International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 9; Issue 07(B); July 2020; Page No.22782-22787
DOI: http://dx.doi.org/10.24327/ijcar.2020.22787.4504

Research Article

SPACE CLOSURE USING STAINLESS STEEL AND NiTi CLOSED COIL SPRING: A CLINICAL STUDY

Dr. Peeyush Jain*, Dr. Saurabh Singh, Dr. Kartikeya Singh, Dr. Surabhi Goyal, Dr. Maulik Patel and Dr. Avinash jaiswal

Reader Department of Orthodontics and Dentofacial Orthopaedics

ARTICLE INFO

Article History:
Received 10th April, 2020
Received in revised form 2nd May, 2020
Accepted 26th June, 2020
Published online 28th July, 2020

Key words:
NiTi CLOSED COIL SPRING

ABSTRACT

Objective: to compare the rate of space closure using stainless steel and niti closed coil spring and to find out the amount of anchor loss during retraction in maxillary arch.
Materials and method: the sample consisted of 14 upper and 12 lower arches from fifteen consecutively treated patients of either sex requiring orthodontic space closure in first premolar extraction site area with fixed appliances.
Results: There was no statistically significant difference found between NiTi and stainless steel closed coil spring enmasse retraction and anchorage loss in maxillary arch was statically similar with both type of springs.
Conclusion: Both nickel-titanium and stainless steel closed coil springs are efficient in providing space closure at similar rate and No significant difference was found in terms of anchorage loss by nickel-titanium and stainless steel closed coil springs.

INTRODUCTION

Extraction of teeth is one of the commonly used method to create space needed to treat malocclusion thus determining the treatment outcome. Premolars are most ideally considered for the relief of both anterior and posterior crowding since the first and second premolars have similar crown forms making it easier to establish an acceptable contact point between the remaining premolar and the adjacent molar and canine. Closure of extraction space using fixed orthodontic appliance is usually accomplished by any of the two general approaches *i.e.* sliding and loop mechanics. Both of these methods have their own advantages and disadvantages.[1]

The ideal force required for en masse retraction of anterior teeth is about 150-300 gms. Most contemporary fixed orthodontic appliances use light continuous forces as part of orthodontic mechanotherapy to effect tooth movement and both nickel-titanium and stainless steel closed springs delivers continuous forces in their elastic limits with varying force deflection range.

In vitro studies have proved that nickel-titanium closed coil springs to be superior as compared to stainless steel closed coil springs. Thus this study was taken to clinically compare the retraction rate of anterior teeth by nickel-titanium and stainless steel closed coil springs.

MATERIALS AND METHOD

Twenty six arches from fifteen consecutively treated patients of either sex requiring orthodontic space closure with fixed appliances were selected.

Corresponding author:* **Dr. Peeyush Jain
Reader Department of Orthodontics and Dentofacial Orthopaedics

Following criteria were taken for consideration during the selection process:
Inclusion criteria:

- Age between 15 to 25 years and permanent dentition with second molars erupted.
- Skeletal class l or mild class ll relation of jaws. This will be diagnosed through clinical and lateral cephalometric evaluation. Only those skeletal class II cases will be considered which can be well manageable with orthodontic camouflage treatment.
- Bilateral class I molar relationship with bimaxillary dentoalveolar protrusion with average growth pattern.
- Condition of oral hygiene and periodontal status satisfactory
- Absence of any craniofacial anomaly, cleft lip and palate.
- All cases well motivated cooperative and eager to get the benefit of treatment.

Exclusion criteria

- Patients with poor oral hygiene and compromised periodontal status.
- Skeletal class ll cases which require surgical treatment for skeletal correction.
- Presence of history of trauma and systemic diseases.

The patient population comprised of 11 females and 4 males with mean age 19.8 years. All the patients treated fulfilled the inclusion criteria and required bilateral extraction of first premolars. In all the patients fixed mechanotherapy i.e. preadjusted edgewise appliance with 0.022"x 0.028" MBT

prescription was followed (fig 1). Active space closure measurements were measured from 14 maxillary and 12 mandibular arches. The second molars were also included in the posterior segment to reinforce the anchorage. Records were taken prior to space closure and at regular intervals.

Fig 1 material used in study

Prior to beginning of space closure (fig 2) 0.019" X 0.025" stainless steel wires with hooks crimped between lateral incisor and canine in each quadrant were placed. The arch wire was left in place for at least 1 month to allow the torque expression to begin before the commencement of space closure. Active space closure was started by placing nickel-titanium (fig 3b) and stainless steel closed coil springs (fig 3c) randomly on either side of each arch. The closed coil springs were ligated and activated to deliver the force of 200gms (approximately 7 ounces) (fig 4). The springs were hooked to the first molar at one end and to crimpable ball hook on the other end just distal to the lateral incisor.

