# Method for evaluation of transverse dimension in self-ligating orthodontic treatment. A comparative study

Alejandra Folco[1], Sandra Benítez-Rogé[1], Diana Calabrese[1], Marina Iglesias[1], María Lumi[1], Pedro Hetch[2], María E. Mateu[1]

[1] *Universidad de Buenos Aires, Facultad de Odontología, Cátedra de Ortodoncia, Argentina*

[2] *Universidad de Buenos Aires. Facultad de Odontología, Cátedra de Biofísica y Bioestadística, Argentina.*

***ABSTRACT***

*Knowledge of the best way to evaluate changes in transverse dimension produced by orthodontic treatment enables the estimation of potential space that may be generated and optimizes planning. The aim of this study was to compare two methods for measuring changes in transverse dimension following tooth alignment by passive self-ligating system: Method 1 (M1) considering palatal landmarks and Method 2 (M2) considering dental landmarks. Subjects were 12 patients of both sexes, aged 15 to 24 years old, with moderate crowding (Nance discrepancy -4 to -6 mm), who were treated with the Damon System at the Department of Orthodontics of the School of Dentistry, Buenos Aires University. Their pre- and post-treatment maxillary casts were analyzed (24 casts altogether). Five measurements were taken on each cast: intercanine width, first and second inter-premolar width and first and second inter-molar width, using the two measurement methods (M1 and M2). Both methods found average width to have increased, though this increase was smaller as measured by M1 than by M2, with statistically significant difference between values ($p<0.05$). M1 and M2 provided significantly different measurements for first and second inter-premolar and first intermolar distances ($p< 0.05$). The values obtained using M1 (palatal landmarks for teeth) present less variation and provide information on the changes in the dental arches without adding tooth tipping. Considering M1, the greatest gain in transverse dimension occurred in first and second inter-premolar distance, there was a slight increase in inter-canine and first inter-molar distance, and a decrease in second inter-molar distance.*

***Key words:*** *Orthodontics, ortodontic brackets, treatment outcome.*

## Método de evaluación transversal en tratamiento con ortodoncia autoligable. Estudio comparativo

***RESUMEN***

*Conocer la mejor manera de evaluar los cambios en el diámetro transversal de las arcadas producidos con el tratamiento ortodóncico permite estimar el espacio que puede generarse y optimizar la planificación del mismo. El objetivo del trabajo fue comparar las modificaciones del diámetro transversal utilizando reparos palatinos (M1) y reparos dentarios, (M2) luego de la alineación dentaria con sistema autoligable pasivo. Se evaluaron los maxilares superiores de 12 pacientes de ambos sexos (24 modelos pre y post tratamiento en total) atendidos con Sistema Damon en la Cátedra de Ortodoncia de la FOUBA, de entre 15 y 24 años de edad con apiñamiento moderado (discrepancia de Nance entre -4 y -6 mm). Se tomaron 5 medidas por arcada: distancia entre caninos, primeros y segundos premolares y primeros y segundos molares de los modelos pre y post alineación por tratamiento ortodóncico, utilizando dos métodos de evaluación (M1 y M2). La variación en el diámetro transversal promedio aumentó en ambos métodos y fue menor utilizando M1 que M2, con diferencia estadísticamente significativa entre los valores ($p< 0.05$). En el análisis de la distancia entre piezas dentarias homólogas, comparando M1 y M2, se encontró diferencia estadísticamente significativa entre primeros, segundos premolares y primeros molares ($p< 0,05$). Las arcadas presentaron incremento del diámetro transversal que fue evidenciado por ambos métodos de medida. Los valores tomando reparos en palatino de las piezas dentarias presentan menos variación e informan sobre las modificaciones de las arcadas dentarias sin agregar las inclinaciones de las piezas. Considerando M1 la mayor ganancia de diámetro transversal se produce en primeros y segundos premolares, con aumento leve en caninos y primeros molares y disminución entre segundos molares.*

***Palabras clave:*** *Ortodoncia, brackets, resultados de tratamiento.*

## INTRODUCTION

Correcting tooth crowding without extractions or interproximal reductions requires an increase in arch perimeter so that teeth may be aligned. In absence of distal movements, dimensional changes in the arch involve dental and buccal changes and expansion[1]. It is a well-known fact that treatment for dental crowding with either self-ligating or

conventional brackets (CLB) without performing any extractions will produce dentoalveolar expansion. The amount of expansion depends on the mechanics applied in each case[1-6].

