Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

A Comparative in vivo evaluation of clinical effectiveness between traditional cu-niti and SmartArch^{TM} Multiforce Archwires in the early stages of orthodontic alignment

Poovizhi Thamizhkumaran
Vinayaka Missions University
Hanumanth Sankar
hanumanth001@gmail.com

Vinayaka Missions University
Sabarinathan Jaganathan
Vinayaka Missions University
Vasanthan Palanivel
Vinayaka Missions University
Udhayan Ashokan
Vinayaka Missions University
Revathy Seetharaman
Vinayaka Missions University
Karthikraja Selvarajan
Vinayaka Missions University

Research Article

Keywords: Copper NiTi, SmartArch multiforce, alignment efficiency, Little's Irregularity Index

Posted Date: September 14th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10675392/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background:

Archwires are essential in fixed orthodontic treatment as they provide the forces necessary for tooth movement. Traditional copper-nickel-titanium (Cu-NiTi) archwires provide continuous, uniform forces, whereas newer SmartArch™ multiforce archwires are designed with variable-force zones to optimise tooth movement. However, clinical evidence comparing their effectiveness remains limited.

Aim:

To compare and evaluate the alignment efficiency of Traditional Cu-NiTi archwires and SmartArch™ multiforce archwires during the initial phase of orthodontic treatment.

Materials and Methods:

This prospective, single-centred, randomised comparative clinical study included 30 patients (15 per group). Group A received conventional Cu NiTi archwires, while Group B received SmartArch™ multiforce archwires. Clinical evaluations were performed at baseline (T0) and at intervals of four weeks up to 16 weeks (T4), an assessment of Alignment efficiency was performed using Little's Irregularity Index (LII). The secondary outcomes involved measuring intercanine and intermolar widths. Statistical analysis was carried out using independent and paired t-tests, with significance set at $p < 0.05$. Results: Both groups showed a significant reduction in Little's Irregularity Index (LII) over time, achieving complete alignment by T4. However, there were no statistically significant differences observed between the two groups at any point regarding alignment efficiency, intercanine width, and intermolar width ($p < 0.05$). Transverse changes were mainly observed in the anterior region, while the dimensions in the posterior area remained the same.

Conclusion:

Both SmartArch™ and traditional Cu-NiTi archwires effectively achieved initial orthodontic alignment, with both groups demonstrating a significant reduction in Little's Irregularity Index. The two types of archwires produced similar increases in intercanine width, while intermolar width remained unchanged, indicating that the primary movement occurred in the anterior teeth.

TRIAL REGISTRATION

CTRI/2026/03/106428 [Registered on 17/03/2026] Clinical Trial Registry India, (https//ctri.nic.in/Clinicaltrials/main1.php?EncHid=88300.90308)

Introduction:

Arch wires are used in fixed orthodontic appliances to apply force to teeth for orthodontic tooth movement. No single arch wire is suitable for all phases of treatment.[1] Orthodontic fixed appliances deliver continuous forces, in contrast to removable appliances that provide intermittent forces. If the forces from fixed appliances are too intense, they could lead to OIIRR (Orthodontic Induced Inflammatory Root Resorption).[2] Cu-NiTi arch wires are marketed to orthodontists due to their distinct features, including the ability to release forces intermittently and being offered in various transformation temperature ranges.[3] Cu-NiTi arch wires were designed to deliver greater effective force during deactivation and sustain a more consistent force level as the teeth progressively approach their desired alignment.[4] Among the arch wires evaluated, the Ormco Cu-NiTi wires initially exhibited the lowest surface roughness and consistently maintained a smoother surface throughout the alignment period, making them the most suitable choice for orthodontic alignment.[5] Despite these advantages, NiTi and Cu-NiTi arch wires deliver uniform forces along their entire length.[6,7] To overcome the limitations of uniform force delivery, an alternative approach was developed using patented pulsating laser technology. This advanced technique enables the fabrication of SmartArch™ Multiforce arch wires with differential force zones along their length.[8] SmartArch™ Multiforce arch wire is a thermodynamically graded wire designed to deliver varying levels of force along the arch wire, with forces gradually increasing from the anterior to posterior segments. It incorporates ten distinct unloading zones.[9] SmartArch™ archwires are roughly twice as expensive as Cu-NiTi archwires. Their performance should be examined in a clinical setting, given their high cost and oral clinical conditions. There is insufficient clinical Research on this topic, underscoring the need for clinical trials to assess their effectiveness. Consequently, the aim of this research was to assess the clinical effectiveness of SmartArch™ Multiforce archwires (Ormco). The purpose of this study is to compare and analyze the efficiency of alignment between Traditional Cu-NiTi arch wires (Ormco) and SmartArch™ Multiforce archwires (Ormco). Additionally, this study aims to assess differences in the width of canines and molars in both the maxillary and mandibular arches in both groups.

METHODOLOGY:

Patients attending the Department of Orthodontics were screened for eligibility. The study was conducted after obtaining Ethical clearance from the Institutional Ethics Committee. This is a Prospective, Single-Centred, Randomised, Comparative clinical study design. Simple randomization is done. The study has received ethical approval from the institution's ethical committee (IEC/447). A minimum of 30 samples (15 per group) was needed, with a final sample size of 30 (15 per group), a 75% precision minimum necessary for the investigation, and a 95% confidence interval and margin of error of 5%. All patients were treated with a preadjusted edgewise appliance (0.022 Slot; AO minimaster), and Group A received 0.016 Traditional Cu-NiTi wire; Group B received SmartArch™ Multiforce wire (ORMCO). The inclusion criteria are: A patient with mild to moderate crowding and a Class I malocclusion,15 to 25 years old with a permanent dentition, Little's irregularity index ranges from 4 mm to 8 mm, No prior

history of incisor damage or root resorption, Patients who are willing to take part in the research The Exclusion criteria are: Prior orthodontic therapy, Less than 4 mm of crowding with a low irregularity index, Individuals receiving endodontic treatment and periodontal disease patients, Patient with anterior region spacing, Patients whose teeth were blocked out and prevented the bracket from being placed during the initial bonding visit. The design of this study was single-blinded. Due to the nature of the investigation, the operator/principal investigator could not be blinded, as their direct participation in the clinical procedures was necessary. However, participant blinding was maintained throughout the intervention to reduce any bias. Every patient participating in the study was bonded following a standardised direct bonding protocol to ensure uniformity and minimise procedural discrepancies.

A bracket positioning gauge (MBT) was placed to ensure exact vertical and horizontal alignment. Archwires were put in accordance with the designated research groups once the bonding process was finished. Group A participants received 0.016-inch Traditional Copper nickel-titanium archwires (Ormco, USA), while Group B participants received 0.016-inch SmartArch™ MultiForce archwires (Ormco, USA). To guarantee uniform engagement for every subject, each archwire was carefully inserted into the bracket slots and fastened with elastomeric modules. Both groups had follow-up appointments every four weeks while the archwires were in place for a total of sixteen weeks. The archwires were evaluated for deformation, breakage, and displacement at each visit. The same archwire was kept unless clinical circumstances necessitated its replacement, and elastomeric modules were routinely changed at each consultation to ensure consistent force levels.

