Time to Alignment of Anterior Segment Crowding Treated with Niti and Copper Niti Arch Wires

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ABSTRACT

Objective: Treatment duration and cost are integral aspects of orthodontic treatment planning and are required to predict outcomes. Shorter treatment regimens prevent the adverse effects of orthodontic treatment. Contemporary arch wires have properties that potentially shorten orthodontic treatment time. This study aimed to determine the time to alignment of anterior segment crowding with NiTi and CuNiTi arch wires.

Methods: A randomized controlled trial carried out at the Orthodontic unit of a tertiary hospital. Thirty-two arches with Little's Irregularity Index (LII) of ≥ 4mm on anterior permanent teeth were involved in the study. The LII was measured on study models at pre-treatment and after commencement of orthodontic treatment, at each review visit until it reduced to 3.0mm or less. The results were analyzed on the Statistical Package for Social Sciences Chicago Inc. V. with Mann-Whitney U test, Kaplan-Meier methods, the Log rank test and Cox regression at $p<0.05$.

RESULTS: The arches had moderate 22 (34.3%), severe 25 (39.1%) and very severe 17 (26.6%) crowding. The mean time to alignment was 55.69 ± 20.18 days (CuNiti) and 67.19±33.91 days (Niti). The time to resolution of crowding for 50% of the arches was similar for the wires ($p = 0.07$). The resolution of crowding was 0.77 times higher with CuNiTi wires. Arches with initial severe crowding had a 4.56 increase in the time to alignment with every 1 mm increase in their LII (p value 0.05).

Conclusion

The time to alignment of anterior segment crowding with NiTi and CuNiTi arch wires was similar.

INTRODUCTION

Anterior segment crowding is a frequent occlusal feature seen in patients presenting to orthodontic clinics in Nigeria,[1-3] for which they require comprehensive orthodontic treatment to improve oral health, oral function, facial esthetics, self-esteem and psychological wellbeing.[4-8] During orthodontic treatment, however, patients are often anxious to complete treatment in the shortest possible time.[9] Shorter treatment regimens prevent patient burn out and adverse effects of orthodontic treatment such as root resorption. It also avails the orthodontist more time to accommodate more patients in the practice.[10] Adequate treatment is, however, not sacrificed simply for shorter duration of treatment to prevent relapse and improper root positioning.[9] For this reason, orthodontists take interest in procedures and materials that lead to faster treatment time, embracing new product , costly materials and technology claiming to produce shorter treatment times.[11,12] This includes the use of high technology arch wires in the first stages of fixed orthodontic (initial alignment stage) when tooth displacements are at its greatest.[10,13,16] The goal of treatment at this stage is to resolve labiolingual displacements, rotations and apical displacements, leading to a reduction in discrepancies of tooth position in the horizontal plane.[17] These labiolingual displacements are usually quantified using the Little's irregularity index.[18] Initial alignment is later followed by individual root torqueing and precise positioning to finish off orthodontic treatment.

Ideal arch wire for initial alignment should possess minimal stiffness, maximum range, medium strength, and ability to produce light forces which generate the best physiological (periodontal) response to elicit rapid tooth movement and prevent periodontal tissue damage.[19-21] Since after the introduction of the first Nickel-Titanium arch wire (Nitinol) in the early 1970s as an improvement over gold and stainless steel arch wires,[22] several other Nickel-Titanium (NiTi) alloy arch wires have been developed, each with an acclaimed superior alignment efficiency. These include: super elastic NiTi, Chinese NiTi, Japanese NiTi, and Heat activated NiTi archwires.[23-25] Copper Nickel Titanium arch wires were introduced in the mid-1990s.[22,26] They possessed lowered loading stress, making it easier to apply arch wires on severely displaced teeth while still providing a high unloading stress and uniform, light continuous forces, which potentially shortens orthodontic treatment time.[27] Thus, orthodontists now have a wide variety of choices for arch wires for initial alignment. The best arch wire to be used in each clinical situation should, however, be based on empirical research.