There is controversy about the response of dental arches regarding expansion or change in transverse diameter produced by treatment with the passive self-ligating system.

It has been claimed that use of Damon self-ligating brackets can expand the upper arch in maxillary constriction cases by using broader archwires and passive self-ligating brackets[2.] Damon D. reports that considerable expansion of the buccal segments can be achieved, producing a broader arch form which is more in balance with the tongue and cheeks[3].

Several studies have evaluated changes in arch transverse dimension in patients under orthodontic treatment, although they record measurements between canine tips and molar fossae, and do not evaluate the response at the level of premolars. The response in transverse dimension of the mandibular dental arch treated with self-ligating orthodontics has also been widely studied, especially dentoalveolar response measured on casts[1, 2, 7-11] and studies evaluating digital models and cone beam images[12].

Damon presents pre- and post-alignment transverse dimension measurements in patients treated with the Damon system using as reference points canine tips and molar and premolar vestibular cusps[3]. Another published method for evaluating changes in width is clinical photogrammetry, in which measurements are made on occlusal photographs, using as a reference the distance between vestibular cusps of first molars and canine tips[5].

The purpose of the current prospective study is to compare two methods for measuring casts in order to evaluate the transverse response of the arches to self-ligating orthodontic treatment. The methods to be compared are M1 using anatomical landmarks with relation to the insertion of teeth at palatine level and method M2, reported in the literature, which uses as landmarks premolar and molar vestibular cusps and canine tips. Our hypotheses are: 1- Measurements using M1 reveal smaller transverse increase than measurements taken using as landmarks canine tips and vestibular cusps of molars and premolars (M2). 2- The greatest increase in transverse dimension occurs in the premolar sector.

The aim of this study is to compare the changes in the transversal dimension of dental arches after tooth alignment with self-ligating system by using palatine and tooth landmarks.

## MATERIALS AND METHODS

This project was approved by the FOUBA Bioethics Committee and subjects signed informed consent. Data were recorded for full diagnosis of patients at baseline (T1) and upon completing dental alignment (T2), including casts and linear tomographies. Subjects were 12 patients of both sexes aged 15 to 24 years, with moderate crowding (-4 to -6 mm de Nance discrepancy), who were treated with the DAMON System (passive self-ligating brackets and round Niti Cu arch wires) at the Department of Orthodontics of the School of Dentistry at Buenos Aires University. Three calibrated double-blinded operators used a Japanese Mitutoyo brand digital caliper to measure the maxillary casts before and after treatment.

Five measurements were taken on the pre- and post-alignment treatment maxillary casts for each patient: inter-canine, first and second inter-premolar, and first and second inter-molar distances, using two different methods: Measurement Method 1 (M1) using palatal landmarks and Measurement Method 2 (M2) using dental landmarks (premolar and molar vestibular cusps and canine tips) (Fig. 1 A and B).

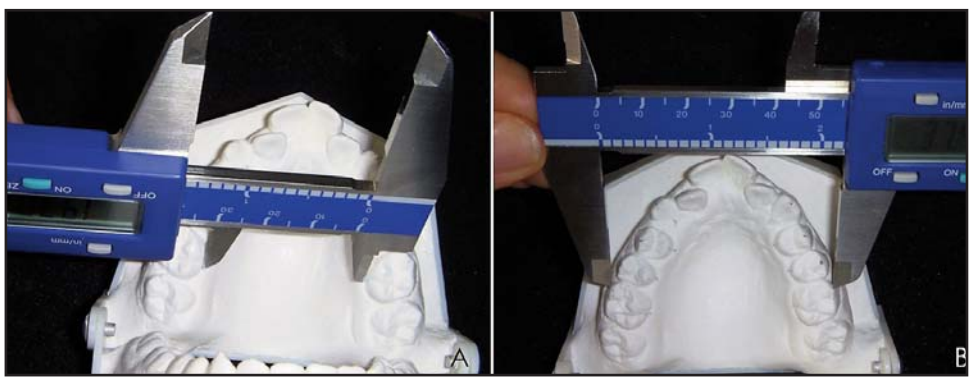


*Fig. 1: Measuring distance between teeth 16 and 26 using a digital caliper, according to the two measurement methods. A: M1 and B: M2.*

