Research article

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Dental Monitoring Application: it is a valid innovation in the Orthodontics Practice?

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Abstract

Aim. The aim of research is to show the effectiveness of 0.014X0.025 CuNiTi wires in self-ligating straight-wire appliance in the working time of 10 weeks, the treatments are monitored with the Dental Monitoring® Applications. A statistical significance analysis of the correspondence between the results of the first phase of fixed orthodontic treatment (alignment), according to the type of wires used, compared to the time (about 8 weeks) suggested by the manufactory house is therefore useful to fully understand the power of these arches in the orthodontic treatment.

Material & Methods. The study provides for the recruitment of 35 cooperating patients with different degrees of crowding, all treated with Damon System(ORMCO), monitoring them through pictures, taken in the Dental Monitoring(DM®) sequence technique, as follows: Time0: Arch-Wire Insertion (0.014x0.025CuNiTi), Time1: Four Weeks, Time2: Eight Weeks, Time3: Ten Weeks.

Results. The results obtained will be compared with records reported by manufactory house. Our results showed that the manufacture information does not correspond to the real efficiency of the device tested. Statistical Analyses performed by T test student.

Conclusions. In Our experience, applying DM Application with self-ligating technique has reduced in term of number of appointments for each patient from 3 appointments in 10 weeks to 2 appointments, when the indirect bonding was effectuated and when we have inserted a 014X025 CuNiTi. This means that there is a reduction in the mean period of chair time, of material 'costs, number of visits; moreover, there is an increase in term of frequency of patient' s monitoring, resulting in a more precise evaluation of treatment by orthodontist. The limits of the present study are presented by the variable patient's compliance and by the small number of patients. This device is an instrument advantageous for the orthodontist's work. In literature, there are few articles inherent to Digital application Mobile, we will hope that this our experience represents a valid support to a major use of this application in the clinical practice. ***Clin Ter 2020; 171 (3):e260-267. doi: 10.7417/CT.2020.2224***

Key Words: *Copper Nichel-titanium archwire, Damon System, DM® Application, Digital dentistry, Straight-wire, dental movement.*

Introduction

Dental Monitoring is a system to ensure doctors maintain perfect control over the progress of any orthodontic treatment, from the first consultation to the retention period. For the first time, dental movement is measured and quantified in between appointments and communicated to the orthodontist, for optimized schedules. Of course, unexpected situations can always arise. Dental Monitoring is divided in three integrated platforms: a mobile application for the patient (Fig. 1), a patented movement tracking algorithm, and a web-based Doctor Dashboard where practitioners receive updates of their patients' evolution. When the patients take photo exams, the pictures are uploaded to our servers and verified to ensure their quality is sufficient to be processed by Dental Monitoring algorithm. Then, Dental Monitoring's patented algorithm can calculate tooth movement with high precision, for all 6 orders. This advanced technology ensures results with a precision of less than one tenth of a millimeter, and less than 0.5° for tip and torque. After analysis, a team of Dental Monitoring doctors to qualify their clinical pertinence checks the results. When the analysis is complete, all results are uploaded to the online Doctor Dashboard (Fig. 2-5). The orthodontist is notified that new results are available and whether alerts have been detected. The Doctor Dashboard is fully web-based and necessitates no installation of software. Each patient file is regularly updated with graphs, photos, and our unique system of 3D Matching.

The Damon system (Ormco, Glendora, CA) is based on the use of a passive self-ligating bracket and super elastic nickel-titanium wires (1-5). This system is attractive due to the promise of excellent treatment of almost every patient, providing treatment without extractions, orthognathic surgery, palatal expansion, and pain, within a brief period (6). The Damon system presents important advances in terms of strength and usability. It is especially emphasized that this system, with low friction brackets, applies only light forces to move the teeth (7). It has been demonstrated that during

