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CLINICAL RESEARCH:

Alignment Efficiency of Two Archwires in Adolescents with Moderate to Severe Crowding

Eficiencia de alineación de dos arcos en adolescentes con apiñamiento dentalmoderado y severo

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ABSTRACT: There is no consensus in clinical orthodontics on which aligning arch wire should be used at the initial stage of treatment. This randomized clinical trial evaluated the efficiency of multistranded Nitinol (Supercable) aligning arch-wire versus a standard arch-wire (Nitinol) in the first stage of orthodontic treatment in adolescents with severe crowding. Forty patients ages 12 to 17 with an Irregularity Index as proposed by Little between 5 to 17 mm were selected. Vinyl polysiloxane impressions (VPS) were taken before treatment (T1) at 6 weeks (T2) and 12 weeks (T3). Roth prescription .022 x .028 Edgewise brackets were bonded using light cure adhesive to the six anterior teeth of each dental arch and bands were placed on all first molars. Subjects were paired by gender and Irregularity Index into two groups of 20 each and assigned either to the control group (Nitinol) or the experimental archwire (Supercable). The predictor variables in this study were the type of archwire, type of dental arch and the time intervals. The outcome variable was the Irregularity Index score. The Irregularity Index was measured using 3D digital study models (e-models) and GeoDigm software from the VPS impressions taken at T1, T2 and T3. The data was analyzed with both a Two and Three-way Analysis of Variance ($p \leq 0.05$) to identify differences in the alignment of the maxillary and mandibular teeth and to determine differences between the two archwires. The Two and Three way ANOVA showed that there was a statistically significant difference ($p \leq 0.05$) in the alignment capabilities between the maxilla and the mandible. However, there was no evidence of a statistically significant difference ($p=0.301$) between NiTi and Supercable archwires at any time interval.

KEYWORDS: Crowding; Teeth alignment; Malocclusion; Corrective orthodontics; Orthodontic wires; Orthodontic treatment.

RESUMEN: El presente artículo es un estudio clínico randomizado realizado con el objetivo de evaluar la eficiencia de dos arcos de alineación (Supercable y Nitinol) en la primera etapa del tratamiento ortodóntico en una muestra de 40 adolescentes entre los 12 y 17 años. Las variables independientes en este estudio fueron: el tipo de arco utilizado, tipo de arco dental y los intervalos de tiempo con los que se realizaron las mediciones. La variable dependiente fue el puntaje del Índice de Irregularidad de Little. Se realizó un Análisis de Varianza (ANOVA) de dos y tres factores para identificar las diferencias entre el alineamiento del arco maxilar y mandibular y las diferencias entre los dos tipos de cables en los tiempos determinados por la investigación. El Análisis de Varianza demostró que hubo una diferencia estadística significante ($p \leq 0.05$) entre la capacidad de alineamiento maxilar y mandibular. Sin embargo, no hubo una diferencia estadística significante ($p=0.301$) entre los arcos NiTi y Supercable en ninguno de los intervalos de tiempo registrados.

PALABRAS CLAVE: Apiñamiento; Alineación dental; Maloclusión; Ortodoncia correctiva; Arcos de ortodoncia; Tratamiento de ortodoncia.

INTRODUCTION

The lack of evidence-based research in the field of orthodontics has left the profession without well-devised prospective and retrospective data on which to analyze and base our clinical decisions (7). Deciding the appropriate treatment approach is difficult due to the wide variety of opinions encountered in the literature (2, 5, 6). These opinions are most of the time based on clinical experiences usually limited to anecdotal case reports (21) and not evidence based. This dilemma has led the orthodontist to use clinical judgment as the principal criteria for decision-making.

Orthodontists commonly have access to a wide variety of arch-wires in the initial stage of orthodontic treatment (6,13), known as the leveling and alignment phase. Typical examples of available arch wires include: Stainless Steel, Multistranded Stainless Steel, Nitinol (NiTi), Chinese NiTi, Japanese NiTi, Copper NiTi and Multistranded NiTi (Supercable) wires.

