closed coil springs than ATB recorded in this study were similar to rates by Samuels et al[5,6] This could be attributed to the close similarity in the methodology where anchorage was controlled by tying the second premolars and first molars together. Thus, space closure was from both anterior retraction and posterior protraction. However, anchorage control was by the use of transpalatal arches in other studies.[710]

In comparing the mean rates of space closure between NITI closed coil springs and Active tiebacks at different time intervals, NITI was faster than ATB at all the time intervals (Figure 1) and this is in agreement with previous studies.[5,6]

However, in a previous study by Shankar et al[8] Active tiebacks were observed to be faster than NITI closed coil springs in the third and fourth months of space closure but the reliability of this result cannot be validated as Shankar et al[8] measured distance moved by each intervention directly intraorally without cast measurements and this method of measurement has been recognized as unreliable due to interferences by the soft tissue.[41]

Conclusion

The rate of space closure with Nickel titanium closed coil springs in first premolar extraction cases was 1mm/month whereas the rate with Active tiebacks was 0.75mm/month.

Nickel-titanium closed coil springs provided a significantly faster rate of space closure than Active tiebacks by 0.25mm/month for premolar extraction cases in the sample studied.

Authors contribution: All the authors contributed to the manuscript.

Conflict of interest: None declared

Funding: Self funded

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Competing interest for a given manuscript exists when the author has ties to activities that could inappropriately influence his or her judgment, whether or not judgment is in fact affected. Financial relationships with industry for example, through employment, consultancies, stock ownership, honoraria, expert testimony, either directly or through immediate family, are usually considered to be the most important competing interests. However, conflicts can

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Acknowledgements

In acknowledgements section, it is suitable to list all contributors who do not meet the criteria for authorship, such as a person who provided purely technical help, writing assistance, or a department head who provided only general support. Financial and material support should also be acknowledged.

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