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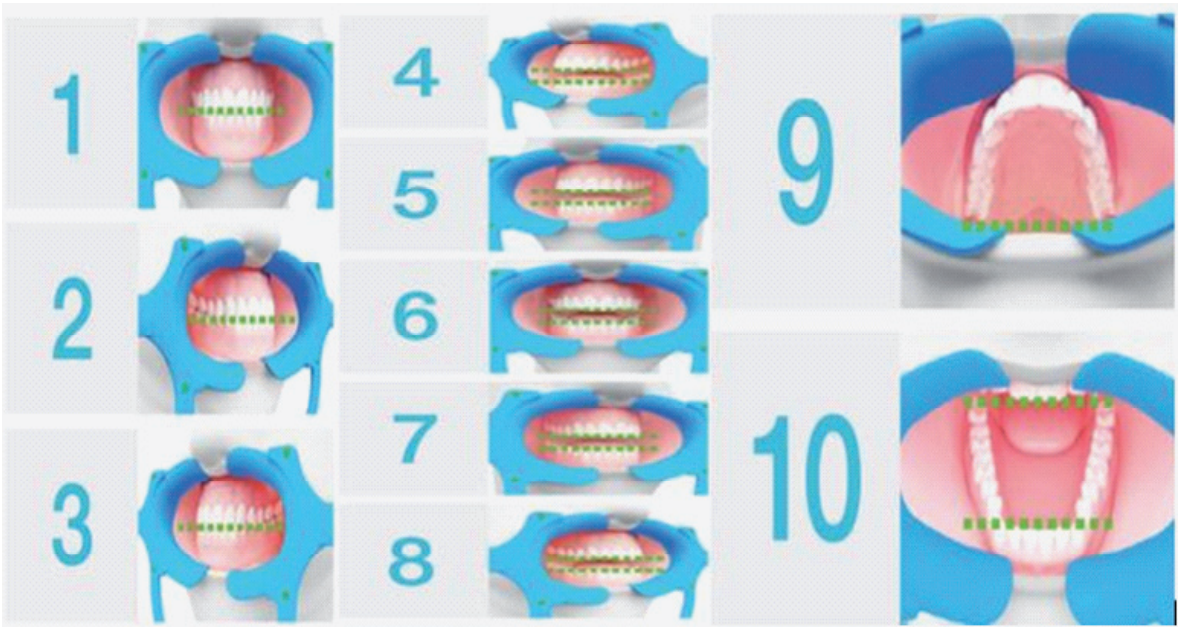


Fig. 1. The view shows the photo's orientation of the closed mouth (1-3), of the slightly open mouth (4-8), of the open mouth (9-10).

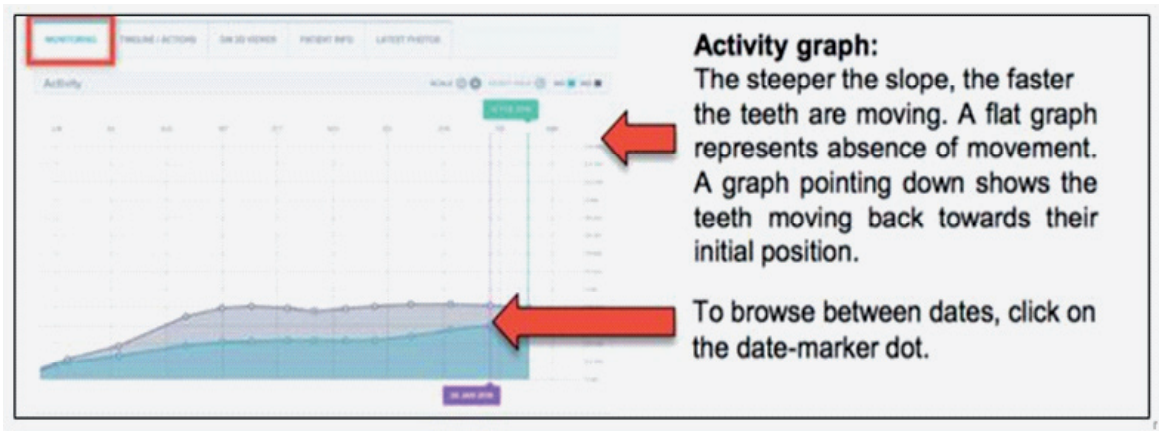


Fig. 2. This View shows the absence, or the faster teeth are moving.