The criteria used to select an initial archwire should be based on their mechanical properties (10,14), as it is widely accepted that the ideal aligning archwire should be one that generates light and continuous forces over a large range of motion (20).

Laboratory tests were developed to measure the difference in mechanical properties of various archwires (17,18, 19). The most commonly used tests are wire behavior under tension using uniaxial tensile tests (cantilever tests) and bending and torsion tests. For example Burstone (15) found that Chinese NiTi had a springback 4.4 times that of a comparable stainless steel wire and 1.6 times that of Nitinol. Berger (11) found, using a three-point bending test, that Supercable exerted 65% less force than a comparable solid superelastic NiTi wire. These results suggest that these orthodontic wires have superior properties.

To measure alignment capabilities the Irregularity index proposed by Little (12) is commonly used. It measures the linear displacement of the anatomic contact points of each anterior tooth from the adjacent tooth anatomic point. The sum of these five displacements represents the degree of anterior crowding and is measured in millimeters. The four categories are: Irregularity Index score: 0=perfect alignment, 1-3=minimal irregularity, 4-6=moderate irregularity, 7=severe and very severe irregularity. According to Little (1), cases with an Irregularity Index of 3mm or less were considered to be minimal crowding thus clinically acceptable.

The clinicians face the challenge that even though various types of wires have shown different properties in laboratory bench tests (3, 4), when employed in randomized clinical trials, none has been able to sustain superior behavior. For example O'Brien (8) evaluated the aligning capabilities of Titanol and Nitinol. Plaster models were digitized using a Reflex Metrograph prior to bonding and 35 days after appliance insertion. The mean movement per contact point was 1.7mm for Titanol and 1.42mm for Nitinol with a 97% coefficient of reliability observed. However, this difference was not statistically significant ($P>0.05$). In this study, the amount of crowding and the absence of anterior teeth in the patients selected were not specified. In addition, the author employed stainless steel ligatures making it difficult to standardize the ligation force. The effect of re-tying the archwire over an extended period of time was not taken into consideration.

In another effort by Cobb *et al.* (9), the efficiency of multi-stranded steel, superelastic NiTi and ion implanted NiTi was tested in 155 dental arches with an Irregularity Index greater than 5mm. The Irregularity Index as proposed by Little was determined monthly until a value below 2mm was obtained. Elastomeric ligatures were replaced during each appointment. The median number of days to achieve the 2mm endpoint was 51 days for the maxillary arch and 46 days for the mandibular arch. No statistically significant differences were found among archwire types. The Irregularity Index was measured directly in the mouth with a caliper; this measuring methodology does not allow for a precise orientation of the instrument. Additionally, two different sizes of brackets (both .018 x .025 and .022 x .028) were used introducing frictional differences and a mixture of twin wing and single wing brackets were employed altering the inter-bracket span within the sample. The subjects' age ranged between 10 to 30 years old, combining adolescents and adults. There are two concerns with this mixture of patients, first the biological differences between adults and adolescents and second, the physiological factors that might possibly affect the amount of alignment experienced.

In a more recent study Pandis (2) evaluated the efficiency of copper-nickel-titanium (CuNiTi) vs nickel-titanium (NiTi) archwires in resolving crowding of the anterior mandibular dentition. Sixty patients were included in this single-center, single-operator, double-blind randomized trial. the amount of crowding of the mandibular anterior dentition was assessed by using the irregularity index proposed by Little (12). All patients were followed monthly for a maximum of 6 months. The type of wire (CuNiTi vs NiTi) had no significant effect on crowding alleviation (129.4 *vs* 121.4 days; hazard ratio, 1.3; $P>0.05$). In this study the amount of crowding varies form mild to severe. The amount of crowding has an impact in the time needed to align the teeth, it also has an influence in the diagnosis between extraction and non-extraction cases which makes other factors influence the end result, therefor to evaluate the capabilities of a wire in alignment, the amount of crowding should be similar between the subjects.