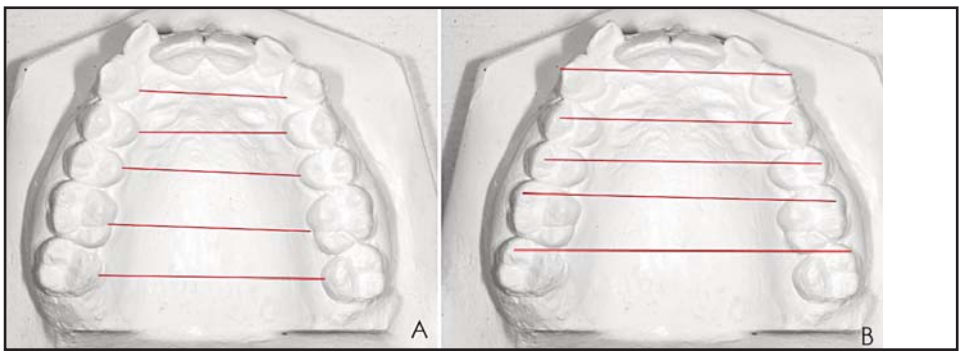


*Fig. 2: The following anatomical points were used as references. For M1: cingulum projection on gum for upper canines; palatal cusp tip projection on gum for upper first and second premolars; palatal sulcus projection o gum for upper first and second molars. For M2: cusp tip for upper canines, cusp tip for upper first and second premolars, mesio-vestibular cusp tip for upper first and second molars.*

Means and standard deviations were calculated. The differences in transverse dimension between homologous teeth achieved by the alignment treatment as measured by methods M1 and M2 were compared. Student's T-test for paired samples was applied (Fig. 2).

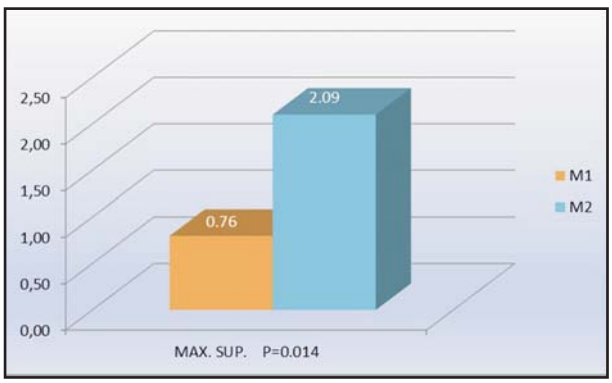


*Fig. 3: Evaluation of the variation of the upper maxillary using measurement method M1 (palatal landmarks) and M2 (dental landmarks). Student's T-test for paired samples. Statistically significant difference between values (p= 0.014), N= 12.*

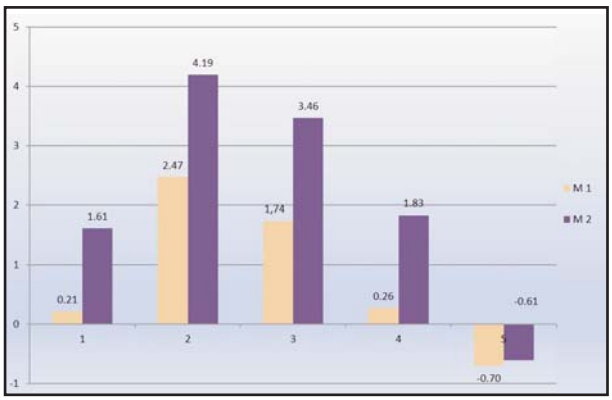


*Fig. 4: Variation in transverse dimension produced by alignment in maxillary, considering palatal landmarks (M1) and dental landmarks (M2). 1: canines; 2: first premolars; 3: second premolars; 4: first molars and 5: second molars. N= 12. Student's T-test for paired samples, N= 12. Analysis of the distance between homologous teeth showed statistically significant differences between first and second premolars and first molars (p< 0.005).*