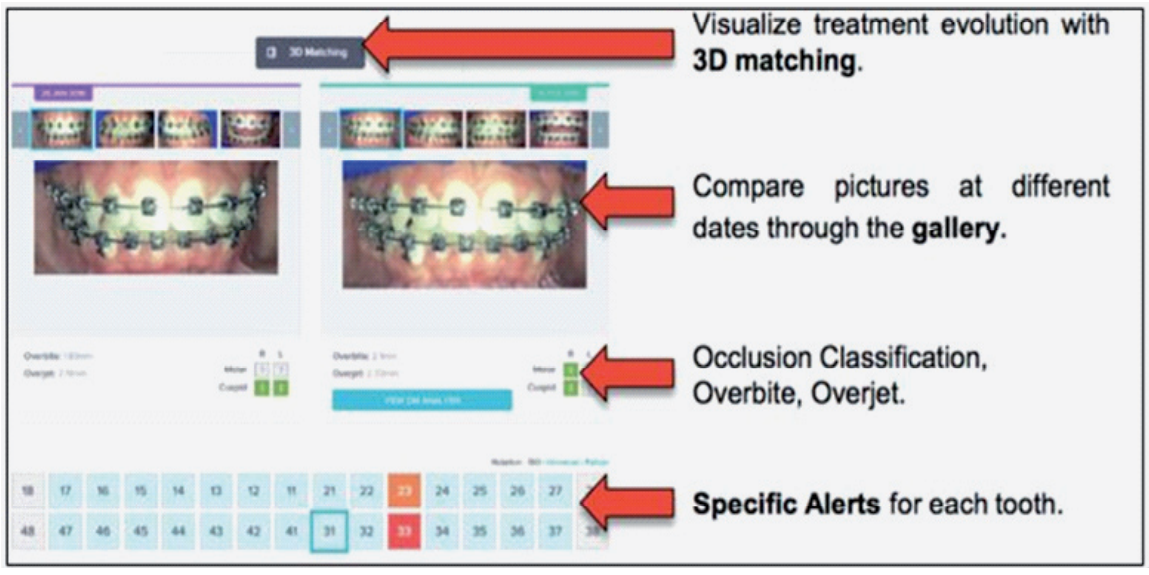


Fig. 3. This View shows the treatment evolution with 3D reproduction and other informations.

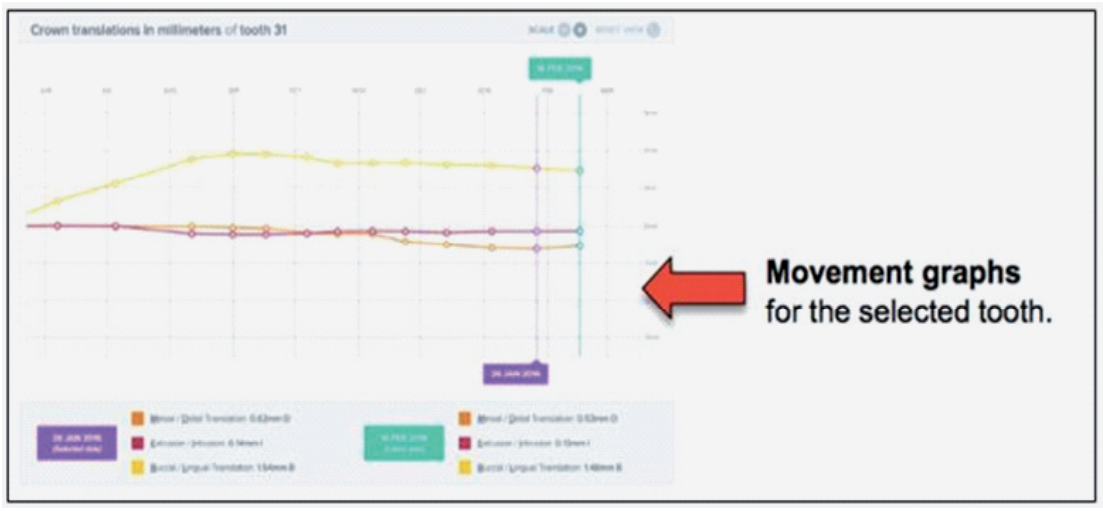


Fig. 4. This View shows specific movement for each tooth.