Controlling the factors that may have introduced bias in the above mentioned clinical trials should help us provide better information as to whether there is any difference in the aligning capabilities between what might be considered a standard wires (i.e. Nitinol) and a material with "improved" laboratory properties (i.e. Supercable) as might be expected.

The null hypothesis of this study was that There is no difference in the time to resolve crowding (aligning capabilities) between Nitinol and Supercable arch wires. The purpose of this study was to compare the efficiency between Nitinol and Supercable, in the level and aligning stage of the orthodontic treatment.

MATERIALS AND METHODS

STUDY DESIGN

This comparative clinical study was designed as an experimental matched-paired complete block design with repeated measurements.

The predictor variables to be considered were the aligning archwires round 0.016 NiTi and 0.016 Supercable, and the time between adjustment appointments 6 weeks. Selected patients were assigned to either the control (NiTi) or the treatment groups (Supercable).

SAMPLE SELECTION

A total of 800 screening forms from the patient's pool waiting for Orthodontic treatment at the Graduate Orthodontic Clinic, School of Dentistry of the University of Puerto Rico, Medical Science Campus (UPR/MSC), were evaluated to see if they met the inclusion criteria of age and crowding for this study.

The selected potential candidates were scheduled for an appointment where they were interviewed, had their medical history taken and a clinical examination was performed to determine if they met all the inclusion criteria, periodontal probing were performed in first molars and anterior teeth. An additional 80 subjects that responded to an advertisement were also evaluated. From the 880 subjects, 40 were selected and paired by gender, and similar Irregularity Index score. All subjects agreed to participate in the study and signed an informed consent approved by the International Review Board (IRB) of the UPR/Medical Sciences Campus, 09/24/02-09/05/03.

The inclusion criteria considered the following factors pretreatment: Irregularity Index >5mm using Little's Irregularity Index, presence of all permanent teeth (3rd molars not necessary), and a range age of 12-17 years old. Exclusion criteria considered previous active orthodontic treatment, permanent tooth missing or extracted (except third molars), anterior tooth completely blocked from the arch, periodontal pockets>4mm, craniofacial syndromes, and systemic diseases.

In order to obtain a sample size with the characteristics of a confidence level of 95% (alpha=5%), a power of 80% with a relative variance $(\sigma_d/\mu_d)^2$ of 3.2 the following formula was employed: $n \geq (\sigma_d/\mu_d)^2 \times (Z_{1-\alpha}+Z_{1-\beta})^2$

n=sample size
$Z_{1-\alpha}$=standard value of z for a confidence level of 95%≈1.645
$Z_{1-\beta}$=standard value of z of Beta=80%≈0.84
$(\sigma_d/\mu_d)^2$=relative variance=3.2

$n=(1.645+0.84)^2 = 6.175225$
$n=(3.2)\ (6.175)$
$n=19.76\approx 20.$

A total of 20 patients were needed for each group for a total of 40 subjects (80 dental arches).

GROUP ASSIGNMENT

The assignment to the control group and the treatment group was paired by gender and Irregularity Index score. Once paired, the patients were randomly assign into the groups. The control group was of 20 patients (40 dental arches) to be treated with 0.016 NiTi wire, 11 females and 9 males with a mean age of 14.05 years. The treatment group was of 20 patients (40 dental arches) to be treated with 0.016 Supercable wire, 10 females and 10 males, with a mean age of 13.85 years.

TREATMENT PROCEDURES

In the initial visit standard baseline information was obtained. These data include intraoral and extraoral photographs, cephalometric and panoramic radiographs. All records were taken following the American Board of Orthodontics standards (3).