Clinical Evaluation Time Points:

Before the first archwire was inserted, baseline recordings were gathered and labelled as T0. Patients were revisited every four weeks after beginning the treatment. Four weeks after the first archwire placement, the first follow-up (T1) was conducted. Further evaluations were conducted at 8 weeks (T2), 12 weeks (T3), and 16 weeks (T4). To assess anterior alignment and transverse dimensions changes, Intraoral scans of both the upper and lower dental arches were obtained during every session with the Fussen intraoral scanner. Little's Irregularity Index was utilized to assess the measurements alignment at each level. To evaluate changes in arch width over the course of treatment, intercanine and intermolar widths were also evaluated at each interval with DentOne Software (Fig. 1).

All examinations and data collection procedures were carried out by a single examiner to ensure consistency and reduce measurement variability.

Primary Outcome Measure :

Anterior alignment was evaluated using LII, The degree of irregularity in the anteriors is assessed by calculating the linear distance between neighboring contact points from one canine to the other. (Fig. 2,3,4,5,6)

Secondary outcome measures:

Intercanine width was determined by measuring the straight-line distance between the cusp tips of the right and left permanent canines. To evaluate alterations in transverse dimensions during the initial alignment phase, this measurement was recorded at the baseline and during each following assessment period. Intermolar Width was taken between the mesiobuccal cusp points of the right and left first permanent molars was used to calculate the intermolar width. To assess changes in posterior transverse arch width associated with archwire engagement during alignment, measurements were taken at each time point.

This study adheres to CONSORT Guidelines and follows the checklist.

Statistical analysis :

IBM SPSS Statistics .Statistical analysis was conducted after the data was inputted into Microsoft Excel.Descriptive statistics, such as the average and standard deviation, were computed for each variable in the study. A significance level of $p < 0.05$ was established as the threshold for determining statistical significance. The data's normality was assessed using the Shapiro-Wilk and Kolmogorov-Smirnov tests. The average values for both the SmartArch ^{TM} archwire group and the Traditional Copper NiTi archwire group were evaluated at each time point using the Independent Samples t-test. To make comparisons within each group, the Paired Samples t-test was employed to evaluate the changes in measurements at different time intervals within each group. This investigation assisted in figuring out how the Smart archwire group's alignment changed over time and the conventional NiTi archwire group. Two-tailed tests were used for all statistical analyses, and results were considered statistically significant if the p value was < 0.05

Results:

In the SmartArch™ group, most variables across time intervals had p-values 0.05, indicating that the data were normally distributed. However, certain measurements, such as canine at T0, Little's irregularity index measured at T2 and T3 revealed p-values lower than 0.05, indicating a departure from normal distribution at these time points. In the Conventional Copper NiTi archwire group, most measurements exhibited a normal distribution (p 0.05) across the various time periods. However, a few variables including LII at T1 and T3 presented P values below 0.05, indicating a non-normal distribution during those periods. Regarding Little's irregularity index at T4, the test statistics were not computed because the values were constant (zero), which prevented normality testing. Overall, the results indicate that most study variables were normally distributed, allowing the use of parametric tests (independent and paired t-tests) for further analysis. (Table 1)

Table 1
Tests of Normality for Different Tooth Types at Various Time Intervals in Smart Cu-NiTi and Conventional Copper NiTi Archwire Groups (Kolmogorov–Smirnov and Shapiro–Wilk Tests)

Time	Type of Teeth	Type of Group	Kolmogorov-Smirnova			Shapiro-Wilk		
			Statistic	df	Sig.	Statistic	df	Sig.
T0	LITTLE	SMART ARCH WIRE	0.122	15	.200*	0.935	15	0.32
		COPPER NITI ARCH WIRE	0.157	15	.200*	0.966	15	0.803
	CANINE	SMART ARCH WIRE	0.215	15	0.059	0.87	15	0.033
		COPPER NITI ARCH WIRE	0.167	15	.200*	0.947	15	0.483
	MOLAR	SMART ARCH WIRE	0.164	15	.200*	0.935	15	0.324
		COPPER NITI ARCH WIRE	0.126	15	.200*	0.952	15	0.551
T1	LITTLE	SMART ARCH WIRE	0.121	15	.200*	0.984	15	0.989
		COPPER NITI ARCH WIRE	0.197	15	0.121	0.874	15	0.038
	CANINE	SMART ARCH WIRE	0.184	15	0.185	0.911	15	0.139
		COPPER NITI ARCH WIRE	0.204	15	0.095	0.916	15	0.168
	MOLAR	SMART ARCH WIRE	0.169	15	.200*	0.946	15	0.466
		COPPER NITI ARCH WIRE	0.108	15	.200*	0.969	15	0.849
T2	LITTLE	SMART ARCH WIRE	0.227	15	0.036	0.866	15	0.03
		COPPER NITI ARCH WIRE	0.176	15	.200*	0.903	15	0.107
	CANINE	SMART ARCH WIRE	0.126	15	.200*	0.925	15	0.231
		COPPER NITI ARCH WIRE	0.198	15	0.116	0.893	15	0.075
	MOLAR	SMART ARCH WIRE	0.138	15	.200*	0.942	15	0.408
		COPPER NITI ARCH WIRE	0.097	15	.200*	0.969	15	0.844
T3	LITTLE	SMART ARCH WIRE	0.468	15	0	0.493	15	0
		COPPER NITI ARCH WIRE	0.317	15	0	0.785	15	0.002

	CANINE	SMART ARCH WIRE	0.201	15	0.104	0.882	15	0.05
		COPPER NITI ARCH WIRE	0.188	15	0.161	0.896	15	0.082
	MOLAR	SMART ARCH WIRE	0.136	15	.200*	0.925	15	0.229
		COPPER NITI ARCH WIRE	0.12	15	.200*	0.958	15	0.65
T4	LITTLE	SMART ARCH WIRE	-	15	-	-	15	-
		COPPER NITI ARCH WIRE	-	15	-	-	15	-
	CANINE	SMART ARCH WIRE	0.2	15	0.11	0.877	15	0.043
		COPPER NITI ARCH WIRE	0.172	15	.200*	0.895	15	0.081
	MOLAR	SMART ARCH WIRE	0.177	15	.200*	0.914	15	0.153
		COPPER NITI ARCH WIRE	0.119	15	.200*	0.951	15	0.535

Between-group analysis: At baseline (T0), no substantial statistical difference was observed between the SmartArch™ archwire group and the Conventional Copper NiTi archwire group concerning Little's irregularity index (p = 0.329), measurements of the canines (p = 0.520), and molar measurements (p = 0.712). This indicates that both groups were comparable before the treatment commenced. At T1, the comparison of the two groups again showed no statistically significant difference in Little's irregularity index (p = 0.284). canine measurements (p = 0.714), and molar measurements (p = 0.741). Similarly, at T2, the analysis showed no significant statistical differences between the SmartArch ^{TM} wire group and the Conventional Copper NiTi archwire group at any assessed time point suggesting that both archwires exhibited comparable clinical efficiency during the initial orthodontic alignment phase. (Table 2)