Fig 2 intraoral photographs before space closure

Fig 3(a,b,c) intraoral photographs after placement of closed coil springs

Fig 4 force measurement with dontrix force measuring guage

During space closure, patients were recalled for routine reviews at regular time interval of 1 month, up to a maximum of 6 visits. At each recall visit thorough checkup of the fixed appliance was done. Arch wires were checked for any damage, the ends were cut to prevent any interference in sliding by the second molars and to avoid any discomfort. The crimpable ball hooks, which could not initially be moved with pressure applied by hand instruments, were checked for any slippage and the springs were checked, activated to deliver the desired force.

To measure the rate of en masse retraction, the patient's records were taken at the start (T0) as well as at regular intervals of 2 months i.e. after 2 months (T1), 4 months (T2), 6 months (T3). The records collected were study models and lateral cephalograms whereever required. The retraction of anterior segment on either side was calculated between the contact point on the distal surface of canine and mesial surface of second premolar. Vernier caliper (least count 0.02mm) was used to carry out the measurements. (fig 5)

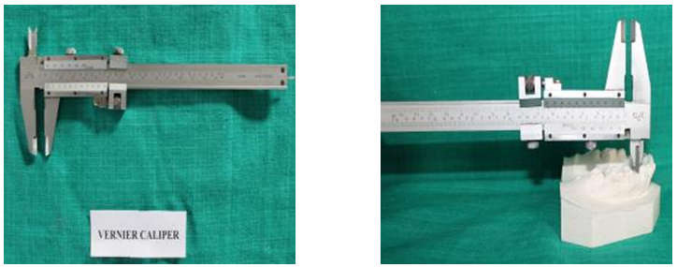


Fig 5 space measurement with vernier caliper

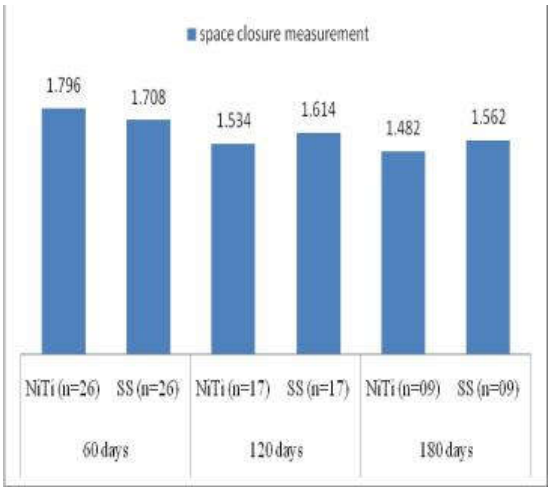
The mesial movement of maxillary first molars (anchorage loss) was evaluated through a transfer guide made up individually in the initial models of each patient (T0). A plug of auto-polymerizing acrylic resin adapted to the region of the palatine rugae had a 0.7mm SS wire extending as far as the mesial pit of the first molar. The guide made on T0 models was then positioned in models obtained at T3. The distance between the mesial pit of first molars and the tip of the wire was considered to be the amount of mesial movement of the maxillary first molars. (fig 6)

Fig 6 evaluation of mesial movement of first molar

RESULTS

In this study, the amount of retraction was measured at 60 days intervals for 6 months. The rate of retraction with stainless steel and Niti closed coil springs for both maxillary and mandibular arches are measured and tabulated. The amount of anchor loss in maxillary arch were also measured and tabulated. Statistical analysis was done using Statistical Package of Social Science (SPSS Version 15; Chicago Inc., USA). The student t-test was used to analyze the variation in the mean between nickel-titanium and stainless steel closed coil springs.

Descriptive statistics of space closure measurements at 60, 120 and 180 days time interval by NiTi and stainless steel closed coil spring. At 60 days space closure was higher for NiTi closed spring than stainless steel closed coil spring, whereas at 120 & 180 days, it was higher for stainless steel closed coil spring. But there was no statistically significant difference between NiTi and stainless steel closed coil spring at 60, 120 and 180 days time interval. (P=0.694,P=0.702,P=802 respectively) (graph 1)



Graph 1 space closure measurements at 60, 120 and 180 days time interval by NiTi and stainless steel closed coil spring