Bracket (RMO, Roth prescription .022X.028 Edgewise) from the same manufacturing lot (lot # 531582) were bonded to all cases. The control group archwires were round 0.016 NiTi for the lower arch (lot# C5031) and for the upper arch (lot # A62773). The Treatment group archwires were round 0.016 Supercable (Lot# C5-7285-5-2B2A1) in all the cases. Plastic ligatures were the ligation method of choice. All the plastic ligatures used were from Rocky Mountain Orthodontic Company, Lot # 105644.

The Appointment procedures were as follow:

T1: Upper and lower arch high quality Vinyl Polysiloxane (VPS) impressions were taken. The impressions were obtained following a two-step technique using the heavy body material (3M STD Firme Set Putty, Lot# 20021030) in a plastic disposable tray to construct a custom individual tray over which the Vinyl Polysiloxane Light-Bodied Consistency-Hydrophilic material from 3M (Lot # 20021015) were used to make the impression of the teeth. Then the impressions were sent within 2 weeks to e-models Inc GeoDigm Corporation) where a non-destructive laser scanning process was performed to obtain 3D digital models of the impressions.

Transbond Plus etching (34% Phosphoric Acid Gel), primer, and Transbond XT light cure adhesive (3M Unitek, Lot# 2AY / 2 EX) were used to bond the brackets in all cases. The manufacturer's recommendations in handling each material were followed. These excess arch lengths were 4 mm long as measured with a caliper from the distal surface of the first molar to the end of the wire. Gray plastic ligatures were used to tie in every wire to the brackets to avoid differences in the force exerted by the ligation method, as it was proposed by Rock and Wilson (4). Each wire was as fully ligated into each bracket as possible, and no anterior teeth were omitted from attachment to the wire.

T2: After six weeks, the plastic ligatures and archwires were removed both in the mandible and maxilla. High quality impressions using Vinyl Polysiloxane were once more taken using the technique previously described. Archwires were re-engaged after the impression procedure and plastic ligatures changed. Electronic models were digitized within two weeks after the impressions were taken.

T3: After 12 weeks from T1, the plastic ligatures and archwires were removed both in the mandible and maxilla. High quality polyvinyl siloxane impressions were taken in a manner similar as before, and electronic models were digitalized within two weeks after the impressions were taken. Upon completion of the study, all subjects were assigned to the Orthodontics' Graduate Clinic to continue their treatment as regular patients.

Three-dimensional models of all study casts were employed, to measure the changes. E-models Inc. software (GeoDigm Corporation) were used to select the landmarks established by the Irregularity Index. Measurements were performed by the same operator (ISD) following Irregularity Index criteria proposed by Little (12). The operator waited to have all the casts digitalized to worked under blinded conditions, not knowing which time interval or which wire was being measured. A total of 238 arches were measured.

CALIBRATION

Repeated measurements of 18 casts were performed before measuring all the sample's study casts, in order to analyze the measurement error. Six maxillary and mandibular casts series from each of the time periods (T1, T2 and T3) were randomly selected from the total sample. The measurements were repeated after a 2-weeks interval. A Pearson Correlation statistical method was employed to determine the reliability of the measurements.

STATISTICAL ANALYSIS

Both a Two and Three-way Analysis of Variance (ANOVA) was employed to identify differences between the alignment of the maxilla and mandibular arch and to determine differences between the two archwires over the duration of the experimental period. These analyses were performed using SPSS statistical program version 10.1 for Windows.

RESULTS

T1 (BASELINE)

Irregularity Index scores included in this study at baseline ranged from 5.28 to 17.00. In both groups, Irregularity Index was higher (3.08mm) in the maxillary arch when compared with the mandibular arch at the start of treatment. The control group (NiTi) had higher index scores than the experimental group (Supercable) for both maxilla (1.01mm) and mandible (0.31mm). The initial data (T1) for both groups is show in Table 1.

The mandibular arch was more evenly distributed, out of the patients, 55% had moderately severe scores and 45% had severe scores. In the maxillary arch 90% had severe scores whereas the remaining 10% had moderate.

