

Increased interpremolar development with self-ligating orthodontics. A prospective randomized clinical trial

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ABSTRACT

In compressed dental arches with mild to moderate crowding, space can be gained during the alignment phase to help improve tooth location.

The aim of this study was to compare transverse measurements before and after the alignment stage in two groups: Group A treated with passive self-ligating brackets, (Damon System) and Group B with conventional brackets (Roth philosophy). The change in transverse diameter between teeth was measured on dental casts taken before and after orthodontic alignment. Twenty four patients of both sexes aged 13 to 36 years, with moderate tooth crowding (4 to 6 mm), were treated. They all received treatment at the Department of Orthodontics, School of Dentistry, University of Buenos Aires. Patients were distributed randomly into

two groups of 12. No extraction was performed until the end of the alignment. Dental casts were measured before and after alignment. The distance between upper first premolars increased more in Group B ($p = 0.008$), and the distance between canines was higher in Group B, with statistically significant difference ($p < 0.01$).

Both systems enable tooth alignment by increasing transverse diameter of the arches in patients with mild to moderate crowding. The greatest transversal development occurs in the inter-premolar area in both techniques and is significantly higher with self-ligating orthodontics.

Inter-canine distance increases significantly with conventional orthodontics compared to self-ligating orthodontics.

Key words: dental arches - orthodontics; development.

Mayor desarrollo interpremolar con ortodoncia de autoligado. Estudio clinico prospectivo randomizado

RESUMEN

En las arcadas dentarias comprimidas, con apiñamiento dentario de leve a moderado, es posible obtener ganancia de espacio que favorezca la ubicación de las piezas en la fase de alineación por remodelación alvéolo-dentaria de las arcadas.

El objetivo de este trabajo fue comparar las diferencias pre y post tratamiento en la etapa de alineación de los grupos A: brackets autoligables pasivos, (Sistema Damon) y grupo B: brackets convencionales (Filosofía de Roth). Se evaluaron las variaciones en el diámetro transversal, antes y después de alinear ortodóncicamente los dientes, utilizando modelos de estudio.

Participaron 24 pacientes de ambos sexos, entre 13 y 36 años con apiñamiento dentario moderado (entre 4 y 6 mm) tratados en la Cátedra de Ortodoncia de la Facultad de Odontología, Universidad de Buenos Aires. Los pacientes fueron distribuidos al azar en dos

grupos de 12 pacientes cada uno. No se realizaron exodoncias hasta finalizar la alineación. Se midieron los modelos pre y post alineación.

La distancia entre primeros premolares superiores aumentó en el grupo A más que en el B ($p=0.008$) y entre caninos fue mayor en el grupo B, con diferencia estadísticamente significativa ($p < 0,01$).

En pacientes con apiñamiento leve a moderado, la expansión con ambos sistemas permite la alineación dentaria por aumento del diámetro transversal de las arcadas fundamentalmente en el área premolar. El mayor desarrollo transversal se produce en el área premolar para ambas técnicas y es significativamente mayor con ortodoncia autoligable.

En ortodoncia convencional, aumenta significativamente la distancia intercanina en comparación con la autoligable.

Palabras clave: arcos dentales - ortodoncia; desarrollo.

INTRODUCTION

Self-ligating brackets were introduced in 1946 by Stolzenberg¹ and the Damon system used in this study was introduced in 1996^{2,3}. Different authors have highlighted advantages of the self-ligating system compared to conventional brackets: reduction in

treatment time and greater comfort for the patient^{4,5} shorter consultations, longer intervals between appointments⁶⁻⁸. Pandis et al. 2008 conducted a clinical trial comparing dental changes during the initial stages of alignment without extractions in lower jaw, finding no statistically significant difference⁹.

Our team compared the gingival response in patients treated with conventional and self-ligating brackets and found that orthodontic treatment increased bacterial plaque and gingival inflammatory response in both groups without statistically significant differences between groups¹⁰. Moreover, adequate basic therapy can maintain gingival and periodontal health. These results are consistent with recent studies published by Kaklamanos et al.¹¹

A review of the literature published by Miles¹² and Herradine¹³ compared conventional with self-ligating treatment, finding that both treatments achieved alignment with a combination of dental arch expansion, with less incisive flaring when self-ligating treatment was used. Celar¹⁴ published a systematic review in 2013 comparing initial pain, number of consultations and treatment time, concluding that further prospective studies are required to define whether there are any differences between the techniques. Reddy et al. reported in 2014 that self-ligating bracket treatments are more efficient regarding space closure than the conventional systems and that alignment occurs through lower incisor inclination¹⁵.