Previous clinical trials have compared different orthodontic arch wires to assess their effectiveness in tooth alignment.[16,28-32] Some trials produced results that challenged the claims made by manufacturers based on laboratory advantages of the arch wires such as a study by Evans in Wales[33] which found no significant difference in alignment between three types of NiTi and multi-stranded stainless steel wires unlike the advertised claims, emphasizing the need for clinical validation of laboratory claims.[33] Similarly, a study by Pandis in Greece[34] compared CuNiTi and NiTi arch wires using the statistical method for survival analysis (time to event analysis) to explore the time to alignment in crowded mandibular arches. The study showed that arches treated with CuNiTi arch wires had a longer time to alignment than those treated with NiTi arch wires. In that study, only one arch wire was used for treatment throughout the period of the study, instead of a sequence of increasing diameter arch wires as is the case in clinical practice.

Ong and co-workers in Australia,[35] using a sequence of increasing diameter wires, compared the alignment efficiency of NiTi, Heat activated NiTi and CuNiTi arch wire sequences while treating crowding with 0.018 slot brackets. The study observed that there was no statistically significant difference in the time to reach working arch wire between any of the 3 groups. The authors therefore concluded that there was no difference between the alignment efficiency of 0.014 NiTi and 0.014 CuNiTi arch wires, and recommended that future research with 0.022 slot prescription appliances may be beneficial. In order to provide more insight to the alignment efficiency of the various orthodontic arch wire types, a systematic review was performed by Jian et al[36] but it concluded that there was no reliable evidence to suggest one type of arch wire is superior in terms of alignment efficiency. More recent updates to the systematic review suggest that, there is still too little evidence to determine if there is a difference between conventional NiTi and Copper NiTi arch wires in terms of speed of alignment.[37,38]

Treatment duration and cost are integral aspects of orthodontic treatment planning as they help manage expectations, increase patient satisfaction and ensures successful outcomes.[39,40] Similarly, cost efficiency is a key concern in modern healthcare management, as prolonged treatments can negatively impact the profitability of orthodontic practices and healthcare systems.[41] High-tech arch wires, while potentially reducing treatment time, must be evaluated for both clinical effectiveness and cost efficiency. In the light of these, this study will contribute data from Nigeria that could inform treatment duration predictions and cost assessments, particularly if orthodontic services are to be included in the Nigerian national health insurance schemes. The results could also be valuable in future meta-analyses, providing strong evidence on the effectiveness of NiTi and Copper NiTi arch wires in treating anterior segment crowding. This study aimed to determine the time to alignment of anterior segment crowding when treated with NiTi and Copper NiTi arch wires. The null hypothesis was that there is no difference in the time to resolve crowding in the anterior segment when NiTi and Copper NiTi arch wire sequences are used for orthodontic treatment. The purpose of this study was therefore to determine the time to alignment of anterior segment crowding when using NiTi and Copper NiTi arch wire sequences for treatment in both maxillary and mandibular arches.

MATERIALS & METHODS

Materials: The participants' personal information was collected and documented, and pre-treatment study models were also obtained. The pre-treatment Little's Irregularity Index (LII0) was measured on these models using a fine-beaked digital caliper (CB Calipers, Brown and Sharpe, U.S.A., Accuracy +/- 0.02 per 150mm, Resolution 0.01mm) and recorded. Subsequently, the orthodontic treatment was initiated by placing brackets using the standard acid etch direct bonding technique, along with Roth 0.022 prescription attachments (Redi-Pak Prescription kit, Lancer Orthodontics Inc., 2330 Cousteau Court, C.A, U.S.A). The assigned arch wires, either NiTi (G4™ nickel titanium arch wire, G&H Wire Company U.S.A) or CuNiTi (Damon optimal force copper NiTi®, Ormco Corporation, Glendora, C.A, and U.S.A), were then placed and secured using elastic ligatures. The sequence involved using a 0.014" diameter arch wire initially, followed by a 0.016" diameter arch wire in both NiTi and CuNiTi groups. Post-operative instructions, both verbal and written, were provided to the participants.

Methods:

Study Design: This was a randomized controlled trial carried out at the orthodontic clinic of the University College Hospital in Ibadan between October 2015 and October 2017.