T2 (SIX WEEKS LATER)

The means for tooth movement as represented by the change in the distance that each contact point moved (in mm) for the NiTi group (from T1 to T2) was 5.07mm for the maxillary arch with S.D.= 3.37mm and a standard error of 0.75. For the mandibular arch the change in alignment in the 6-week period was 4.28mm with S.D.= 1.82 and a standard error of 0.41. In the Supercable group, the maxillary arch changed in alignment 4.87mm (from T1 to T2), with a standard deviation of 2.38mm and a standard error of 0.53. In the mandibular arch the change (from T1 to T2) was 4.77mm; with a standard deviation of 2.24mm and a standard error of 0.50mm. Mean Irregularity Index scores for the NiTi and Supercable groups is show in Table 2.

The irregularity scores for the NiTi group in this period (T2) ranged from 0.00mm to 14.08mm in the maxilla and from 1.25mm to 11.16mm in the mandible. The Supercable group ranged from a minimum of 2.73mm to a maximum of 12.29mm in the maxillary arch. In the mandibular arch the range for the Supercable was from 1.40mm to 8.80mm.

T3 (6 WEEKS FROM T2)

The means for tooth movement for the NiTi group from T2 to T3 (6 weeks period), was 4.48mm for the maxillary arch (SD 2.87mm, SE 0.6), and 1.84mm (SD 1.75mm, SE 0.39) for the mandibular arch. In the Supercable group, the mean change in alignment from T2 to T3 was 3.35mm for the maxilla, (SD 2.50mm, SE 0.57), and 1.96mm in the mandibular arch (SD 1.52mm, SE 0.35). Irregularity Index mean scores for the NiTi and Supercable groups at T2 & T3 is show in Table 2.

The Irregularity score expressed by Little Irregularity Index for the NiTi group in this period ranged from a minimum of 0.00mm to a maximum of 12.31mm in the maxillary arch and from 0.00mm to 6.79mm in the mandibular arch. In the Supercable group the range was from 0.00mm to 8.47mm in the maxilla and from 0.00mm to 7.82 in the mandible.

FROM T1 TO T3

The mean changes in alignment in the maxillary arch from the start of treatment (baseline) over a 12 weeks period for the NiTi group was 9.55mm. with a standard deviation of 4.19 mm. and a standard error of 0.94mm, as it is show in Table 7. In the mandible the mean change was 6.12mm. with a standard deviation of 2.21mm. and a standard error of 0.49 mm. In the Supercable group the mean change in alignment in the maxillary arch from the start of treatment over a 12-week period was 8.39 mm with a standard deviation of 2.73mm and a standard error of 0.63mm. In the mandible the mean change was 6.78mm with a standard deviation of 2.63mm and a standard error of 0.60mm, as it is show in Table 2.

DIFFERENCES BETWEEN WIRES

Analysis of variance (ANOVA) models were fitted in order to assess differences between the two archwires to determine whether a significant difference existed in their ability to bring about rapid alignment. The results of the two-way ANOVA of the changes in both maxilla and mandible from T1 to T2, T2 to T3 and T1 to T3 are shown in Table 3.

Data analysis results using a three-way Analysis of Variance with repeated measures on the factors, irregularity score as the dependent variable, wire type, time, arch type (maxilla or mandible) as the source of study is show in Table 4.

Table 1. Irregularity Index at Baseline (T1) for both archwires.

	T1 Maxilla		T1 Mandible	
	Mean (mm)	**SD**	**Mean (mm)**	**SD**
NiTi	12.84	2.26	9.41	2.10
Supercable	11.83	2.79	9.10	2.16
Both Groups	12.34	2.56	9.25	2.11

Table 2. Irregularity Index means by type of wire and arch at T1, T2 and T3.