## RESULTS

Considering all upper maxillary measurements, values were 0.76 ± 1.9 mm for M1 and 2.09 ± 2.4 mm for M2, with statistically significant difference (p=0.014) according to Student's T-Test (Fig. 3).

Comparison of M1 and M2 for determining the distance between homologous teeth showed statistically significant differences between first premolars (p=0.003), second premolars and first molars (p=0.03) (Table 1).

The bar chart in Fig. 4 shows average variation in transverse dimension after dental alignment for the two measuring methods.

ANOVA was applied to evaluate variation between maxillae and between specific teeth. Differences were found between teeth and between measurement methods (M1 vs. M2).

The measurements recorded differed depending on whether they were taken considering palatal landmarks or dental landmarks (M1 vs. M2), with dental landmarks providing higher values, and there is a positive relationship considering the type of anatomical landmark evaluated and specific teeth, particularly in the premolar sector.

## DISCUSSION

Dental arch expansion by means of self-ligating brackets and broader superelastic archwires has recently become a subject of study. On the basis of this idea, several studies have compared dento-alveolar expansion using conventional brackets and self-ligating brackets. A study by Pandis measured transverse dimensions on pre- and post-alignment casts, using as landmarks canine cusps and molar central fossae. It compared conventional and self-ligating bracket systems, finding that transverse

**Table 1: Difference in transverse dimension with alignment in maxillary using measuring systems M1 (palatal landmarks) and M2 (dental landmarks).**

| Measurements between | Media M 1 | SD M1 | Media M2 | SD M2 | Student T p value |
|---|---|---|---|---|---|
| Canines | 0.21 | 2.45 | 1.61 | 1.93 | 0.1356 |
| First premolars | 2.47 | 1.11 | 4.19 | 1.40 | * 0.0030 |
| 2nd premolars | 1.74 | 1.53 | 3.46 | 2.09 | * 0.0313 |
| First molars | 0.26 | 1.55 | 1.83 | 1.80 | * 0.0331 |
| 2nd molars | -0.70 | 1.12 | -0.61 | 1.69 | 0.8831 |

SD: standard deviation, *significant difference

dimension increased using both systems, with statistically significant differences in inter-molar distance for the self-ligating group[13].

In the current study, both measuring methods show an increase in transversal dimension. This is in agreement with Lineberguer's study on digital casts of growing patients comparing patients treated with self-ligating orthodontics to untreated patients[4]. Our values recorded by method M1 show less variation and provide information on changes in arches, which we assume is because this method does not add the modifications due to tipping of teeth (with statistically significant difference between values found for first and second premolars and first molars).

Our results showed a greater increase in transverse dimension when vestibular cusps were used as landmarks than when palatal landmarks were used, suggesting an increase in the transverse dimension at alveolar level as a result of an increase in the distance between palatal or lingual cortical plate and contralateral palatal or lingual cortical plate, which would increase the diameter of dental arches. Thus we believe that the increase in transverse dimension could be considered to be produced at the expense of alveolar-dental remodeling and not only due to an increase in torque or tipping of teeth toward the vestibular.

With regard to the change in transverse dimension considered for each tooth with the M1 measuring method, space is gained mainly in the premolar area, with inter-canine distance and first inter-molar distance increasing very slightly, while second inter-molars distance decreases with the treatment. This is in agreement with Vajaria et al.[9], who compared self-ligating and conventional orthodontics using digital casts, finding greater increase for the self-ligating group, which also presents evidence that the premolar area is responsible for the increase in transverse dimension It is also in agreement with Lineberger's study[4] on digital casts, which found significant increase in inter-premolar distance in the group treated with the Damon system, compared to the control group without treatment[4].

