

Is nickel titanium superior to multistranded stainless steel wire in aligning crowded lower anteriors? A comparative in-vivo study.

DR. R. Ramya Vimalathithan¹, M.D.S., Dr.N.Kurunji kumaran², M.D.S, Ph.D.,
Dr. K. Rajasigamani³, M.D.S., Dr.R.S.Chenguttuvan⁴, M.D.S

^{1,4}(Department Of Orthodontics and Dentofacial Orthopedics, Madha Dental College and Hospital, Chennai, Tamilnadu, India.)

^{2,3}(Department Of Orthodontics and Dentofacial Orthopedics Rajah Muthiah Dental College and Hospital, Annamalai Nagar, Chidambaram, Tamilnadu, India.)

Abstract: Introduction: One of the most perplexing phenomena in orthodontics is the crowding of anterior teeth, which brings the patient to the orthodontist seeking remedy because of its aesthetic and functional consequences. The present study was aimed to clinically evaluate and compare the efficiency of NiTi and multistranded stainless steel wire during initial levelling and aligning of crowded lower anteriors. Material and methods: 30 subjects aged between 14 -20 were chosen for the study and divided in to two groups. All the subjects were fully explained about nature, purpose and treatment. Both groups were bonded with 0.022" MBT prescription brackets. After bonding, for Group A patients 0.016" NiTi arch wire was placed and secured with elastomeric modules, similarly for Group B patients 0.0155" multistranded (SS) wire was placed and secured. Time period needed for decrowding of each group was calculated. Result: Average number of days taken by nickel titanium wire in de-crowding mandibular anteriors is 89.67 days while multistranded SS wire took 113.2 days to de-crowd. Even though multistranded wire has low stiffness, because of its shape memory and super elasticity, nickel titanium wire is clinically efficient in decrowding severely crowded lower anteriors. To conclude, a marginal advantage of NiTi wire exists in accordance to the time period taken to decrowd mandibular anteriors.

Keywords: Aligning, Decrowding, Multistranded wire, NiTi wire, Shape memory.

I. Introduction

One of the most perplexing phenomena in orthodontics is anterior crowding. Vander Linden [1] classified crowding on the basis of its cause as primary, secondary, and tertiary. He defined primary crowding as an inherent discrepancy between tooth size and the available arch length, mainly of genetic origin. Secondary crowding was caused by environmental factors influencing the dentition, such as caries and extractions. Tertiary crowding or late crowding occurs in the post-adolescent period. Newer wires and innovations in the bracket systems have simplified and reduced the time span of the aligning stage.

One such innovation is Nickel titanium (NiTi) wires with the advantages of superelasticity, torsional strength, stress constancy, physiological compatibility, shape memory, dynamic interference, and wear resistance hysteresis. Earlier multistrand wire prevailed over multilooped arch wires due to their mechanical advantage, preformed availability and low load deflection rate.

Even though NiTi performance is superior in in-vitro [2,3,4], the present study was aimed to clinically evaluate and compare the efficiency of NiTi and multistranded stainless steel wire during initial leveling and aligning of crowded lower anteriors.

II. Materials and Method

A total of 102 patients screened out of which, 30 subjects (aged 14 -20) who fulfilled the following inclusion/exclusion criteria, were chosen for the study and divided in to two groups(Group A and Group B) among which 17 were male and 13 were female.

2.1 Inclusion criteria:

Subjects with following criteria were included in the study,

- Crowding in lower arch with irregularity index in the range of 7-9 (severe crowding).
- Therapeutic extraction of mandibular first premolars.
- All the permanent teeth erupted except third molar before experiment.

2.2 Exclusion criteria

Subjects with following criteria were not included in the study,

- Congenitally missing permanent teeth,
- Systemic disease condition,
- History of previous orthodontic treatment or trauma to orofacial region.

All the subjects were informed about the nature, purpose and treatment procedure. The study was duly reviewed and accepted by the Institutional human ethical committee. (IHEC, Annamalai University, India)

The little's irregularity index [5] was used to assess the crowding and the measurements were made on the initial cast using fine tip digital calliper and all values recorded.