	Maxilla (mean mm.)						Mandible (mean mm.)					
	T1		**T2**		**T3**		**T1**		**T2**		**T3**	
	Mean (mm)	**SD**	**Mean (mm)**	**SD**	**Mean (mm)**	**SD**	**Mean (mm)**	**SD**	**Mean (mm)**	**SD**	**Mean (mm)**	**SD**
Niti	12.84	2.26	7.77	3.79	3.29	4.34	9.41	2.10	5.12	2.60	3.28	1.73
Supercable	11.83	2.79	6.97	2.99	3.78	2.55	9.10	2.16	4.33	1.77	2.52	2.19

Table 3. Two-way ANOVA for differences between the two archwires.

Mean Changes	Groups	Sum of Squares	df	Mean Square	F	Sig.
Maxilla - T2 to T1	Between	.426	1	.426	.050	.824
	Within	323.146	38	8.504		
	Total	323.573	39			
Maxilla - T3 to T2	Between	12.385	1	12.385	1.704	.200
	Within	268.996	37	7.270		
	Total	281.380	38			
Mandible - T2 to T1	Between	2.347	1	2.347	.563	.458
	Within	158.333	38	4.167		
	Total	160.681	39			
Mandible -T3 to T2	Between	.146	1	.146	.054	.818
	Within	100.254	37	2.710		
	Total	100.400	38			
Maxilla - T3 to T1	Between	13.216	1	13.216	1.046	.313
	Within	467.322	37	12.630		
	Total	480.539	38			
Mandible - T3 to T1	Between	4.156	1	4.156	.709	.405
	Within	217.002	37	5.865		
	Total	221.158	38			

Table 4. Three-Way ANOVA for differences between the two archwires.

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	10641.615	1	10641.615	576.247	.000
	Error	701.751	38	18.467		
Wire	Hypothesis	20.335	1	20.335	1.101	.301
	Error	701.751	38	18.467		
Time	Hypothesis	2390.961	2	1195.481	309.556	.000
	Error	293.506	76	3.862		
Time * Wire	Hypothesis	2.702	2	1.351	.350	.706
	Error	293.506	76	3.862		
Arch type	Hypothesis	266.999	1	266.999	21.628	.000
	Error	469.106	38	12.345		
Time * Arch type * Wire	Hypothesis	9.099	2	4.550	1.560	.217
	Error	221.643	76	2.916		
Time * Type	Hypothesis	69.990	2	34.995	12.000	.000
	Error	221.643	76	2.916		

DISCUSSION

Evaluating when an arch is aligned can be measured with more precision using the Irregularity Index proposed by Little in 1975 because it measures the features of interest and fewer characteristics are incorporated to the analysis as opposed to other indexes such as and the PAR index (22), which have broad application in public health settings, as it evaluate many characteristics of the patient's malocclusion.

The present study controlled the age factor in order to avoid a mixture of adults and adolescent because different age groups may behave differently in their responses to treatment. Adolescents were chosen as the target group because this age group seeks orthodontic treatment the most.

To be able to draw conclusions about the wire's capabilities for aligning all other factors had to be equal. The same types of bracket from the same manufacturing lot were bonded to all cases. The same brand and lot of plastic ligatures were used. Plastic ligatures were the ligation method of choice because they generate the same amount of friction in every case. Stainless steel ligatures tie produce different amount of friction depending on the tension generated in the amount of twists given by the operator, and this could introduce bias to the study.

A round 0.016 mil wire was selected because a 2-mil clearance is the minimum needed for reasonable free sliding as it was confirmed by Kusy (18). This size of wire in the .022 x .028 slot edgewise brackets allowed at least a 6-mil clearance.

The results of the data analysis in the maxilla and mandible over the initial 6 weeks period (T1-T2) using a two-way ANOVA revealed a p-value of 0.82 and 0.46 respectively. Since 0.82>0.05 and 0.46>0.05, we can say with a confidence level of 95% that there is no difference in the aligning capabilities between Nitinol and Supercable at the six weeks interval.