Recently published studies quantify the increase and bone loss by vestibular and lingual / palatal with cone beam tomography in orthodontic patients. Transverse changes in dental arches have been analyzed in plaster study casts¹⁶ and in digital models¹⁷.

Our hypothesis is that the greatest gain in space with the self-ligating system occurs in the lateral areas of the arches, at the level of the premolars, with no alteration of inter-canine or inter-molar distance.

Our goal is to compare differences in the distance between canines, first and second premolars and first and second molars in both arches before and after alignment using both techniques.

MATERIAL AND METHODS

This project was approved by the Bioethics Committee of the school of Dentistry of the University of Buenos Aires, and follows the principles of the Declaration of Helsinki. Patients signed informed consent to participate in this prospective clinical trial.

Patients

Inclusion criteria: Patients 13 to 36 years old of both sexes, with permanent dentition, with little

development in their dental arches, moderate dental crowding (-4 to -6 mm of dental discrepancy).

Exclusion criteria: patients with joint disorders, untreated caries or periodontal disease. Patients with mixed or temporary dentition. Patients with diastemas, teeth retained or absent except third molars.

Treatment plan: Patients were assigned randomly to treatment with one of the techniques. Treatment plans were made after diagnosis, which was based on cephalometric analysis, study of plaster casts and clinical analysis. Extractions were determined from the clinical analysis of facial aesthetics, sagittal problems, open bite, dental protrusion and dental discrepancy. When extractions were required, they were performed after the alignment stage.

Experimental design

Patients were treated by calibrated professionals from the Orthodontic department, with unified criteria. The sample was distributed into two groups of 12 patients each.

Group A: 12 patients of both sexes, 13 to 34 years old, were treated with the Damon System (low friction). Damon II brackets (A Company), nickel-titanium-copper archwires (Damon Cooper-Ni-Ti.014 and 0.016), Damon format.

Group B: 12 patients of both sexes, 13 to 36 years old, were treated with a straight wire technique (with friction). Roth brackets (A Company, Synthesis), nickel-titanium archwires (Ni-Ti .012, .014 and .016), True Arch format and elastomeric ligature (Fig.1).

The treatments followed the protocol of each technique. Routine diagnostic studies were performed (Panoramic Rx, Tele-Rx profile, cephalometric

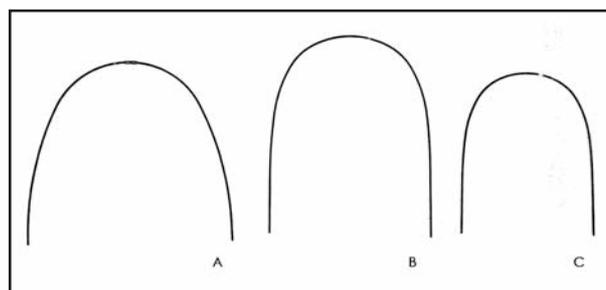


Fig. 1: The archwires used for the treatment with Damon System present Damon format, which is the same for both jaws (a). Treatments performed with Roth's Philosophy True Arch used archwires with different shapes for upper (b) and lower jaw (c).

analysis, articulator mounting, clinical examination and dental study casts). The dental arch was considered aligned when it was possible to place the rectangular archwire. During the initial stage, no extractions or interproximal wear were performed. Operational definitions of variables: Pre- and post-alignment dental casts were studied.

Dental cast study

The expansion of the dental arches in transverse direction was measured in upper and lower jaws. Measurements were performed taking as a guide the projection on the gingiva of the palatal sulcus of the first or second upper molars and the lingual groove of the lower molars, the projection on the gingiva of the tip of the palatine cusp of the first and second upper and lower premolars, and the projection on the gingiva of the cingulum of the upper and lower canines.

Measurements were taken with a digital caliper (Mitutoyo Digimatic NTD12-6" C; Mitutoyo Corp., Tokyo, Japan). Five measurements per jaw were taken on each patient for transverse analysis. The casts were measured by three calibrated operators who were blinded to the groups (pre- and post-treatment, identified with numbers)¹⁸ (Fig. 2).

Measurements were compared using descriptive statistics of mean, SD and 2-tailed Student's T-test for unpaired samples.

RESULTS

Analysis of dental casts: transversal variation

Table 1 shows the averages and Standard Deviations (SD) of the variation in the distance between contralateral teeth of 24 patients at the end of the alignment stage taking into account all transverse measurements.