Table 2
Between-Group Comparison of Mean Alignment Changes Between Smart Cu-NiTi and Conventional Copper NiTi Archwire Groups at Different Time Intervals (Independent Samples t-test Analysis)

Time	Type of Teeth	Type of Group	N	Mean	SD	MD	t	df	p
T0	LITTLE	SMART ARCH WIRE	15	6.64	1.3757	0.5067	0.994	28	0.329
		COPPER NITI ARCH WIRE	15	6.133	1.4151				
	CANINE	SMART ARCH WIRE	15	29.167	4.785	-1.1333	-0.651	28	0.52
		COPPER NITI ARCH WIRE	15	30.3	4.7437				
	MOLAR	SMART ARCH WIRE	15	47.4	5.2772	-0.6267	-0.374	28	0.712
		COPPER NITI ARCH WIRE	15	48.027	3.7888				
T1	LITTLE	SMART ARCH WIRE	15	3.993	1.9185	0.66	1.092	28	0.284
		COPPER NITI ARCH WIRE	15	3.333	1.3399				
	CANINE	SMART ARCH WIRE	15	30.52	4.3882	-0.6267	-0.37	28	0.714
		COPPER NITI ARCH WIRE	15	31.147	4.8712				
	MOLAR	SMART ARCH WIRE	15	47.047	5.5491	-0.5933	-0.333	28	0.741
		COPPER NITI ARCH WIRE	15	47.64	4.0947				
T2	LITTLE	SMART ARCH WIRE	15	1.96	2.0805	0.66	1.113	28	0.275
		COPPER NITI ARCH WIRE	15	1.3	0.9739				
	CANINE	SMART ARCH WIRE	15	31.173	4.5289	-0.88	-0.515	28	0.61
		COPPER NITI ARCH WIRE	15	32.053	4.8203				
	MOLAR	SMART ARCH WIRE	15	47.073	5.4802	-0.8867	-0.506	28	0.617

Time	Type of Teeth	Type of Group	N	Mean	SD	MD	t	df	p
		COPPER NITI ARCH WIRE	15	47.96	4.0001				
T3	LITTLE	SMART ARCH WIRE	15	0.367	0.8457	-0.26	-0.866	28	0.394
		COPPER NITI ARCH WIRE	15	0.627	0.7977				
	CANINE	SMART ARCH WIRE	15	31.747	4.5506	-0.7	-0.407	28	0.687
		COPPER NITI ARCH WIRE	15	32.447	4.8751				
	MOLAR	SMART ARCH WIRE	15	46.8	5.6972	-1.2333	-0.686	28	0.499
		COPPER NITI ARCH WIRE	15	48.033	4.0076				
T4	LITTLE	SMART ARCH WIRE	15	0	.000a				
		COPPER NITI ARCH WIRE	15	0	.000a				
	CANINE	SMART ARCH WIRE	15	31.673	4.5401	-0.4933	-0.296	28	0.77
		COPPER NITI ARCH WIRE	15	32.167	4.5959				
	MOLAR	SMART ARCH WIRE	15	46.693	5.766	-1.4533	-0.792	28	0.435
		COPPER NITI ARCH WIRE	15	48.147	4.16				

Discussion:

This research compared the Cu-NiTi and SmartArch™ Multiforce archwires in vivo to evaluate their effectiveness in alignment and the alterations in intermaxillary arch dimensions. The optimal archwire should be near the ideal characteristics. The previous article claimed that the archwire best fit this description are the new Multiforce archwires.[11] It is widely approved that light forces are preferable.During the movement of teeth with orthodontics, applying forces greater than 70 grams might result in the hyalinization of the periodontal ligament which may slow down or delay tooth movement.[12,13] Crowding occurs more frequently in the mandibular arch because teeth tend to shift toward the midline. Additionally, continuous dental eruption and the development of contact facets

between adjacent teeth reduce mesiodistal tooth width and the overall arch perimeter, contributing to crowding.[14] According to this research, another study indicated that Cu-NiTi archwires showed a considerably higher rate of reduction in the irregularity index in comparison to heat-activated NiTi. In support of these findings, prior studies [15,16,17,18] revealed no significant differences in alignment efficiency between Cu-NiTi and various NiTi archwires. Riley and Bearn [19] performed a systematic review and found that the current evidence is insufficient to identify the most effective archwire for alignment. In a similar fashion, a meta-analysis [20] reported comparable results regarding both the efficiency of alignment and sequence of archwire use. In this study, only round Cu-NiTi archwires were used for evaluating alignment efficiency. This contrasts with earlier studies [21,22,23] which utilized both round and rectangular archwire sequences for full alignment. Other studies [24,15,16,17,18] used only round wires to check the alignment efficiency. 0.016 Archwire sequence was selected to promote efficient alignment while avoiding the mesiodistal root movements associated with rectangular wires, which can hinder tipping movements.[25] According to one of the aforementioned study [21] NiTi and Cu-NiTi archwires demonstrate comparable efficiency in tooth alignment. However, in clinical practice, Cu-NiTi archwire may offer an advantage by improving engagement in cases of severely displaced teeth. Ahmed et al [26] reported that SmartArch and Super elastic NiTi archwires showed comparable effectiveness during the alignment stage of orthodontic treatment, which is in accordance with our study. Two studies conducted by Evans et al [27] and Westel et al [28] did not specify the type of brackets used and concluded that alignment efficiency is similar between archwires; additionally, variations in ligation methods were observed across clinical trials. Cobb et al [29] and Cioffi et al [30] employed elastomeric modules. In this study, we have used either elastic modules or stainless steel ligatures, which are similar to the previous study by Sebastian et al[31] Most of the studies [15,16,17,32,23,33,31,34] have investigated the effectiveness of alignment using various NiTi archwires. Primarily, their attention was on the levelling of the anterior teeth in the mandible, largely because of the more significant crowding and the shorter distance between brackets in this area. Nevertheless, to the greatest extent possible of our knowledge, only a limited number of clinical studies [35,36,29] have evaluated the alignment efficiency in maxillary anterior teeth with different types of levelling archwires. Therefore, the present study concentrated on the alignment efficiency of the maxillary/mandibular anterior segment. In maxillary arch, the greatest interbracket distance compared to the mandibular arch enhances the flexibility and resilience of the wire, which may contribute to an increased degree of tooth movement.[18] In the present study duration of 16weeks is evaluated for alignment efficiency which is similar to previous studies.[16,32] In contrary to this, two studies evaluated for four weeks [33] and for six weeks [37],where as other two studies [38,36] evaluated for 12 weeks and 8 weeks and some studies till end of alignment phase. The four week review interval used in the present study is consistent with the protocols followed by cobb et al [29] and ulhaq et al[36] In contrast, longer intervals were reported by gok et al [32] and ong et al [34] who scheduled appointments, every 8 to 10 weeks. Some studies did not specify the appointment interval. Overall Bennet and Mclaughlin [39] suggested that a 4–6 week interval is appropriate when using the same bracket system as in the present study. Pandis et al[15] reported comparable findings in a double blinded RCT, he reported that intraoral

aging may lead to notable morphological and structural changes in wires, such as loss of structural integrity in NiTi, surface delamination, crater formation and increased porosity. In this study both the archwires exhibited comparable clinical efficiency during the initial orthodontic alignment phase in accordance with the results of other studies[17,32] .