All the clinical procedures were carried out by single operator (Dr.Ramya). The bonding procedure was standardised to all the subjects according to the manufacturer's specification. The bonding of 0.022" MBT brackets (Mini Master brackets, American orthodontics.) was done using light cure adhesive paste and primer (Transbond 3M Unitek). Passive lacebacks [6] were placed and were not tightened in subsequent visits. Group A subjects received 0.016" NiTi arch wire, where as Group B subjects received 0.0155" multistranded wire (SS). The wires were secured with elastomeric modules and cinched.

Subjects reported with loose bands, broken wires or lacebacks, dislodged brackets, missing or lost modules, poor oral hygiene maintenance leading to gingival hyperplasia will be excluded from the study and considered to be drop outs.

Patients were reviewed every month and modules changed in each appointment. Completion of decrowding was judged by visual inspection of proximal contacts and by little's irregularity index. Intra oral photographs and casts were made (figure 1, 1a, 2, 2a, 3, 3a and 4, 4a). The date of bonding and date of decrowding were recorded as D1 and D2 respectively. The time period taken for decrowding of mandibular anteriors for each groups was calculated as D2-D1.

III. Result

The arithmetic mean and standard deviation were calculated. Paired student 'T' test with 95% confidence level was used to compare both groups. Statistical significance level was established at $P < 0.05$. Construction of 95 percent confidence interval (PCI) and application of T-test to test the equality of mean days between multistranded wire and Nickel Titanium wire in de-crowding mandibular anteriors (Table 1&Graph 1).

Average number of days taken by nickel titanium wire in de-crowding mandibular anteriors is 89.67 days while multistranded SS wire took 113.2 days to de-crowd. As the observed P value 0.0004 is less than 0.05 (5%), we rejected the equality of mean days between multistranded wire and Nickel Titanium wire and the difference in such means is significant. Further the average number of days of the Nickel Titanium wire group is smaller than multistranded wire group, it was concluded that Nickel Titanium wire performed better than multistranded wire.

IV. FIGURES AND TABLES



Figure 1: Day one of bonding (D1) and after placement of NiTi wire (Group A)



Figure 1a: After decrowding (D2) using NiTi wire (Group A)



Figure 2: Day one of bonding (D1) and after placement of NiTi wire (Group A)



Figure 2a: After Decrowding (D2) using NiTi wire (Group A)



Figure 3: Day one of bonding (D1) and after placement of multistranded stainless steel wire (Group B)



Figure 3a: After decrowding (D2) using multistranded stainless steel wire (Group B)



Figure 4: Day one of bonding (D1) and after placement of multistranded stainless steel wire (Group B)



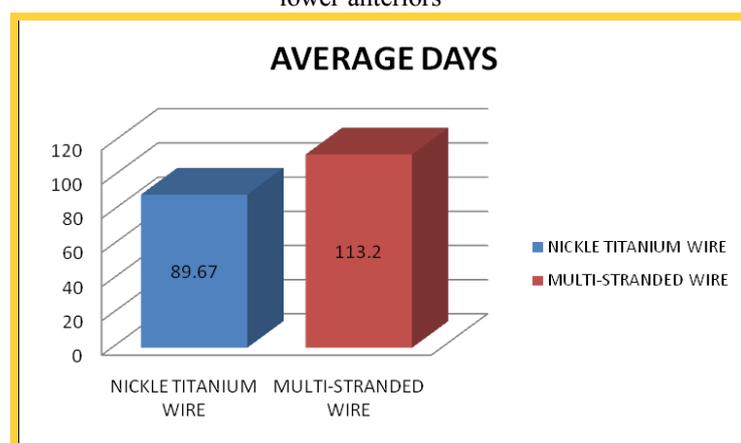
Figure 4a: After decrowding (D2) using multi stranded stainless steel wire (Group B)

Table 1: Statistical comparison of mean number of days taken by multistranded stainless steel wire and nickel titanium wire to decrowd the mandibular anteriors.