Franchi et al. found 4 degrees buccal tipping of the molars and concluded that this may imply that molar expansion observed with self-ligating brackets is related to the displacement or tipping of molars rather than to bodily movement or basal maxillary expansion[14].

## CONCLUSIONS

The preferred method for weighting changes in the transverse dimension on casts in order to evaluate transverse development of arches would be the method that uses anatomical landmarks near palatal cortical plates of teeth (M1). This method avoids the distortion that may be induced by a change in torque or vestibular tipping of the teeth evaluated, mainly in the area of premolars and first molar.

Both measuring methods showed an increase in transverse dimension of arches aligned using passive self-ligating system. However, method M1 shows that the gain occurs in the premolar area, with inter-canine distance and first inter-molar distance increasing very slightly, while second inter-molar distance decreases.

**AKNOWLEDGMENTS**

This study was conducted within the Grant Program of the University of Buenos Aires, UBACYT O408 and 0020090200390. We thank the firm Orthodontika for its cooperation.

**CORRESPONDENCE**

Dr. Alejandra Folco
Cátedra de Ortodoncia, Facultad de Odontología, UBA
M.T. de Alvear 2142, Buenos Aires, Argentina
alefolco@hotmail.com

## REFERENCES:


1. Fleming PS, DiBiase AT, Lee RT. Self-ligating appliances: evolution or revolution? Aust Orthod J 2008 ;24:41-49.
2. Fleming PS, Johal A.J: Self-ligating brackets in orthodontics. A systematic review. Angle Orthod 2010 ;80:575-584.
3. Harradine NT. Self-ligating brackets: where are we now? J Orthod 2003; 30: 262-273.
4. Lineberger MB, Franchi L, Cevidanes LH, Huanca Ghislanzoni LT, McNamara JA (Jr).Three-dimensional digital cast analysis of the effects produced by passive self-ligating system. Eur J Orthod 2016;38:609-614.
5. Birnie DJ. The Damon passive self-ligating appliance system. Semin Orthod 2008; 14: 19 -35.
6. Damon D, Bagden A, Damon Manual de Trabajo, 2004 Ormco Corporation.
   URL::www.damonsystem.com
7. Fleming PS, DiBiase AT, Sarri G, Lee RT. Comparison of mandibular arch changes during alignment and leveling with 2 preadjusted edgewise appliances. Am J Orthod Dentofacial Orthop 2009;136:340-347.
8. Normando D, Lima da Silva P, Moraes Mendes A. A clinical photogrammetric method to measure dental arch dimensions and mesio-distal tooth size. Eur J Orthod 2011; 3 :721-726.
9. Vajaria R, BeGole E, Kusnoto B, Galang MT, Obrez A. Evaluation of incisor position and dental transverse dimensional changes using the Damon system. Angle Orthod 2011; 81:647-652.
10. Yu YL, Tang GH, Gong FF, Chen LL, Qian YF.A comparison of rapid palatal expansion and Damon appliance on non-extraction correction of dental crowding. Shanghai Kou Qiang Yi Xue 2008;17:237-242.
11. Atik E, Ciğer S. An assessment of conventional and self-ligating brackets in Class I maxillary constriction patients. Angle Orthod 2014 ;84:615-622.
12. Cattaneo PM, Treccani M, Carlsson K, Thorgeirsson T, Myrda A, Cevidanes LH, Melsen B. Transversal maxillary dento-alveolar changes in patients treated with active and passive self-ligating brackets: a randomized clinical trial using CBCT-scans and digital models. Orthod Craniofac Res 2011; 14: 222-233.
13. Pandis N, Polychronopoulou A, Makou M, Eliades T. Mandibular dental arch changes associated with treatment of crowding using self-ligating and conventional brackets. Eur J Orthod 2010;32:248-253.
14. Franchi L, Baccetti T, Camporesi M, Lupoli M. Maxillary arch changes during leveling and aligning with fixed appliances and low-friction ligatures, Am J Orthod Dentofacial Orthop 2006; 130: 88-91.