During the alignment phase, changes in arch form occur in the transverse dimension, which play an important role in relieving crowding in non-extraction cases[40,41]. Both archwires demonstrated a stronger tendency toward protrusion, which may compromise longterm stability. An increase in arch perimeter has been observed following non-extraction orthodontic treatment in patients with class I malocclusion.[42,43] The intercanine width was recorded as 1.86mm for the Cu-NiTi group and 2.51mm for the SmartArch group. Previous studies have indicated a rise in intercanine width ranging from 0.54 to 1.96 mm in Cu-NiTi [42,43,44]. Preventing alterations in intercanine width throughout orthodontic therapy can enhance long-term treatment stability and retention outcomes[45]. They suggest that the chance of relapse, which can occur after treatment in both the groups should be evaluated in future studies. The present study found no significant change in intercanine width in the Cu-NiTi group. This is in concordance with the previous study[46]. This may be attributed to the fact that Cu-NiTi wires generally deliver lower forces for intercanine expansion compared with superleastic NiTi wires[47]. A previous study discovered no considerable difference in the changes of mandibular arch width measurements between Cu-NiTi and NiTi archwires. A significant observation from this study was that there were no significant statistical differences in the molar measurements observed between the two groups over the course of the treatment period. This result suggests that the anterior part of the dental arch is primarily affected by the early alignment phase, whereas the posterior teeth remain largely stable. The utilization of passive archwire engagement and the lack of active mechanics aimed at molar movement during this period may further contribute to the stability of molar positions during alignment. According to Proffit et al [25] posterior anchorage units are largely stable, although front teeth are primarily affected by early alignment mechanics.

Limitations:

This study's comparatively small sample size is one of its main drawbacks. A larger sample size would have increased the study's statistical power. The length of the investigation is another drawback. The initial alignment phase of orthodontic therapy was the primary focus of this inquiry. As a result, the archwire’s long-term performance throughout subsequent phases, including space closure, finishing, and detailing, was not assessed. Other elements like root resorption, three-dimensional tooth movement, torque expression, and placement were not evaluated. The impact of patient-related factors on the rate of orthodontic tooth movement, including patient compliance, and pain score, is another possible drawback.

Conclusion:

Initial orthodontic alignment can be achieved with both SmartArch ^{TM} and Conventional Cu-NiTi archwires. There was a marked reduction in Little's irregularity index for both groups throughout the trial period. In terms of alignment efficiency during the initial stages of orthodontic treatment, the more recent multi-force Cu-NiTi archwire does not demonstrate a clear clinical advantage over traditional Cu-NiTi archwires. Tooth movement was primarily controlled in the anterior region without causing unintended posterior modifications. To have a better understanding of the long term clinical effectiveness of the newer Cu-NiTi archwire system, more research with bigger sample sizes and longer observation periods is advised.

Declarations

Ethics approval and consent to participate:

This study was approved by the Institutional Ethics Committee of (Approval No. IEC/447). All procedures were conducted in accordance with the ethical standards of the institutional research committee Written informed consent was obtained from all participants prior to enrollment in the study. Participants below the age group of 16 years consent were obtained from their parents.

Ethics Approval:

Institutional Ethical Committee, Vinayaka Mission’s Sankarachariyar Dental College

CLINICAL TRIAL NUMBER:

CTRI/2026/03/106428 [Registered on: 17/03/2026]

Consent for publication:

Not applicable

Competing interests

Nil

ACKOWLEDGEMENTS:

I express my sincere gratitude to my college and the **Department of Orthodontics and Dentofacial Orthopaedics** for providing the facilities, infrastructure, and academic environment necessary for the

successful completion of this study.I like to extend my heartfelt appreciation to **Mr.Mohan and Mr. Kesavan** for their invaluable technical assistance and support in data collection, software handling, statistical analysis, and other technical aspects of the research.

I am also grateful to all the faculty members, postgraduate colleagues, and supporting staff of the department for their cooperation, guidance, and encouragement throughout the study. Finally, I express my deepest gratitude to my parents for their unwavering support, encouragement, understanding, and motivation throughout the course of this research and academic journey.

Funding:

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Author Contribution

• Author 1 PT: Conceptualization, methodology, data collection, statistical analysis, manuscript drafting.• Author 2 HS: Study supervision, methodology, manuscript review and editing.• Author 3 SJ: Title and study supervision • Author4 VP: manuscript editing • Author 5 UA:data collection • Author 6 RS: manuscript review • Author 7 KR: Critical revision of the manuscript

Data Availability

The materials described in the manuscript, including all relevant raw data, will be freely available to any scientist wishing to use them for non-commercial purposes, without breaching participant confidentiality and will be given on request.

References

1. Jian F, Lai W, Furness S, McIntyre GT, Millett DT, Hickman J, Wang Y. Initial arch wires for tooth alignment during orthodontic treatment with fixed appliances. Cochrane Database Syst Reviews. 2013(4).
2. Ballard DJ, Jones AS, Petocz P, Darendeliler MA. Physical properties of root cementum: part 11. Continuous vs intermittent controlled orthodontic forces on root resorption. A microcomputed-tomography study. Am J Orthod Dentofac Orthop. 2009;136(1):8.
3. Biermann MC, Berzins DW, Bradley TG. Thermal analysis of as-received and clinically retrieved copper-nickel-titanium orthodontic archwires. Angle Orthod. 2007;77(3):499–503.
4. Rosen M. *Mechanical properties of copper-nickel-titanium aorthodontic wires* (Master's thesis, Marquette University).2016.