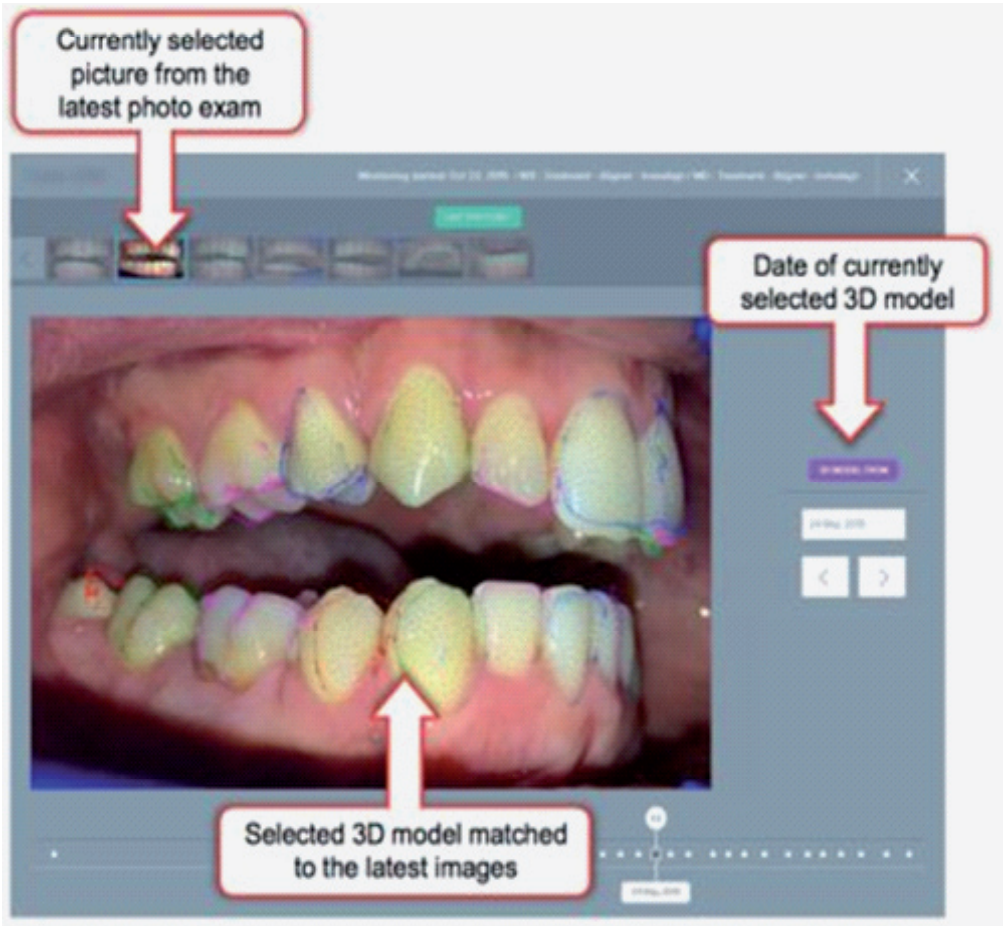


Fig. 5. This View shows Evolution of treatment.

the initial levelling and alignment stage, root resorption with this system is like conventional preadjusted edgewise bracket systems (8-9).

The first phase of orthodontic treatment is the aligning phase, finalized to correction rotation, inclination and vertical position of the teeth and, in the straight wire techniques, to achieve the proper alignment of the bracket's slot.

The introduction of aligning arches of small diameter in CuNiTi has apparently shortened the time spent in this first stage of treatment. Nevertheless, small studies have been performed to analyze the real effect of this arch wires, used as suggested by the Companies. A statistical significance analysis of the correspondence between the results of the first phase of fixed orthodontic treatment (alignment) about 10 weeks, according to the type of wires used, compared to the time (about 8 weeks) suggested by the manufactory house is therefore useful to fully understand the power of these arches in the orthodontic treatment. The aim of research is to show, in 35 patients, the effectiveness and the real time to spent the force of a 014X025 CuNiTi wires, in self ligating straight wire appliance in the working time of 8 and 10 weeks; all patients will be treated by the same orthodontist with the aid of the indirect bonding technique (10-16), with individually thermoformed trays, to reduce errors due to a malposition of brackets. The results obtained will be compared with records reported by manufactory house. The Study can moreover analyze the influence of external factors, like dental misalignment grade, compliance, oral hygiene (17-21) and detachment brackets rate (22-25). The study provides for the recruitment of 35 cooperating patients with different degrees of crowding, all treated with Damon System (ORMCO), monitoring them through pictures, taken in the Dental Monitoring® (DM®) sequence technique, as follows:

TIME 0 INDIRECT BONDING AND WIRE INSERTION
TIME 1 FOUR WEEKS
TIME 2 EIGHT WEEKS
TIME 3 TEN WEEKS

Materials & methods

We performed a preliminary study with 5 pairs of subjects to estimate the power of the study (PS) and to establish the effect size (ES) of the population sampled for the experimental study, (Table 1). For each column, we have calculated a statistical significance to determine an exact number of patients for to become a study; we are reported the individual details for each criteria considered. If the sample size recommended is >5% compared to the population from which it is extracted, its sample size can be reduced. We have extended the sample size by 5 (number size significative) to 35 subjects that we have been selected, respected the inclusion criteria considered in the experimental study design (malocclusion, crowding, abnormal overbite, plaque index,

Table 1, Group Control to Establish The Sample Size Statistic Significant

PATIENT NAME	CLASS	OVB	ROTATIONS	CROSS	BITE-RAISING	IDP	IDT	% DEBONDING
A.I	II CL II DIV	5 MM	2	NO	SI	1	0	0
C.D	III CL	6 MM	2	4 TEETH	NO	1	0	1
D.M	II CL	3 MM	3	4 TEETH	NO	1	1	1
M.F	II CL II DIV	5 MM	3	1	SI	2	1	3
P.P	II CL	1.5 MM	1	NO	NO	2	1	1
R.F	II CL	5 MM	0	0	SI	1	0	1
T.A	I CL	2 MM	1	NO	SI	2	0	0
Z.A	III CL	1 MM	4	1	NO	2	3	0
M.G	II CL	4 MM	3	NO	SI	1	0	2
	I class 0.11%	OVB normal (3-5mm) 0.55%	Absents 0.11%	Absents 0.55%	Absents 0.44%	Index 0 0%	Index 0 0.55%	No Debonding 0.33%
	II class 0.66%	OVB reduced (<3mm) 0.33%	Presents 0.88%	Presents 0.44%	Presents 0.55%	Index 1 0.55%	Index 1 0.33%	1 Debonding 0.44%
	III class 0,22 %	OVB increased (>5 mm) 0,11				Index 2 0.44%	Index 2 0%	2 Debonding 0.11%
						Index 3 0%	Index 3 0.11%	3 Debonding 0.11%

Table 2. Detailed for Some Patients Selected For The Study

PATIENT NAME	CLASS	OVB	ROTATIONS	CROSS	BITE-RAISING	IDP	IDT	% DEBOND-ING
A.I	II CL II DIV	5 MM	2	NO	SI	1	0	0
C.D	III CL	6 MM	2	4 TEETH	NO	1	0	1
D.M	II CL	3 MM	3	4 TEETH	NO	1	1	1
M.F	II CL II DIV	5 MM	3	1	SI	2	1	3
P.P	II CL	1.5 MM	1	NO	NO	2	1	1
R.F	II CL	5 MM	0	0	SI	1	0	1
T.A	I CL	2 MM	1	NO	SI	2	0	0
Z.A	III CL	1 MM	4	1	NO	2	3	0
M.G	II CL	4 MM	3	NO	SI	1	0	2
	I class 0.0%	OVB normal (3-5mm) 0.43%	Absents 0.43%	Absents 0.86%	Absents 100%	Index 0.14%	Index 0 0.57%	No Debonding 0.14%
	II class 0.66%	OVB reduced (<3mm) 0.43%	Presents 0.57%	Presents 0.14%	Presents 0.0%	Index 1 0.43%	Index 1 0.43%	1 Debonding 0.29%
	III class 0,0 %	OVB increased (>5 mm) 0,14				Index 2 0.43%	Index 2 0%	2 Debonding 0.14%
						Index 3 0%	Index 3 0%	3 Debonding 0.43%