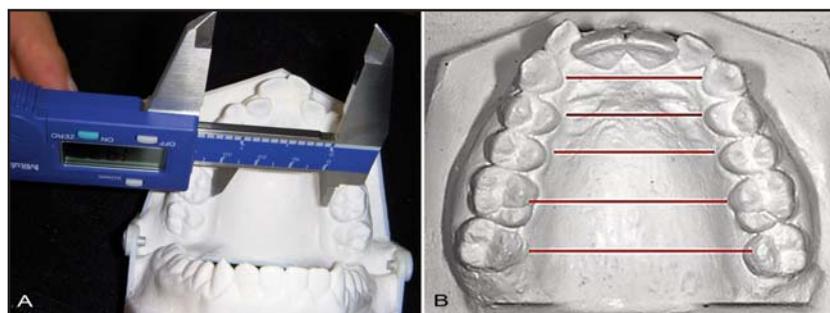


Fig. 2: A: Measurement with digital caliper of the transverse distance between homologous teeth in upper jaw casts. B: Transverse measurements performed pre- and post-alignment in upper jaw casts.

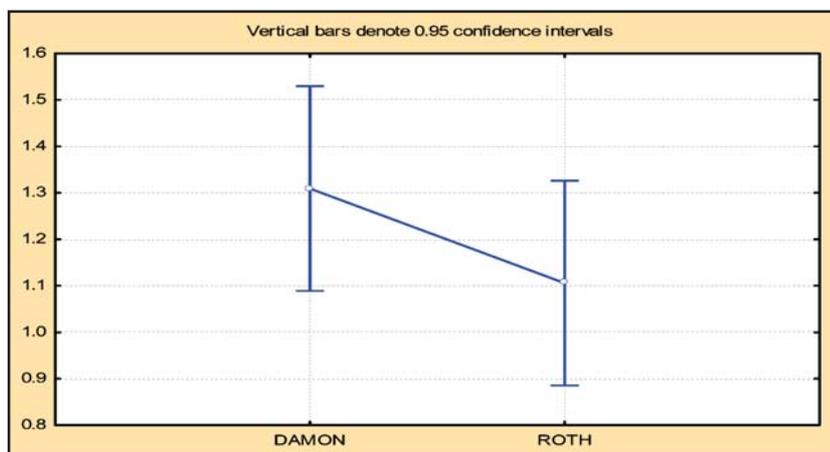


Fig. 3: Bar chart considering both jaws. Difference in the development of the arches with self-ligating (Damon System) ($n = 12$) and Roth Technique ($n = 12$) ($p = 0.19$).

Statistical analysis

The following descriptive statistics were performed: average, SD and Student T Test for two-tailed unpaired samples for comparison between samples. Comparative analyses were performed by jaws, by techniques and by teeth. Student's T-test showed statistically significant differences in the distance between first upper premolars, which was greater with self-ligating brackets ($p = 0.008$). At the level of the canines, there was greater expansion with the conventional technique ($p \leq 0.01$). The rest of the comparisons showed no statistically significant difference. Considering both maxillaries, the sum of the distances between all contralateral teeth evaluated increased with the alignment by an average 1.3mm in group A (self-ligating) and 1.1mm in Group B (conventional); with no statistically significant difference ($p = 0.19$) (Fig. 3).

Table 1: Variation in the distance between contralateral homologous teeth in alignment treatment.

VARIATION BETWEEN	MAXILLARY	DAMON SYSTEM n=12		CONVENTIONAL ROTH n=12		TEST T UNPAIRED
		AVERAGE	DS	AVERAGE	DS	p
CANINES	UPPER	0,217	2,458	0,81	1,6476	* < a 0,001
1PMs	UPPER	2,47	1,111	2,077	1,674	*0.008
2PMs	UPPER	1,741	1,538	1,434	1,301	0,614
1Ms	UPPER	0,268	1,556	-0,227	0,957	0,357
2Ms	UPPER	-0,7	1,127	-0,296	2,33	0,594
CANINES	LOWER	0,416	1,637	1,903	0,923	*0,011
1PMs	LOWER	1,744	2,394	1,879	1,177	0,862
2PMs	LOWER	1,66	1,847	1,111	2,016	0,493
1Ms	LOWER	-0,09	1,45	-1,07	1,645	0,135
2Ms	LOWER	0,055	1,465	-0,535	1,206	0,292

DISCUSSION

The Damon system uses self-ligating brackets and heat-activated copper-Ni-Ti archwires which are the same size for both jaws, whereas the Roth system uses True Arch Ni-Ti archwires, with the upper archwire being larger than the lower. Our hypothesis is that these two different orthodontic systems produce different responses in the tissues.