Ethical Review: Ethical clearance for this study was sought for and obtained from the University of Ibadan/College Hospital Ethical Committee with approval number UI/EC/14/0275. Written informed consent was obtained from all the participants and their guardian, a verbal explanation of the procedure was also given to the participants and a verbal assent was also obtained from participants less than 18 years old.

Inclusion Criteria: Individuals aged 10 to 18 years were invited to participate in the study if they possessed fully erupted anterior permanent teeth (i.e., incisors and canines) in either the upper or lower arch, or both arches. In addition, those who had no prior orthodontic treatment history and had anterior segment crowding with a Little's Irregularity Index score (LII) of 4mm or higher, indicating moderate, severe, or very severe crowding18, were included in the study.

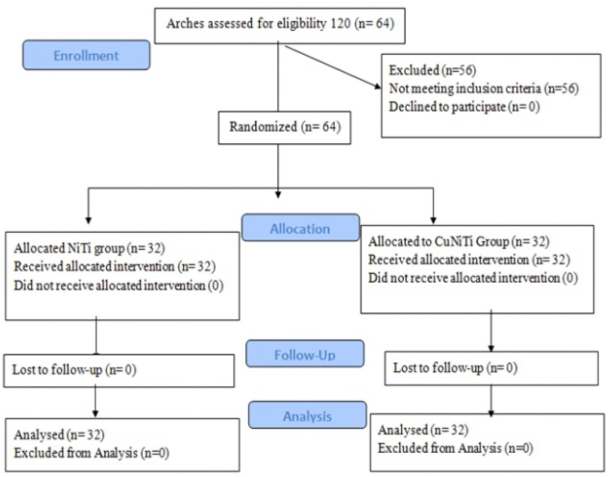


Fig 1. CONSORT flow chart showing patient flow during the trial

Exclusion Criteria: The presence of mild crowding in the anterior segment, defined by a Little's Irregularity Index of less than 4mm[18]; history of using medications known to affect tooth movement rates (e.g., bisphosphonates); sole need for a segmental fixed appliance; impacted teeth requiring exposure; craniofacial syndromes like cleft lip and palate; morphological anomalies in teeth such as peg-shaped laterals; lingually/palatally displaced teeth that cannot be bonded during the initial bonding visit; systemic disorders like sickle cell disease, or a refusal to participate in the study.

Sample size and Randomization: The determined sample size for each group was 32 arches, resulting in a total of 64 arches from 60 participants included in the study for the two groups. The allocation of participants into the arch wire groups (NiTi group and CuNiTi group) was achieved through simple balloting process. Participants were required to have at least one arch meeting the inclusion criteria, which could be either the maxillary arch, mandibular arch, or both. In cases where orthodontic treatment was needed for both arches but only one arch fulfilled the inclusion criteria, both arches were treated with the same type of arch wire to ensure uniformity.

Each participating arch was assessed every 6 weeks after the brackets were bonded and initial wires were placed, with a maximum observation period of 24 weeks (equivalent to 4 visits). During each review visit, study models were acquired, and the Little's Irregularity Index (LII) was measured on the models until the LII reduced to 3.0mm or less. The casts obtained at pre-treatment, 6 weeks, 12 weeks, 18 weeks, and 24 weeks were sequentially labeled as LII 0, LII 1, LII 2, LII 3, and LII 4, respectively. For arches that achieved a reduction in LII to 3.0mm or less before the conclusion of the 24-week review period, their orthodontic treatment progressed to the next stage, employing stiffer arch wires as the arch reached the predetermined endpoint. Consequently, these arches exited the study. Additionally, arches that did not attain alignment by the end of the 24-week review period had their orthodontic treatment continued as deemed appropriate, concluding the study for that arch at that point, and they exited the study.

Data analyses: The results were analyzed using the Statistical Package for Social Sciences Chicago Inc. V. 21.0 statistical software. Kaplan-Meier methods of survival analysis and the Log rank test were used for bivariate statistical analysis. Cox regression was used for multivariate analysis. The level of statistical significance was set at $p<0.05$[42,43].