5. Mohammed SA, Mahmood AB, Al-Sheakli I. Measurement of surface roughness of copper nickel titanium arch wires at dry and wet conditions: An in vitro study. J Res Med Dent Sci. 2019;7(6):21–6.
6. Rodrigues PF, Fernandes FB, Magalhães R, Camacho E, Lopes A, Paula AS, Basu R, Schell N. Thermo-mechanical characterization of NiTi orthodontic archwires with graded actuating forces. J Mech Behav Biomed Mater. 2020;107:103747.
7. Viecilli RF, Burstone CJ. Ideal orthodontic alignment load relationships based on periodontal ligament stress. Orthod Craniofac Res. 2015;18:180–6.
8. Olsen ME. SmartArch multi-force superelastic archwires: A new paradigm in orthodontic treatment efficiency. J Clin Orthod JCO. 2020;54:70–81.
9. Roberts WE, Roberts JA, Tracey S, Sarver DM. SmartArch multi force, super-elastic archwires: A new paradigm in orthodontics. J Digit Orthod. 2019;55:66–79.
10. Little RM. The irregularity index: A quantitative score of mandibular anterior alignment. Am J Orthod. 1975;68:554–63.
11. Lombardo L, Ceci M, Mollica F, Mazzanti V, Palone M, Siciliani G. Mechanical properties of multi-force vs. conventional NiTi archwires. J Orofac Orthopedics/Fortschritte der Kieferorthopädie. 2019;80(2):57–67.
12. Reitan K. Tissue behavior during orthodontic tooth movement. Am J Orthod. 1960;46(12):881–900.
13. O'Brien K, Lewis D, Shaw W, Combe E. A clinical trial of aligning archwires. Eur J Orthod. 1990;12(4):380–4.
14. Brantley WA, Eliades T. Orthodontic Materials: Scientific and Clinical Aspects. Stuttgart: Thieme; 2001. pp. 9–310.
15. Pandis N, Polychronopoulou A, Eliades T. Alleviation of mandibular anterior crowding with copper-nickel-titanium vs nickel-titanium wires: a double-blind randomized control trial. Am J Orthod Dentofac Orthop. 2009;136(2):152–e1.
16. Pandis N, Polychronopoulou A, Eliades T. Alleviation of mandibular anterior crowding with copper-nickel-titanium vs nickel-titanium wires: a double-blind randomized control trial. Am J Orthod Dentofac Orthop. 2009;136(2):152–e1.
17. Aydın B, Şenışık NE, Koşkan Ö. Evaluation of the alignment efficiency of nickel-titanium and copper-nickel-titanium archwires in patients undergoing orthodontic treatment over a 12-week period: A single-center, randomized controlled clinical trial. Korean J Orthod. 2018;48(3):153–62.
18. Atik E, Gorucu-Coskuner H, Akarsu-Guven B, Taner T. A comparative assessment of clinical efficiency between premium heat-activated copper nickel-titanium and superelastic nickel-titanium archwires during initial orthodontic alignment in adolescents: a randomized clinical trial. Prog Orthodont. 2019;20(1):46.
19. Riley M, Bearn DR. A systematic review of clinical trials of aligning archwires. J Orthodont. 2009;36(1):42–51.

20. Papageorgiou SN, Konstantinidis I, Papadopoulou K, Jäger A, Bourauel C. A systematic review and meta-analysis of experimental clinical evidence on initial aligning archwires and archwire sequences. Orthod Craniofac Res. 2014;17(4):197–215.
21. Bhatia NK, Chugh VK, Shankar SP, VINAY AP R, Singh S, Moungkhom P, Sardana R. Alignment efficiency and three-dimensional assessment of root resorption after alignment with conventional and copper-nickel-titanium archwires: A randomized controlled trial. Dent Press J Orthod. 2023;28:e2323177.
22. Mandall NA, Lowe C, Worthington HV, Sandler J, Derwent S, Abdi-Oskouei M, Ward S. Which orthodontic archwire sequence? A randomized clinical trial. Eur J Orthod. 2006;28(6):561–6.
23. Maria de Castro Serafim C, de Araújo Gurgel J, Mota Tiago C, Rodolfo de Jesus Tavarez R. Matos Maia Filho E. Clinical efficiency of two sequences of orthodontic wires to correct crowding of the lower anterior teeth. Sci World J. 2015;2015(1):690280.
24. Jain S, Sharma P, Shetty D. Comparison of two different initial archwires for tooth alignment during fixed orthodontic treatment—A randomized clinical trial. J Orthodontic Sci. 2021;10(1):13.
25. Proffit WR, Fields H, Larson B, Sarver DM. Contemporary orthodontics. 6th edition. Philadelphia: Elsevier Health Sciences;, Jones ML, Newcombe RG. Clinical comparison and performance perspective of three aligning arch wires. American journal of orthodontics and dentofacial orthopedics. 1998;114(1):32 – 9.
26. Ahmed OK, Kadhum AS. Effectiveness of laser-engineered copper-nickel titanium versus superelastic nickel-titanium aligning archwires: A randomized clinical trial. Korean J Orthod. 2024;54(1):16–25.
27. Evans TJ, Jones ML, Newcombe RG. Clinical comparison and performance perspective of three aligning arch wires. Am J Orthod Dentofac Orthop. 1998;114(1):32–9.
28. West AE, Jones ML, Newcombe RG. Multiflex versus superelastic: a randomized clinical trial of the tooth alignment ability of initial arch wires. Am J Orthod Dentofac Orthop. 1995;108(5):464–71.
29. Cobb NW III, Kula KS, Phillips C, Proffit WR. Efficiency of multi-strand steel, superelastic Ni-Ti and ion-implanted Ni-Ti archwires for initial alignment. Clin Orthod Res. 1998;1(1):12–9.
30. Cioffi I, Piccolo A, Tagliaferri R, Paduano S, Galeotti A, Martina R. Pain perception following first orthodontic archwire placement-Thermoelastic vs superelastic alloys: A randomized controlled trial. Quintessence Int. 2012;43(1).
31. Sebastian B. Alignment efficiency of superelastic coaxial nickel-titanium vs superelastic single-stranded nickel-titanium in relieving mandibular anterior crowding. Angle Orthod. 2012;82(4):7038.
32. Gok F, Buyuk SK, Ozkan S, Benkli YA. Comparison of arch width and depth changes and pain/discomfort with conventional and copper Ni-Ti archwires for mandibular arch alignment. J World Federation Orthodontists. 2018;7(1):24–8.
33. Mahmoudzadeh M, Farhadian M, Alijani S, Azizi F. Clinical comparison of two initial arch wires (A-NiTi and Heat Activated NiTi) for amount of tooth alignment and perception of pain: A randomized clinical trial. Int Orthod. 2018;16(1):60–72.

34. Ong E, Ho C, Miles P. Alignment efficiency and discomfort of three orthodontic archwire sequences: a randomized clinical trial. J Orthodont. 2011;38(1):32–9.
35. Nordstrom B, Shoji T, Anderson WC, Fields HW Jr, Beck FM, Kim DG, Takano-Yamamoto T, Deguchi T. Comparison of changes in irregularity and transverse width with nickel-titanium and niobium-titanium-tantalum-zirconium archwires during initial orthodontic alignment in adolescents: A double-blind randomized clinical trial. Angle Orthod. 2018;88(3):348–54.
36. Ulhaq A, Esmail Z, Kamaruddin A, Meadows S, Daus J, Vitale M, Perillo L, Sherriff M, Bister D. Alignment efficiency and esthetic performance of 4 coated nickel-titanium archwires in orthodontic patients over 8 weeks: a multicenter randomized clinical trial. Am J Orthod Dentofac Orthop. 2017;152(6):744–52.
37. Azizi F, Extiari A, Imani MM. Tooth alignment and pain experience with A-NiTi versus Cu-NiTi: a randomized clinical trial. BMC Oral Health. 2021;21(1):431.
38. Keerthana P, Chitra P. Alleviation of lower anterior crowding with super-elastic and heat-activated NiTi wires: a prospective clinical trial. Turkish J Orthod. 2021;34(2):127.
39. Bennett JC, McLaughlin RP. Fundamentals of orthodontic treatment mechanics. London and Dubai: Le Grande Publishing; 2014.
40. BeGole EA, Fox DL, Sadowsky C. Analysis of change in arch form with premolar expansion. Am J Orthod Dentofac Orthop. 1998;113(3):307–15.
41. Kim E, Gianelly AA. Extraction vs nonextraction: arch widths and smile esthetics. Angle Orthod. 2003;73(4):354–8.
42. Maltagliati LA, Myiahira YI, Fattori L, Capelozza Filho L, Cardoso M. Transversal changes in dental arches from non-extraction treatment with self ligating brackets. Dent press J Orthod. 2013;18(3):39–45.
43. Fleming PS, Lee RT, Mcdonald T, Pandis N, Johal A. The timing of significant arch dimensional changes with fixed orthodontic appliances: data from a multicenter randomised controlled trial. J Dent. 2014;42(1):1–6.
44. Burke SP, Silveira AM, Goldsmith LJ, Yancey JM, Van Stewart A, Scarfe WC. A meta-analysis of mandibular intercanine width in treatment and postretention. Angle Orthod. 1998;68(1):53–60.
45. Sadowsky C, Sakols EI. Long-term assessment of orthodontic relapse. Am J Orthod. 1982;82(6):456–63.
46. Msungu PJ, Machibya FM, Mlangwa MM. Comparison of Clinical Efficiency between Super Elastic Nickel Titanium (SE NiTi) and Copper Nickel Titanium (Cu NiTi) Archwires during Alignment Phase of Orthodontic Treatment. Int J. 2024;15(3):35–45.
47. Gatto E, Matarese G, Di Bella G, Nucera R, Borsellino C, Cordasco G. Load–deflection characteristics of superelastic and thermal nickel–titanium wires. Eur J Orthod. 2013;35(1):115–23.