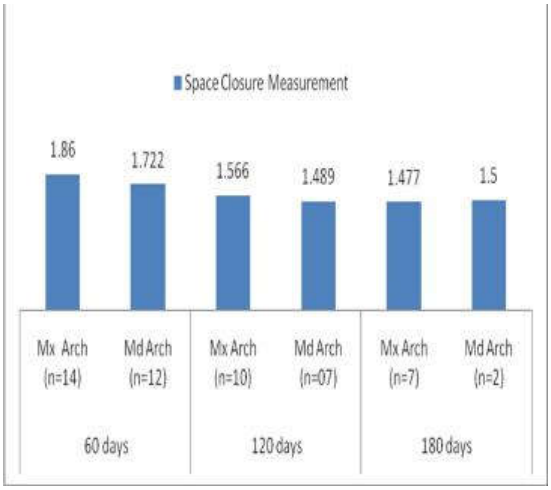
For maxillary Arch at 60 days space closure was higher for NiTi closed spring than stainless steel closed coil spring, whereas at 120 & 180 days it was higher for stainless steel closed coil spring. But, no statistically significant difference was found between NiTi and stainless steel closed coil spring at 60, 120 and 180 days time interval. (P=0.336, P=0.706, P=0.850 respectively) there was no statistically significant difference was found between NiTi and stainless steel closed coil spring at 60, 120 and 180 days time interval.(P=0.671,P=0.904,P=0.895 respectively) (graph 2)

Graph 2 maxillary arch space closure measurements at 60, 120 and 180 days time interval by NiTi and stainless steel closed coil spring

1. For mandibular arch at 60,120 and 180 days space closure was higher by stainless steel closed coil spring than NiTi closed coil spring. But there was no statistically significant difference was found between NiTi and stainless steel closed coil spring at 60, 120 and 180 days time interval.(P=0.671,P=0.904,P=0.895 respectively) (graph 3)

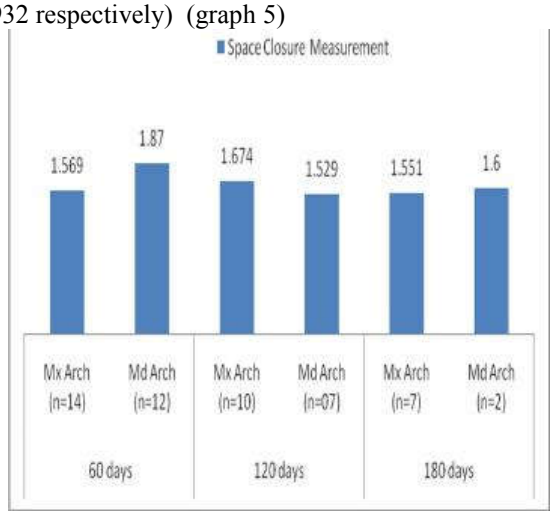
Graph 3 mandibular arch space closure measurements at 60, 120 and 180 days time interval by NiTi and stainless steel closed coil spring

Space closure measurements at 60, 120 and 180 days for maxillary and mandibular arch by NiTi closed coil spring. At 60 &120 days space closure by NiTi closed coil springs was higher for maxillary arch than mandibular arch, whereas at 180 days it was higher for mandibular arch. But there was no statistically significant difference in the mean space closure measurements at 60, 120 and 180 days between maxillary arch and mandibular arch.(P=0.663,P=0.729,P=0.970 respectively) (graph 4)



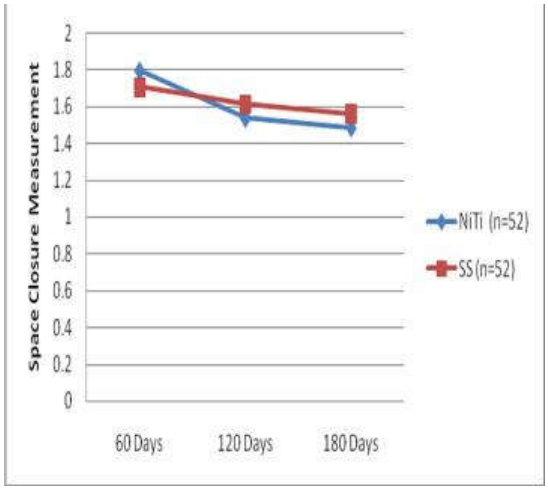
Graph 4 space closure measurements at 60, 120 and 180 days for maxillary and mandibular arch by NiTi closed coil spring

At 60 &180 days space closure by stainless steel closed coil spring was higher in mandibular arch than maxillary arch, whereas at 120 days it was higher in maxillary arch. But, no statistically significant difference was found in mean space closure measurements at 60, 120 and 180 days between maxillary arch and mandibular arch. (P=0.365, P=0.702, P=0.932 respectively) (graph 5)