The Kaplan-Meier method is a time to event method of survival analysis used in studies that involve recruitment of participants at different dates, but the length of the study is the same for all participants (as obtained in this study); it takes into consideration information about participants up to the point that they achieved the planned event (alignment)[42,44,45].

RESULTS:

Sixty subjects participated in this study. From these participants, 64 arches were included in the study. Their demographics and clinical characteristics are shown on Table 1.

Table 1: Demographics and Clinical Characteristics of Study Participants

Clinical Characteristics		Frequency N =60	Percentage %
Age (years)			
11-14	Mean age = 15.43	24	40.0
15 -18	SD ± 2.46 years	36	60.0
Gender			
Male		21	35.0
Female		39	65.0
Angle's classification			
Class I		46	76.7
Class II		9	15.0
Class III		5	8.3
Overjet			
1-3mm		29	48.3
4-6mm		22	36.7
7-13mm		9	15.0
Overbite			
Normal		24	40.0
Increased		16	26.7
Decreased		20	33.3

SD = Standard Deviation

Distribution of arches, treatment modality & pre-treatment Little's severity of crowding between arch wire types

There was an even distribution of the arches with respect to the arch wire type: 32 (50%) of the arches were treated with NiTi arch wire and a similar proportion for CuNiTi. Among the arches treated with NiTi arch wire, 18 (56.2%) were maxillary arches and 14 (43.8%) were mandibular arches. Nineteen (59.4%) maxillary arches and 13 (40.6%) mandibular arches treated with CuNiTi arch wires as shown on Table 2. Their treatment modality and pre-treatment Little's Index severity of crowding are also seen in Table 2.

Table 2: Distribution of arches, treatment modality and pre-treatment crowding levels

Arch wire types	NiTi n=32(100%)	CuNiTi n=32(100%)	Total N= 64(100%)
Arches			
Maxillary	18(56.2)	19(59.4)	37(57.8)
Mandibular	14(43.8)	13(40.6)	27(42.2)
Treatment Modality			
Premolar extraction	18(56.2)	10(31.3)	28(43.8)
Non-Premolar extraction	14(43.8)	22(68.7)	36(56.2)
Pre-treatment Little's Irregularity Index			
Moderate (LII 4.0-6.9mm)	10(31.3)	12(37.5)	22(34.4)
Severe (LII 7.0-9.9mm)	12(37.5)	13(40.6)	25(39.0)
Very severe(LII ≥10.0mm)	10(31.2)	7(21.9)	17(26.6)

Comparing time to alignment of anterior segment crowding for arches and arch wire types

Arches treated with CuNiTi arch wires had a mean time to alignment of 55.69 days ± 20.18 days, while arches treated with NiTi arch wires had a mean time to alignment of 67.19±33.91days. This difference was not statistically significant using the Mann-Whitney U test (p-value = 0.27).

Maxillary arches had a mean time to alignment of 62.16 ± 32.38days, while for mandibular arches it was 60.44 ±22.22days. This difference was also not statistically significant when subjected to Mann-Whitney U test (p-value =0.65). See Table 3.

Table 3: Comparison of time to alignment of anterior segment crowding for the arches and arch wire types

	Time to alignment (Days)						
	Mean(SD)	Median	Minimum	Maximum	IQR	U Value	p- value
NiTi	67.19(33.91)	48.00	42.00	168.00	42	432.00	0.27
CuNiTi	55.69(20.18)	42.00	42.00	98.00	38		
		Arches					
Maxillary	62.16(32.28)	42.00	42.00	168.00	41	467.50	0.65
Mandibular	60.44(22.22)	50.00	42.00	98.00	42		

SD = standard deviation; IQR = Interquartile range; U value = Mann-Whitney U test value

Comparing the time to alignment within the arches

Using the Kruskal-Wallis test to compare time to alignment within the arches, it was found that there was no statistically significant difference in the time to alignment between the different levels of crowding in the maxillary arch (p=0.307) nor in the mandibular arch (p=0.065). This is shown in Table 4