When the results of the changes between weeks 7 and 12 (T2-T3), using a two-way ANOVA, are analyzed in the maxilla and the mandible, an observed p-value of 0.22 and 0.82 respectively was obtained. Since 0.22>0.05 and 0.82>0.05, we can say with a confidence level of 95% that there is no difference in the aligning capabilities between Nitinol and Supercable in the last six weeks interval (T2 and T3).

The changes in a 12 weeks interval between T1-T3 using a two-way ANOVA disclosed a p-value for the maxilla and the mandible of 0.313 and 0.405 respectively. Since 0.31>0.05 and 0.4>0.05, we can again say with a confidence level of 95% that there is no difference in the aligning capabilities between Nitinol and Supercable over the 12 weeks interval between T1 and T3.

THREE-WAY ANOVA

When the data was analyzed using a three-way Analysis of Variance with repeated measures on the factors (Irregularity Index score as the dependent variable) and wire type as the source of variation (explanatory variable) a p-value of 0.30 was obtained for the differences in the aligning scores between the NiTi and Supercable groups in both maxilla and mandible. Since 0.30>0.05, we can say that there is no evidence of difference in the aligning capabilities between Nitinol and Supercable.

Data analyzed using a three-way Analysis of Variance with repeated measures on the factors, with Irregularity Index score as the dependent variable, and time as the source of variation (explanatory variable), revealed a p-value of 0.00, showing that there is a statistically significant difference in alignment between T1-T2-T3. This result was expected because archwires do align teeth if they are left in place long enough. Typically, at this stage the more time a wire is left in place the more alignment can be observed (16).

The results of the data analysis using a three-way Analysis of Variance with repeated measures on the factors, with the Irregularity Index score as the dependent variable, and type of arches (maxilla or mandible) as the source of variation (explanatory variable) revealed a p-value of 0.00. This finding shows a statistically significant difference in the aligning capabilities between the maxillary and the mandibular arch.

An explanation for the differences in aligning capabilities may be the proximity of the cortical bone and the smaller volume of cancellous bone found in the mandible when compared with the maxilla. These results are in agreement with those found by Evans *et al*. (23), where a statistically significant difference p<0.001 between arches was found in the anterior segment; no statistically significant difference was found when the posterior segment was analyzed. Our results are in contradiction with those reported by Cobb *et al*. (9), where the time to align and the rate of alignment were similar for a 0.018 slot appliance. It must be pointed out that we used a 0.022 appliance that generates less friction than the smaller 0.018 slot bracket used by Cobb. In addition, in Cobb's study twin and single brackets were employed and the binding forces may have affected the final outcome; in the present study only twin brackets were used.

In a clinical perspective, even though there were no statistically significant difference between NiTi and Supercable groups, patients in Supercable group broke the mandibular wire 5 times more than NiTi group. This situation causes discomfort to the three study subjects that presented with this problem. From a practical perspective the clinical disadvantage mentioned above made the NiTi wire a more desirable option over the Supercable wire.

CONCLUSIONS & RECOMMENDATIONS

This study demonstrates that there is no statistically significant difference (p-value 0.301) in the aligning capabilities between Nitinol and Supercable, with a confidence level of 95%. The observed power in order to detected differences in the Irregularity Index of at least 1.3mm and 1.5mm between NiTi and Supercable wires was 76% and 85% respectively.

With increasing time, effective tooth movement occurred in both maxillary and mandibular dental arches (statistically significant p-value of 0.00), regardless of the archwire type used.

There is a statistically significant difference in the aligning capabilities between the maxilla and the mandibular arch (p-value 0.000) at a confidence level of 95% and a power of 99.5%.

The most important recommendation of this study is that it is critical that new orthodontic materials should not only be tested in laboratory experiments, to assess improvements in physical properties, but also clinical trials should be conducted to determine the material's performance in everyday clinical situation.

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