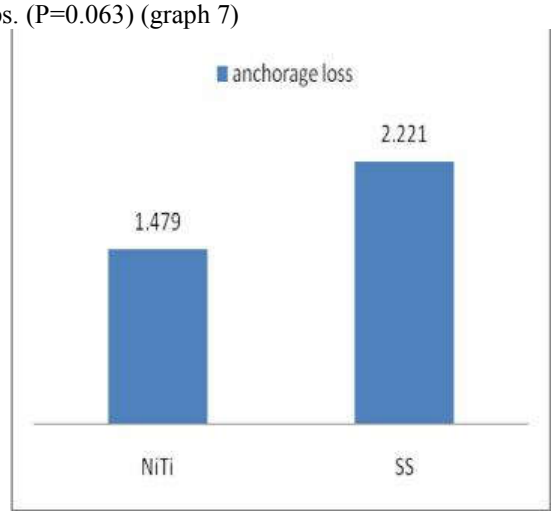
Graph 5 space closure measurements at 60, 120 and 180 days for maxillary and mandibular arch by SS closed coil spring

Table 6 reveals the space closure measurements at 60, 120 and 180 days time interval for NiTi & stainless steel closed coil spring. For NiTi it was 1.796mm at 60 days which reduced to 1.482mm at the end of 180 days, whereas for stainless steel closed coil spring it was found 1.707mm at 60 days which was reduced to 1.562mm at 180 days. For both the springs it was continuously decreasing with the time. But there was no statistically significant difference of mean space closure measurements at 60, 120 and 180 days. (graph 6)



Graph 6 space closure measurements at 60, 120 and 180 days time interval for NiTi & stainless steel closed coil spring

Mean value of anchorage loss in NiTi group is 1.479 which is less than the mean value for SS group (2.221). But, no statistically significant difference was found between both groups. (P=0.063) (graph 7)



Graph 7 anchorage loss

DISCUSSION

Rate of retraction for 60,120 and 180 days

Mean space closure measurements at 60, 120 and 180 days for nickel titanium closed coil springs were 1.796mm, 1.534mm and 1.482mm respectively, while that for Stainless steel spring were 1.708mm, 1.614mm and 1.562mm respectively. But there is no statistically significant difference in the rate of space closure between nickel titanium and Stainless steel closed coil spring at 60, 120 and 180 days time interval.

During space closure measurements sample size was reduced in 120 and 180 days group patients as compared to 60 days group patients because space was utilized either during leveling and alignment or by early space closure in these group patients.

At 60 days, rate of space closure was higher by nickel titanium closed coil spring while at 120 & 180 days rate of space closure was higher for stainless steel closed coil spring. But there was no statistically significant difference in the rate of

space closure between nickel titanium and stainless steel closed coil spring at 60, 120 and 180 days time interval.

Nickel-titanium closed coil springs provide light continuous forces for space closure because of their property of super elasticity and shape memory while stainless steel closed coil springs give efficient space closure when they are frequently activated within their elastic limit. This study has supported the fact of frequent activation of stainless steel closed coil springs which was responsible for more efficient space closure in comparison to NiTi closed coil springs.

Agarwal DK *et al* (2011)[2] in their study of orthodontic coil springs suggested that stainless closed coil springs on their minimal extension provide force level within optimal range and they are capable of providing clinically significant force level when extended to 100% level.

Boshart BF *et al* (1990)[3] in their study regarding load deflection range measurements of activated closed coil springs founded that with varying length of closed coil springs clinically valuable force level can be achieved. This factor may be possible for decreasing the force deflection rate required for optimal tooth movement.

Although this study has shown no significant difference in the rate of space closure between nickel-titanium and stainless steel closed coil springs, it is evident that both active elements are equally efficient to carry out space closure.

Time related rate of space closure

Space closure measurements for nickel titanium closed coil springs at 60, 120 and 180 days for maxillary arch are 1.86mm, 1.56mm and 1.47mm respectively, while that for mandibular arch are 1.72mm, 1.48mm and 1.50mm respectively. While space closure measurements for stainless steel closed coil springs at 60, 120 and 180 days for maxillary arch are 1.56mm, 1.67mm and 1.55mm respectively, while that for mandibular arch are 1.87mm, 1.52mm and 1.60mm respectively. This change in the space closure measurements can be attributed to force degradation with duration of time.

Angolkar PV *et al* (1992)[4] in their study of force degradation of closed coil springs founded that all the springs showed force loss over time. The major force loss was found to occur in the first 24 hours for most of the springs. They also found higher force degradation in one of nickel-titanium closed coil spring group and concluded the variation in the loss of force between nickel-titanium and Stainless steel closed coil springs.