Table 4: Comparing time to alignment within the arches

	Number of arches (N)	Kruskal Wallis	Mean rank Value	p-value
Maxillary Arches (n=37)				
Moderate (LII=4.0-6.9mm)	12	18.50		0.307
Severe (LII=7.0-9.9mm)	14	18.50		
Very severe (LII≥10mm)	11	20.18		
Mandibular Arches (n=27)				
Moderate (LII=4.0-6.9mm)	10	9.70		0.065
Severe (LII=7.0-9.9mm)	11	15.36		
Very severe (LII≥10mm)	6	18.67		

Comparing the probability of achieving resolution of crowding at different time intervals for the arch wire types using Kaplan Meier method of survival analysis and the Log Rank Test

The probability that arches in this study treated with NiTi arch wires will survive (not achieve alignment) between the 6th and 12th week (42-84 days) was 0.22 as denoted by the survivor function – SF = 0.22. Conversely the probability for achieving alignment during this interval was 0.78.

At this same interval, the probability that arches treated with CuNiTi arch wires in this study will not achieve alignment was 0.13 (SF=0.13), while the probability to achieve alignment was 0.87. This value is higher than that for the NiTi arch wires. This is shown in Table 5. This difference, however, was not statistically significant with the Log rank test (p=0.07). By the end of 18 weeks, 100% of the arches treated with CuNiTi arch wire sequence had achieved alignment, while it was 90.6% for arches treated with NiTi arch wire sequence.

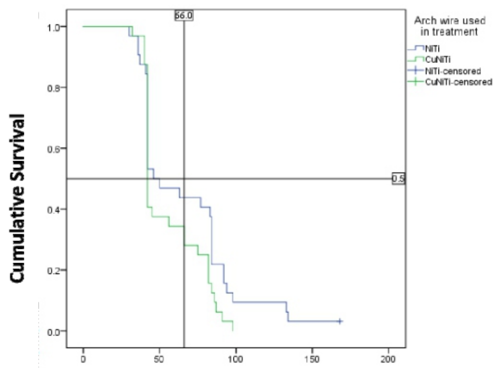
The values obtained from Table 5 were used to generate the Kaplan Meier plot shown in figure 2. From the horizontal line in the figure, it can be deduced that fifty percent of the arches treated with CuNiTi arch wires achieved resolution of anterior segment crowding by 48 days, while it was 50 days for the same proportion of arches treated with NiTi arch wires. This difference was also found not to be statistically significant (Log Rank Test x^2 =3.36; p =0.07).

The vertical line in the figure shows that at the median treatment time of 66 days, 44% of arches treated with NiTi were yet to achieve resolution of anterior segment crowding compared with 28% for the arches treated with CuNiTi arch wires.

Table 5: Comparing the probability of survival at time interval by arch wire type

Time (Days)	*Censored Arches (*a*)	‡Events (*b*)	Cumulative number of events	Remaining cases	†Cumulative proportion surviving (Survivor Function SF)	⸸Probability of alignment = (1-SF)
NiTi Arch Wires						
42 – 84	32	25	25	7	0.22	0.78
85-126	7	4	29	3	0.09	0.91
127-168	3	3	32	0	0.00	1.00
CuNiTi Arch Wires						
42 – 84	32	28	28	4	0.13	0.87
85-126	4	4	32	0.00	0.00	1.00
127-168	0	0	32	0.00	0.00	1.00

*Censored arches – Number of arches that had not achieved resolution of crowding prior to an interval.
‡Events – Number of arches with resolution of crowding during an interval.
†The survivor function (SF) denotes the cumulative probability of survival which is the probability of not achieving alignment in that interval.
⸸The Probability of alignment at an interval = 1- Survivor Function of that interval.



Log Rank Test x^2 = 3.36, p- value = 0.07

Fig 2. The survival probabilities by arch wire types using Kaplan-Meier survival estimates

Cox regression for the effect of predictors on the probability of alignment of anterior segment crowding

The probability of achieving resolution of anterior segment crowding was 0.77 times higher in arches treated with CuNiTi arch wires compared with those treated with NiTi arch wires, though this difference was not statistically significant (p value = 0.38) as shown in Table 6.