TYPE OF WIRE	N	Mean	SD	DF	T observed	P value
Multistranded SS wire	15	113.2	3	10	6.82	0.0004
Nickel Titanium wire	15	89.67	8			

N-Sample size, SD-Standard deviation, DF-Degree of freedom, P Value-5% level of significance.

Graph 1: Comparison of number of days between NiTi and multistranded stainless steel wire in decrowding lower anteriors



V. DISCUSSION

Although it is generally accepted that tooth movement should be undertaken with light forces, there is only circumstantial evidence to guide the clinician as to the appropriate level of force that should be applied, particularly during the initial alignment of irregular teeth.

Hyalinization of the periodontal ligament and consequent delays in tooth movement are liable to occur when any but the lightest forces are used for this type of movement as shown by Reitan [7]. Waters et al [4] have shown that conventional arch wires can generate very large forces, even when deflected by only very small amounts. The introduction of new metallic alloys paved way for rethinking the use of multi-looped arch wires for alignment. With newer alloys, the chair side time and duration of the treatment period were considerably reduced with less discomfort to the patient. One such alloy is Nickel titanium wires which have won a worldwide acceptance because of its high spring back and low stiffness. With the advent of the heat activated NiTi the range further increased.

One of the favourable properties of small diameter wire is its increased springiness; however its strength is questionable. When more than one small diameter wires are coiled together like multistranded wire, the property of springiness is almost maintained along with an increase in strength.

Hence a 0.0175" multistranded wires will have much more range and springiness than a 0.018" steel wire, and a much higher strength than the individual wires that are coiled. Finally the properties of multistranded wires depend on the individual wires that are coiled, and on how tightly they are coiled together.

Kusy and Stevens [8] studied the properties of triple stranded 0.0175" (3x0.008") SS wire and found that the stiffness was comparable to that of 0.016" NiTi. In contrast, in our study we encountered deformation of multistranded wire. Ingram et al [3] showed that for multistranded wires, the range was independent of wire size

and nearly consistent for different configurations of wires. This applies to round as well as rectangular multistranded wires.

Although multistranded wire might be an option, according to Taneja et al [9] they do not display the consistently low and moderately decreasing forces at different degree of deflection as NiTi wires do. Therefore, the clinician must have knowledge of the behaviour of multistranded wire when using them as NiTi substitutes.

The statistically significant difference in the performance of individual wires in various mechanical test stimulations, does not guarantee such difference will exist in clinical performance. In a crowded dentition, the high force may be dissipated through inter dental contacts and in overcoming friction among the brackets, wire, and ligatures. Evans et al [10] compared the alignment efficiency of multistranded stainless steel wire, superelastic NiTi and thermoactivated NiTi over a longer period in a controlled randomized trial and found no significant difference in aligning capability of these three wires. However in the present study NiTi wire decrowded the lower anteriors 21 days ahead of multistranded SS wire, this could be due to the increased incidence of wire deformation in multistranded stainless steel wires than super elastic NiTi wires. From the clinical point of view this marginal difference will not promise a reduction in treatment duration during aligning stage. Since our study focus only on the initial aligning stage, further studies are required to judge the efficiency of variable dimensions of NiTi wire at different treatment stages.

The amount of crowding should be a major consideration in selection of the wire, hence the present study recommends the use of NiTi wires for severely crowded lower anteriors where as multistranded SS wire might perform competitively in mild to moderate crowding.

VI. Conclusion

The following conclusion were drawn,

1. The average mean number of days taken by NiTi wire in decrowding mandibular anteriors was 89 days.
2. The average means number of days taken by multistranded stainless steel wire in decrowding mandibular anteriors was 113 days.
3. NiTi wires are efficient in decrowding the severely crowded lower anteriors than multistranded SS wires.
4. Incidence of wire deformation is increased in multistranded stainless steel wires than super elastic NiTi wires.

To conclude, with in the limitations of the present study, even though NiTi wires are efficient than multistranded SS wire, this can be considered as marginal advantage in accordance to the time period taken to decrowd mandibular anteriors.

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