Figures

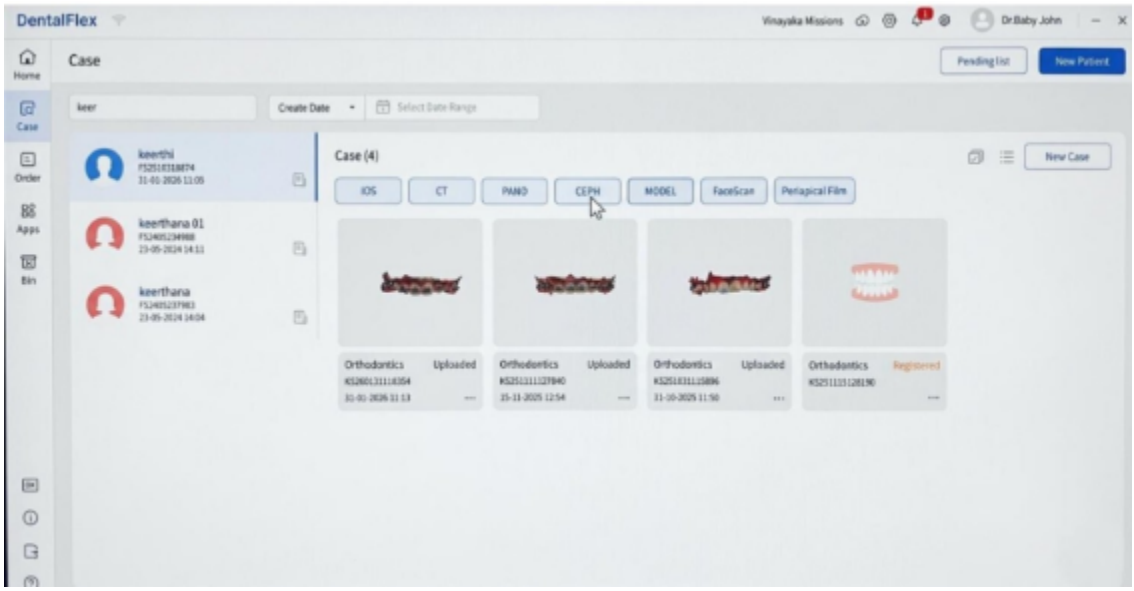


Figure 1

Intraoral scans

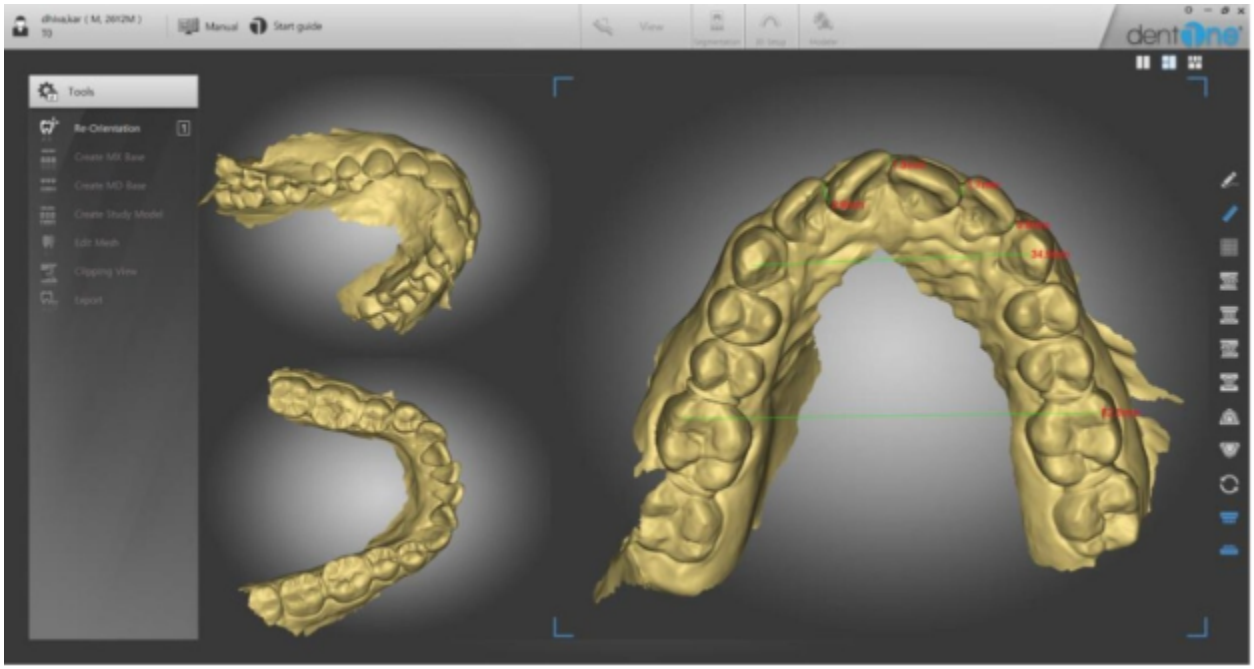


Figure 2

Intraoral scan at TO

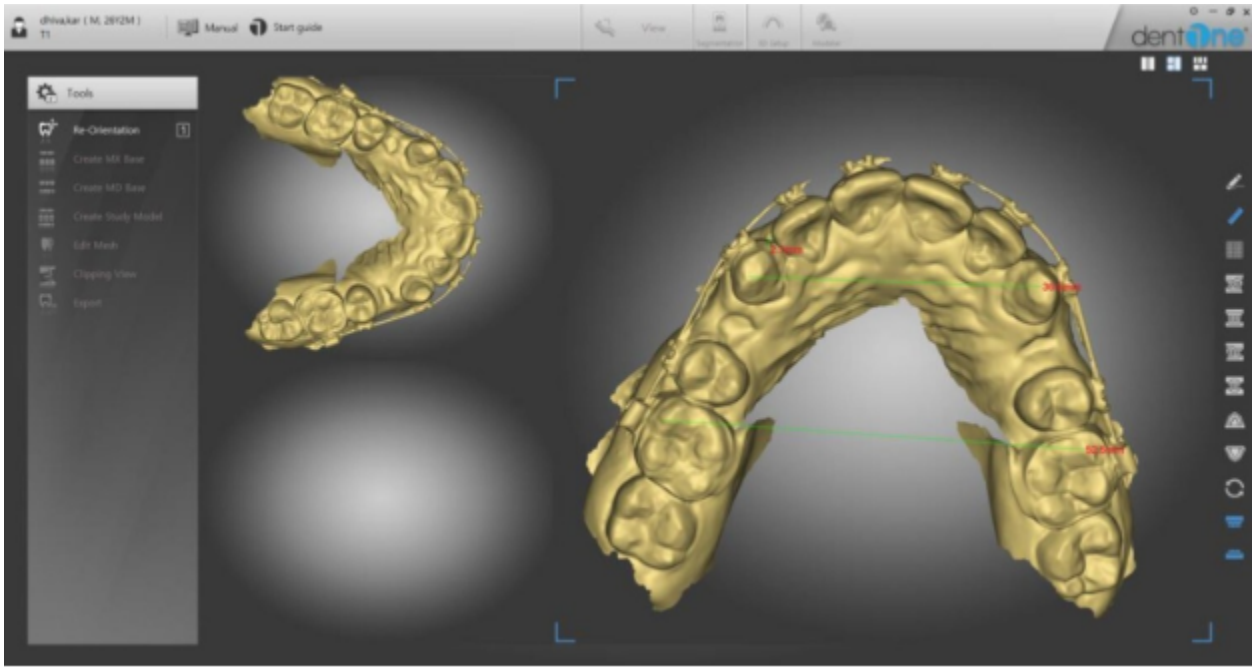