Pre-treatment LII was noted to be a significant predictor of time to alignment, for arches with severe crowding there was 4.56 increase in the time to alignment with every 1 mm increase in the LII (p value <0.05).

Table 6: Cox regression for the effect of predictors on instant probability of alignment

	Exp(β)	95% Confidence Interval	p value
Arch wire type			
NiTi	Reference		
CuNiTi	0.77	0.44–1.38	0.38
Pretreatment severity			
Moderate crowding	Reference		**0.007**
Severe crowding	4.56	2.06-10.05	
Very severe	2.68	1.13-5.50	

* Exp(β) is the probability of achieving alignment. It is interpreted as the relative risk of an event

DISCUSSION

This study aimed to determine the time to alignment when using the cheaper NiTi or more costly Copper NiTi arch wire sequences for treatment of anterior segment crowding, in patients in an Orthodontic clinic in a Nigerian tertiary hospital. The finding of a study showed that crowded arches treated with CuNiTi arch wire sequence had higher probability of achieving full alignment within twelve weeks when compared with crowded arches treated with NiTi arch wire sequence. Similarly, the time to alignment in days was shorter by about 11 days, among crowded arches treated with CuNiTi arch wires compared with the arches treated with NiTi arch wires. In addition, 100% of the arches treated with CuNiTi arch wire sequence had achieved alignment by the end of 18 weeks, while it was 90.6% for arches treated with NiTi arch wire sequence. These differences, however, were not statistically significant. Thus, our null hypothesis could not be rejected which stated that, "there is no difference in the time to resolve crowding in the anterior segment when NiTi and CuNiTi arch wire sequences are used for orthodontic treatment." These findings align with findings from a research by Azizi et al[46] who compared alignment with a super elastic NiTi and CuNiTi arch wires for alignment efficiency and found no statistically significant difference.

Although, the study by Azizi et al observed the treatment arches for 6 weeks while the present study observed the arches for a maximum of 24 weeks. Another study by deCastro Serafim et al[32] compared the time to alignment of anterior crowding treated with NiTi arch wires and Heat activated NiTi arch wire, and reports similar findings to this present study, with 100% of the arches treated with Heat activated NiTi achieving alignment at the end of the 5 months study period while it was 70% for the arches treated with NiTi arch wires. The Heat activated NiTi arch wires and CuNiTi arch wires belong to the same class of Thermoelastic Active Martensite, also known as thermodynamic alloys or Martensitic active alloys. These alloys exhibit a thermally induced shape memory effect. Their transitory temperature range is close to intra oral temperature. When preformed arch wires of the active martensitic alloys are inserted into the mouth, the original preformed shape is distorted. The warmth of the oral cavity activates the wire and causes it to return to its preformed shape — in so doing, it brings a pull on the teeth and causes movement.[21] Alloys can transform from one crystalline internal structure or phase to another.[47] The Martensitic phase exists at low temperature or high stress while the Austenite phase exists at higher temperature or low stress. This transformation, called martensitic transformation, is reversible and occurs at a set Transition Temperature Range (TTR),[48] in response to changes in temperature (thus exhibiting true shape memory) or changes in applied force (thus exhibiting super elasticity).[49] However, NiTi arch wires belong to the class of Martensitic stable wires so they do not transform readily, while CuNiTi arch wires belong to the class of austenitic active alloys which means that they can transform readily at the set TTR.[22]