Santos ACS *et al* (2007)[5] in their study found that nickel titanium closed coil springs shows progressive force decay over a period of time. This can be correlated with progressive decrease in the rate of space closure for closed coil springs.

Melsen B *et al* (1994)[7] found that there were some variation in the force provided by the same batch of the springs. This variation and the individual variation between patients are likely to have contributed to the variance of results for each of the spring. However this can also be attributed to the variation in the results shown by stainless steel closed coil springs.

Cox C *et al* (2014)[7] in their in vivo study of force decay of nickel titanium closed coil springs suggested that these springs do not deliver continuous force when used intraorally. The force decays in a non linear proportion to spring stretch duration. These findings can be attributed to the variation in the rate of space closure shown by these springs.

Anchorage loss in maxillary arch

Mean value of anchorage loss in NiTi group is 1.479 which is less than the mean value for SS group (2.221). Stainless steel closed coil springs have been found to cause more changes on the anchor teeth in comparison to nickel titanium closed coil springs. But, no statistically significant anchorage loss was found between both groups. (P=0.063)

The factors responsible for anchorage loss, as mentioned by **Geron S *et al* (2003)**[8] in his study can be multiple like crowding, age, mechanics, overjet. So these multiple factors may also be the reason for variable anchorage loss.
Light continuous forces are considered to be ideal for physiologic tooth movement[9],but as a clinician we need to be aware of variation in the force deflection and interval between activation for each type of active element used for space closure.

Both nickel titanium and stainless steel closed coil springs provide similar rate of space closure, so being cost effective stainless steel closed coil springs can be used as viable alternative.

Although no clinically significant differences were found between stainless steel and nickel-titanium closed coil springs, even then further evaluation probably with a larger sample size and by controlling other variable factors needs to be carried out.

CONCLUSION

- The following conclusions were drawn from this study
- Both nickel-titanium and stainless steel closed coil springs are efficient in providing space closure at similar rate.
- No significant difference was found in space closure by nickel-titanium and stainless steel closed coil springs.
- No significant difference was found in terms of anchorage loss by nickel-titanium and stainless steel closed coil springs.
- Being cost effective stainless steel closed coil springs can be considered as a good option for clinicians to carry out the process of space closure.

Acknowledgement

I take this opportunity to express my heartfelt gratitude to those who supported, guided and accompanied me throughout my research procedure. We thank our colleagues who provided insight and expertise that greatly assisted the research.

References

1. Choy K, Pae EK, Kim KH, Park YC, Burstone CJ. Controlled space closure with a statically determinate retraction system. Angle Orthod. 2002 Jun;72(3):191-8.
2. Agarwal DK, Razdan A, Agarwal A, Bhattacharya P, Gupta A, Kapoor DN. A comparative study of orthodontic coil springs. J Ind Orthod Soc 2011;45(4):160-8.
3. Boshart BF, Currier GF, Nanda RS, Duncanson MG. Load deflection rate measurements of activated open and closed coil springs. Angle Orthod. 1990;60(1):27-32.
4. Angolkar PV, Arnold JV, Nanda RS, Duncanson MG. Force degradation of closed coil springs: an in vitro evaluation. Am J Orthod Dentofacial Orthop. 1992 Aug;102(2):127-33.
5. Santos ACS, Tortamano A, Naccarato SRF, Dominguez-Rodriguez GC, Vigorito JW. An in vitro comparison of the force decay generated by different commercially available elastomeric chains and NiTi closed coil springs. Braz Oral Res. 2007 Jan-Mar;21(1):51-7.
6. Melsen B, Topp LF, Melsen HM, Terp S. Force system developed from closed coil springs. Eur J Orthod. 1994;16(6):531-9.
7. Cox C, Nguyen T, Koroluk L, Ko CC. In-vivo force decay of nickel-titanium closed-coil Springs. Am J Orthod Dentofacial Orthop. 2014 Apr;145(4):505-13.
8. Geron S, Shpack N, Kandos S, Davidovitch M, Vardimon AD. Anchorage Loss—A Multifactorial Response.Angle Orthod. 2003 Dec;73(6):730-7.
9. Krishnan V, Davidovitch Z. Cellular, molecular, and tissue-level reactions to orthodontic force. Am J Orthod Dentofacial Orthop. 2006 Apr;129(4):469.e1-32.

How to cite this article:

Dr. Peeyush Jain *et al* (2020) ' Space Closure Using Stainless Steel and Niti Closed Coil Spring: A Clinical Study', *International Journal of Current Advanced Research,* 09(07), pp. 22782-22787.
DOI: http://dx.doi.org/10.24327/ijcar.2020. 22787.4504

****