Figure 3

Intraoral scan at T1

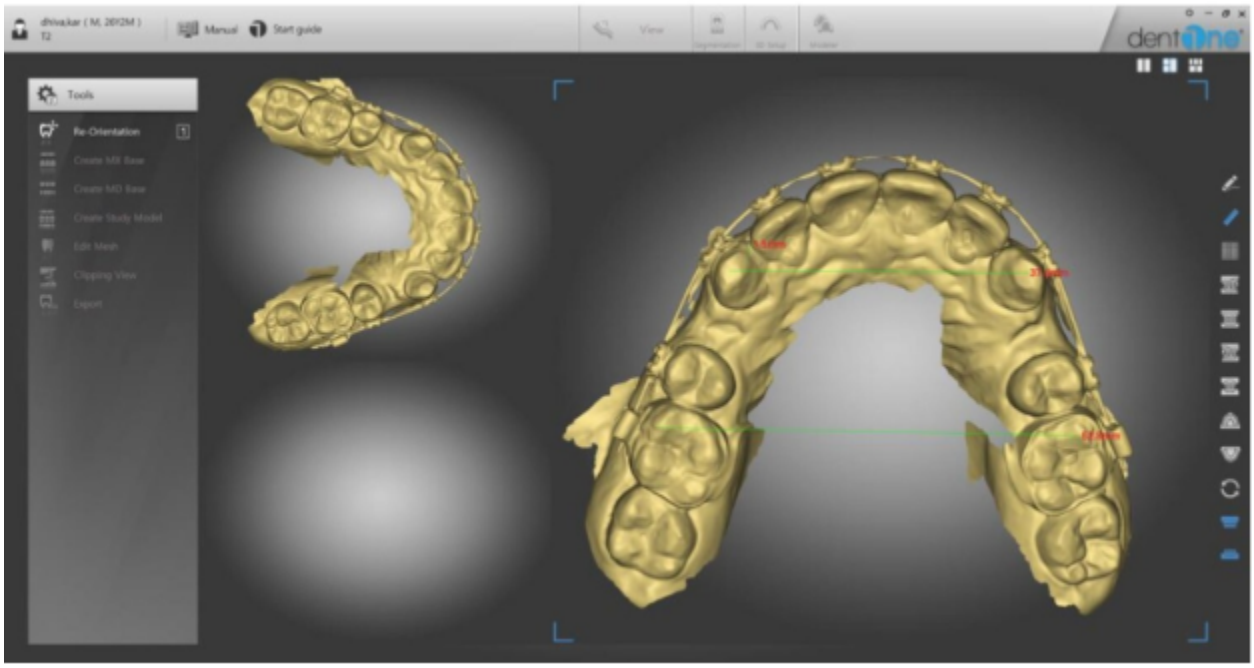


Figure 4

Intraoral scan at T2

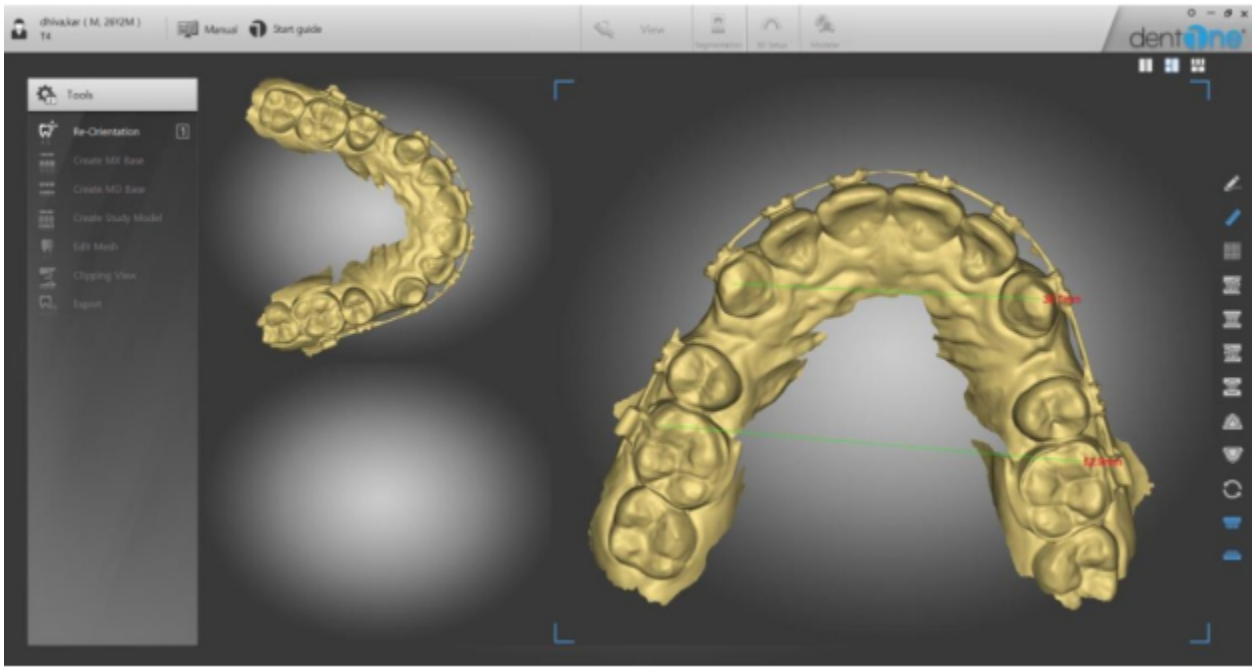


Figure 5

Intraoral scan at T3

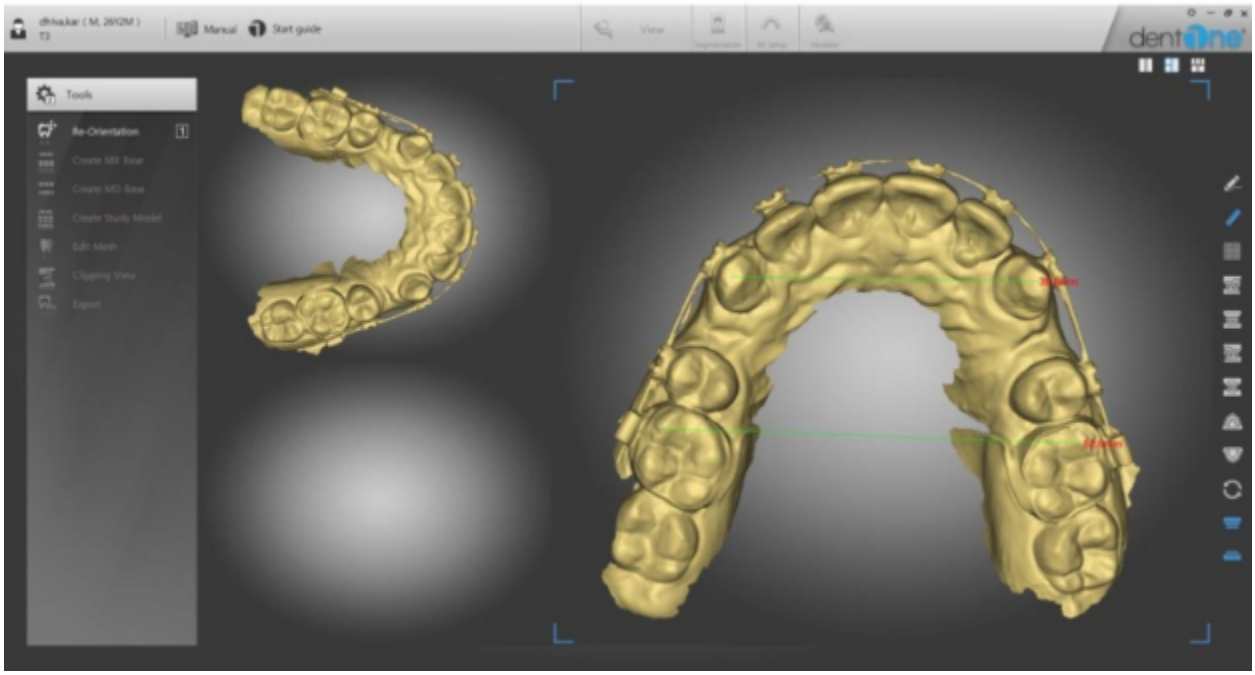