The force produced by the austenitic active wires do not vary over a large range of deflection, thus, producing constant levels of forces – the light continuous forces necessary for the physiological tooth movement. This may explain the faster time to alignment noted among the arches treated with CuNiTi arch wires. A study by Pandis et al[15] showed results contrasting with the findings of this present study. Pandis et al noted that arches treated with CuNiTi arch wires had longer time to alignment compared to those treated with NiTi arch wires.[15] This may have been because Pandis et al used the 37^{0}C CuNiTi arch wires used in their study, which had an austenite finish transition temperature of 37^{0}C and, thus, delivered lower forces compared to the 27^{0}C CuNiTi arch wires used in the present study. CuNiTi arch wires manufactured with an austenite finish (A_f) transition temperature of 37^{0}C are expected to be martensitic at room temperature but partially austenite at oral temperature of 36^{0}C. CuNiTi 37^{0}C arch wires are known to deliver lower force values compared to the 27^{0}C CuNiTi.[50] Considering the arch wire groups, the mean time to alignment in days obtained in this study was about 50–70 days shorter when compared with values obtained from the study by Pandis et al.[15] This may be because treatment was carried out in this study using a sequence of increasing diameter arch wires (0.014; 0.016) leading to faster time to alignment, unlike in the study by Pandis et al,[15] where only one arch wire was used throughout the study. In comparison with the study by Ong et al,[35] the mean time to alignment in this study was about 2 months shorter. The study by Ong et al also used a sequence of arch wires but observed the arches from the date of the first arch wire placement up to the date of placement of the working rectangular arch wire, hence, the longer time observed. Time to alignment in this study was defined as length of time in days from the date of the first arch wire placement to date of observation of an irregularity index (LII) of 3.0mm, after which the arches may be treated with other arch wires such as 0.018 stainless steel and 0.020 stainless steel before the placement of the working rectangular arch wire — 0.019 x 0.025 stainless steel as was the protocol of the clinic.

Comparing the time to alignment and pre-treatment severity of crowding using the Little's irregularity index LII, it was observed that pre-treatment crowding level was the only significant predictor of time to alignment as arches with severe and very severe crowding had a higher probability of a longer time to alignment compared with arches with moderate crowding. This is similar to findings from a previous study where the severity of crowding was also noted to be a predictor of time to alignment.[15] Thus, the more severe the crowding, the higher the probability of a longer treatment time or longer time to alignment. The implications of findings from this study may mean that the superior laboratory properties of the CuNiTi arch wires did not translate clinically to outperform the NiTi arch wires used in this study and, thus, may not justify the additional cost of using the CuNiTi arch wires for initial alignment in moderate to severe anterior segment crowding, except as part of a special appliance system. The variation in days between the groups of arch wires may not make much of a difference in choosing between the two arch wires based on the time to alignment. But the values obtained in this study can be used in predicting the performance of both arch wires in a clinical situation.

The finding from this study can influence clinical decision-making by highlighting that the perceived benefits of copper NiTi wires in terms of faster alignment may not be as substantial as previously thought. This can lead to more evidence-based choices in treatment planning. Orthodontists may need to reconsider using CuNiTi arch wires solely with intent of reducing treatment time since the time to alignment is not significantly different from the NiTi arch wire. Thus, the choice of arch wire material might be based more on other factors such as cost, and specific clinical scenarios. Copper NiTi arch wires are often more expensive than traditional NiTi wires, since they do not offer a significant advantage in treatment duration, practitioners may opt for the more cost-effective option without compromising treatment outcomes.

Limitation

For this study, the date of alignment was taken as the day the participants arrived for their routine review, though there is a possibility that the arches may have achieved alignment before the date of presentation. As it was not possible to observe the participants at home, the date of presentation was taken as the date of the observation. The study opens avenues for further research to explore other potential benefits of copper NiTi wires, such as pain reduction, ease of use, or long-term stability, which might justify their use despite the lack of significant difference in alignment time.

Conclusion

There is no difference in the time to alignment when NiTi and CuNiTi arch wires are used in the initial alignment stage for treatment of anterior segment crowding in the maxillary arch or in the mandibular arch. Thus, the more expensive CuNiTi arch wires do not offer a significant advantage over the cheaper NiTi wires in producing faster rate of tooth movement when used in initial alignment for anterior segment crowding. In addition, the severity of the pre-treatment anterior segment crowding measured using the Little's Irregularity index is an important predictor of the time to alignment when measured in days. The more severe the crowding, the higher the probability of a longer time to alignment.

Recommendations

Based on the findings of this study, the authors recommend that there may be no need for the extra cost associated with the use of CuNiTi arch wires except they are readily available and affordable as the NiTi arch wires perform equally well. Furthermore, the severity of anterior segment crowding based on the Little's Irregularity Index should be taken into consideration when predicting possible duration of treatment as well as in counselling patients on possible treatment time.

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