In the study subjects, who presented mild to moderate discrepancy, transversal development was slightly higher for the self-ligating system, although with no statistically significant difference. This would indicate that an archwire larger than the dental arch does not produce an expansion greater than needed when its composition is superelastic, as is the case of heat-activated copper-nickel-titanium, which exerts a very low force that can be controlled by the musculature

A paper published in 2014 by Atik et al¹⁹ compared the two treatment systems taking into account the position of the incisors, the changes in transverse dimensions in the upper arch, inclination changes in upper teeth, the clinical periodontal parameters and the intensity of pain in patients with a Class I malocclusion by studying pre- and post-treatment casts and cephalometry in patients with dental crowding. The study concluded that there was no difference between the two systems relative to the position of the incisors, changes in the dental arch, transverse dimension, periodontal clinical parameters or intensity of pain. We believe that the

same outcomes can be achieved with both systems because a Quad-Elix expander was used prior to the conventional treatment, enabling treatment without extractions. We understand that arches behave differently according to whether they are treated with passive self-ligating system or conventional system.

Analysis of transverse dimension between teeth

The increase in transverse diameter is mainly the result of variations in the shape of the arches. In compressed dental arches with moderate crowding, light arch wires can be used during the alignment phase to gain space and help improve tooth location. Franchi *et al.* (2006) compared the use of low-friction ligature instead of self-ligating brackets, reporting a similar increase in upper inter-molar width in comparison to that obtained by conventional ligation with elastomers. The study showed 4 degrees of vestibular molar inclination and concluded that this may imply that the molar expansion observed with self-ligating brackets is related to displacement or inclination of the molars rather than to bodily movement or basal maxillary expansion²⁰.

In the present study, the evaluation of the distance between contralateral teeth used anatomical landmarks as reference: insertion of the teeth at the palatal or lingual level. This explains why the transverse increase is smaller in millimeters than when the increase is measured at the crown level.

Inter-canine distance

For inter-canine distance, the increase was slight: $0.2\text{mm} \pm 2.4$ with Damon system and $0.8\text{ mm} \pm 1.6$ with Roth. In the lower jaw, average variation was $0.4\text{mm} \pm 1.6$ with the self-ligating system and $1.9\text{mm} \pm 0.9$ with the Roth system. Differences were statistically significant in both cases.

Premolars and molars

For premolars and molars, the average increase in transverse diameter was $2.47\text{ mm} \pm 1.11$ for the self-ligating group and $2.07\text{ mm} \pm 1.67$ for the Roth group, with statistically significant difference ($p = 0.008$).

Vajaria et al included the measurement of the distance between premolars to compare the Damon system with straight-wire appliance, and found increased distances between canines and premolars for both groups, though with no significant difference in transverse level between groups²¹.

Almeida et al studied the changes produced with both types of treatment only in the lower arch¹⁶, finding no significant increase between premolars. However, in said study the measurements were taken at the cusps, which are anatomical landmarks different from those evaluated in the current study or in the study by Fleming et al²².

Pandis et al. in 2009, carried out a comparative study between straight-wire appliance and self-ligating, finding that mandibular crowding was corrected through incisive flaring and expansion of the arches. However, they recorded measurements between canines and molars, without taking into account the inter-premolar distance, which in our study is the distance that varies the most and differs significantly between techniques⁹.

ACKNOWLEDGMENTS

We thank Orthodontika Company for its cooperation with orthodontic materials and orthodontists Pelizardi C and Herrera del Corral MA.

FUNDING

This study was supported by grants from Buenos Aires University: 2008-2010 Program (code O 408), 2010-2012 Program (code 0020090200390) and 2012-2014 Program (code CO22).

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In the individual evaluation of the response in the arches with the self-ligating system, it was found that the greatest modification in the transverse diameter of upper and lower arches occurs at the level of the inter-premolar distance, in agreement with papers recently published by Cattaneo et al¹⁷. They evaluated digital casts of patients treated with passive self-ligating and active orthodontics; finding a statistically significant increase at the level of premolars. Lineberger et al²³ used digital casts to study 25 patients treated with self-ligating brackets compared to untreated controls, and found a 2 - 2.2 mm increase in transverse diameter at the level of premolars and an increase in torque.

In the molar sector, the differences found were minimal. There was even reduction between upper and lower first and second molars with the conventional technique, and between second upper molar and first lower molar with the self-ligating technique, with no statistically significant difference between techniques.

Vajaria et al found a significant increase between molars in the treatment with Damon System, but the measurements were made using dental landmarks, so the results may be due to the vestibular inclination of the crowns²¹.

In patients with mild to moderate crowding, transverse development with conventional and self-ligating treatments enable dental alignment, in both cases by increasing transverse diameter.

Most of the transverse development occurs in the premolar area with both techniques and is significantly greater with self-ligating orthodontics. Inter-canine distance increases significantly more for both jaws with conventional than with self-ligating orthodontics.

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