tartar index, detachment rate, cross rate, rotations numbers, bite-raising presents), have been bonded with indirect technique with Damon bracket system and (arch wire .014 CuNiTi inserted in all patients); successively, they have been clinically monitored for 10 weeks when arch wire 14X25 CuNiTi inserted. Prior data indicate that the difference in the response of matched pairs is normally distributed with standard deviation (SD) 5,3. If the true difference in the mean response of matched pairs is 0.02, we will be able to reject the null hypothesis that this response difference is zero with probability (PS) 0.5. The Type I error probability associated with this test of this null hypothesis is 0,05. We will need to study a minimum number (ES) of 5 subjects to be able to reject the null hypothesis that this response difference is zero with probability (power) 0,5. The sample consisted of 35+2 (excluded) (25 females and 10 male) subjects with a mean age of 19 ± 5.7 years. Participants were selected from a large pool of cases in treatment to the Department of Orthodontics of Sapienza University of Rome according to the inclusion and exclusion criteria, (Table 2). Two patients were excluded for an insufficient collaboration. The patients in the sample received the standard torque version inch slot appliances (Ormco, Damon Q ®). The arch wire sequence involved 0.014-inch CuNiTi (Ormco), 0.014 × 0.025-inch CuNiTi, for the upper and/or inferior arch. The average active treatment time was ten weeks. Complete records including cephalometric radiographs effectuated by the same operator, extra oral and intraoral photographs, and plaster models prepared from alginate impressions were obtained before treatment, it is scanned with Appliance and converted with Software in. STL File for obtained a 3D models. All patients are monitored by the DM application, after the setting of 3D models, from the arch wire insertion to subsequent ten weeks of work by 0.014 x 0.025-inch CuNiTi.

Results

We analyzed the following values at four, eight and ten weeks, for each tooth and patient:

- Mesial/ distal movement (mm)
- Ingression / egression movement (mm)
- Vestibule/ lingual movement (mm)
- Torque (degree)
- Rotation (degree)
- Tip (degree)

For erase the error tied to sign positive or negative of type of movements, we have considered the absolute value for each parameter.

We have calculated, for each patient, a statistical analysis: Mean, coefficient of Variation, Value Minimum, First quartile, Median, Third quartile, Value Maximum, For:

Each tooth, at 4,8 and 10 weeks (Fig. 6);

Same tooth in all patient in range of 0-4 weeks, 4-8 weeks, 8-10 weeks and from 0-10 weeks;

Anterior Section (from canine to canine) superior and inferior arch, from 8-10 weeks;

Posterior section (from first premolar to second molar) superior and inferior arch, 8-10 weeks and from 0-10 weeks;

Moreover, we have calculated a relationship between a movement's range from 8 to 10 weeks, considering the absolute values. These values show the residual movements obtained in the two last weeks, the blue point indicate the measure of the deviation, which in most cases is near 0. This measure is significant (Fig. 7). Finally, we have effectuated a T Student Test Analysis for every Region. The Student's t-distribution is a special case of the generalised hyperbolic distribution. (Graphic 1-2). In the first graphic, the test says that the deviations between 8 and 10 are significantly equal

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	Patient					PZ1			PZ2			PZ3			PZ4			PZ5		
2	N° weeks				0	4	8	10	4	8	10	4	8	10	4	8	10	4	8	10
3	unite	n° quadrant	n° tooth	movement's type																
4	mm	1	7	mesial_distal		0,6	1,25	1,19	-0,76	-1,3	-1,3	0	0	0	0,39	-0,08	-0,08	0	0	0
5	mm			ingression_egression		-0,85	-1,3	-1,26	0,02	0,11	-1,3	0	0	0	-0,18	-0,17	-0,17	-0,03	-0,04	-0,05
6	mm			vestibulo_lingual		0,01	-0,77	-0,53	-0,36	-0,52	0,11	-0,05	-0,05	-0,05	0,26	0,27	0,27	-0,31	-0,4	-0,46
7	degree			torque		-1,22	-3,66	-5,05	-1,65	-1,99	-0,52	0	0	0	-5,13	-5,1	-5,1	0	0	0
8	degree			rotation		-5,67	-13,87	-13,08	-0,27	0,19	-1,99	0	0	0	2,08	1,87	1,87	0	0	0
9	degree			tip		-1,15	-5,06	-9,48	-2,79	-4	0,19	0	0	0	3,3	3,26	3,26	0	0	0

Fig. 6. This view shows an example of statistical analysis for each patient and Each tooth, at 4,8 and 10 weeks.