Figure 6

Intraoral scan at T4

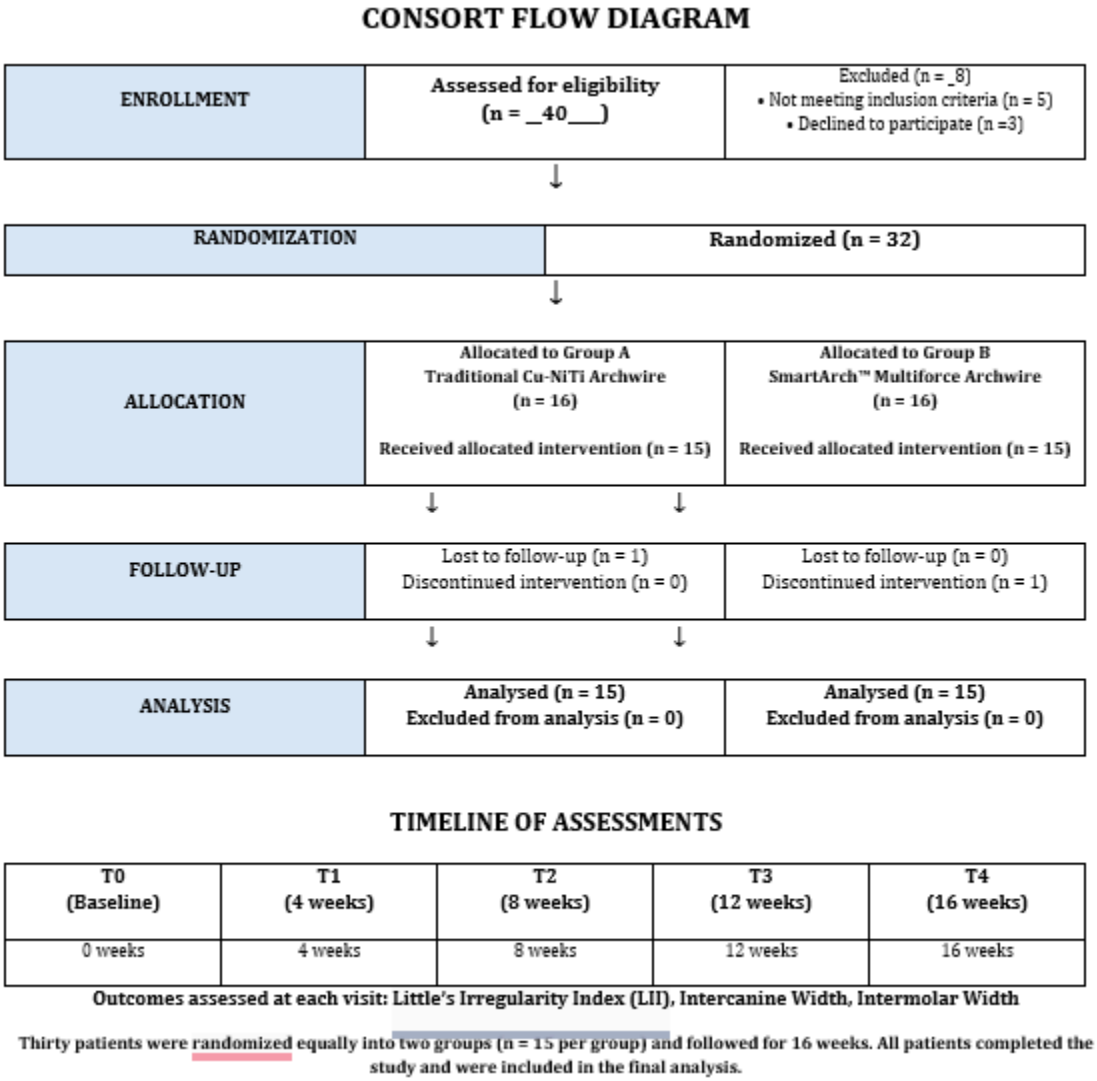


Figure 7

CONSORT Guideline

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- CONSORTchecklist.docx