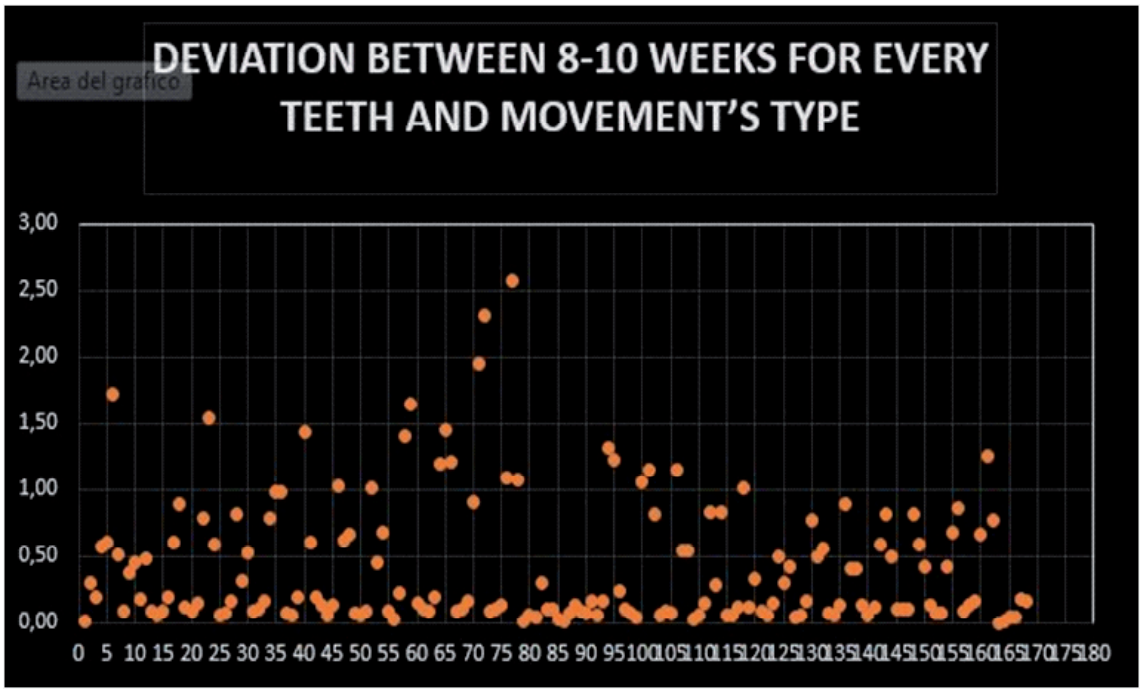
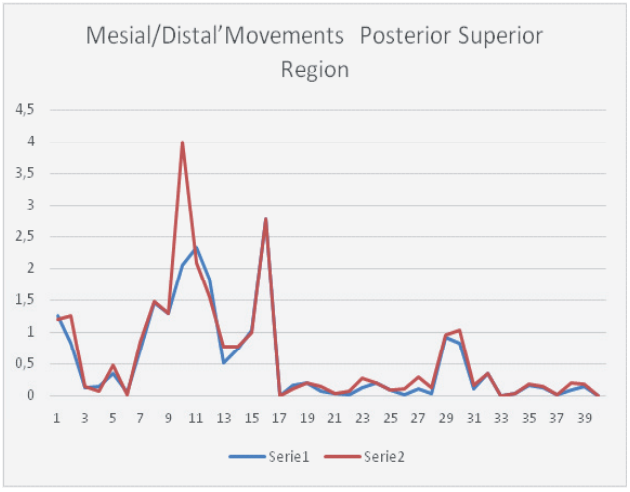
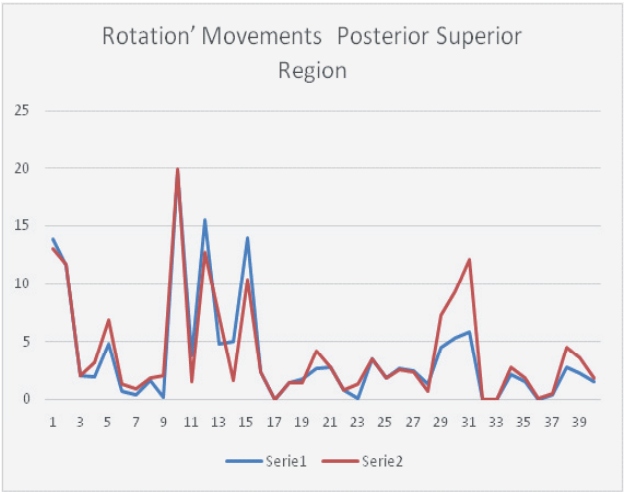


Fig. 7. This view shows blue point that indicate the measure of the deviation of movements between 8-10 weeks.



Graphic 1.



Graphic 2

to 0, in the second graphic, the test says that the deviations between 8 and 10 are significantly different from 0. If two dependent samples the data is (of course) paired, i.e.: each observation of a sample is coupled with one and only one of the other observation sample. In our case, we have auto-paired data: each subject serves as control of himself, and the data is obtained by the same individuals at different times. Of our interest, in this case, it is given to 8 weeks and at 10 weeks (for each individual comparison of the first positioning tooth (8 weeks) and after (10 weeks). The analysis is reduced to the sole series resulting from the differences between the elements of each pair.

The null hypothesis is given by:

– H 0 (null hypothesis): the population mean of the differences between the position at 10 weeks and at eight weeks is 0,
– H1 (alternative hypothesis): the average difference is not 0.

In other words, if the null hypothesis is accepted, the deviation of 8 to 10 weeks is close to zero. If the null hypothesis is rejected, you may say that the deviation between 8 and 10 weeks statistically different from zero.

Choosing a significance level α 1%.

– Anterior degrees of freedom for the test are 29 (= 30-1)
– Posterior degrees of freedom for the test are 39 (= 40-1)

In the table of the t distribution, in correspondence of the above-mentioned degrees of freedom and for a $\alpha = 0.01$ are the quantiles: the $t\alpha$_ant value = 2.75 and = 2.71 $t\alpha$_post that delimit the area of rejection of the hypothesis nothing.

When the empirical value of t> $t\alpha$_ant you decide to reject the null hypothesis according to which, the difference between 8 and 10 weeks is due to chance, with the probability of only 1% of committing error. It is concluded, therefore, that the deviation between 8 and 10 weeks has significantly different from zero in 99% of cases. This conclusion was found for all movements: mesial distal, ingression egression, vestibulo-lingual, torque, rotation, tip. In all Regions, except for the teeth of the Posterior Upper Region about mesial-distal movement; the data shows that the difference between 8 and 10 weeks has significantly near to 0.

Discussion

Digital technologies are nowadays widely used in the several branches of dentistry. By carrying out a literature review, various digital methods have emerged that have been applied in orthodontics, gradually modifying normal orthodontic practice in the last years, but the process has been slower in orthodontics than in other fields of dentistry. The design of self-ligating brackets claims improved sliding mechanics with the main advantages: reduced friction between brackets and wire, smaller orthodontic forces, greater treatment efficiency, inferior overall treatment time, and consequently a fewer number of appointments (22-25). Treatment time does not depend exclusively on the type of bracket. There are several influencing factors, such as the extent of malocclusion, former orthodontic therapy, compliance and the number of missed appointments, slow or fast tooth movement according to the rate of bone turnover (26), the therapist's skill and experience (including the ability to motivate patients) (27), faulty bracket bonding and time correction, frequency of emergencies such as arch wire fracture or bracket failures, as well as diseases and drug use (28). The number of appointments is of interest when considering treatment duration. Retrospective studies reported four (29) and seven (30) visits less in conjunction with self-ligating brackets.

Conclusion

In this experimental study, applying Dental Monitoring Application (31) with self-ligating technique we have found that the therapy's time was reduced in term of number of appointments, for each patient, from 4 appointments in 10 weeks to 2 appointments, specifically, at first appointment when we have effectuated the indirect bonding and at second appointment when we have inserted a 014X025 CuNiTi. These values indicate that there is a reduction in the mean period of material 'costs, number of visits; moreover, there is an increase in term of frequency of patient's monitoring, resulting in a more precise evaluation of treatment by orthodontist. Finally, there is a reduction of treatment time, which is an advantage for both the orthodontist and the patient. It is consequence of the reduction of the steps and worktime, and it is due to the real monitoring that can be performed on the patient. So, it is concluded that the device should be worn for 10 instead of 8 weeks. Only for two patients has been necessary another appointment for re-bonding faulty brackets (32). Moreover, these Results reveals a major precision in term of gradual development of Orthodontics therapy (33) and unquestionably Movement's Control to top level. Furthermore, the application of the digital technologies in the monitoring helps the orthodontist to make clinical decisions supported on measurable data and not just on clinical experience. The limits of present study are presented by the patient's compliance and by the small number of patients. This device is an instrument advantageous for the orthodontist's work (34). In literature, there are few articles inherent to Digital application Mobile, we will hope that this our experience represents a valid support to a major use of this application in the clinical practice.

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