



Original Article

Evaluation of lower anterior dental changes in patients treated with self-ligating brackets

Wendel M.M. Shibasaki, Lucas Hian da Silva, Acácio Fuziy, Tarcila Triviño*, André L.F. Costa, Ana C.R. Nahás-Scocate

School of Dentistry, University of São Paulo City, São Paulo, Brazil

ARTICLE INFO

Keywords:

Orthodontic brackets
Orthodontics
Tooth movement

ABSTRACT

The aim of this study was to evaluate and compare changes in linear distance and inclination of lower incisors and canines and intercanine distance after a 30 months orthodontic treatment with self-ligating appliances. Seven patients were treated orthodontically with a Roth prescription passive self-ligating bracket. To perform the measurements and comparisons, CBCT scans were taken before the start of the orthodontic treatment (T_1) and after a period of 30 months treatment (T_2). The following measurements were performed: (1) the lower incisors and canines inclination in relation to the mandibular plane, (2) intercanine linear distance in millimeters and (3) linear distance in millimeters of the incisal and apical part of lower anterior teeth to a plane (POGM) passing through pogonion point and perpendicular to the mandibular plane. No significant difference were observed between T_1 and T_2 for canine inclination ($p = 0.835$), incisors inclination ($p = 0.149$), canine incisal distance to POGM ($p = 0.423$) and incisors incisal distance to POGM ($p = 0.966$), however canine apical distance ($p = 0.049$) and incisors apical distance ($p = 0.002$) to POGM was lower at T_1 than at T_2 . The intercanine distance was significantly lower ($p = 0.022$) at T_1 when compared to T_2 . The use of passive self-ligating brackets in orthodontic treatment to solve 4 mm tooth crowding were able to produce dental arch expansion by bodily tooth movement.

1. Introduction

The self-ligating brackets began to gain popularity from the 70 s, with the promise of reduce the chair time, be more comfortable for the patients and decrease the total time of the orthodontic treatment. All this supported by the fact that the self-ligating brackets would generate forces in lower levels compared to the conventional brackets, present less biofilm retention and less friction with archwire due the non-use of metallic or elastic ligatures.^{1,2}

One important concept that is been discussed over the scientific literature, is that these low level forces generated by the self-ligating brackets act less aggressive to the oral tissues, enabling the arch to reshape itself by bone neof ormation to accommodate teeth.^{3,4} Furthermore, it is believed that the gain in arch length occurs by teeth translatory movement with little or no buccal inclination.^{4,5} However, these concepts are still controversial, since there is evidence showing no difference in the expansion of the dental arch and transversal bone thickness after orthodontic treatment by comparing the performance of conventional brackets with self-ligating brackets.^{6,7} Furthermore, considerable and uncontrolled dental tipping, up to ~26 degrees, were

reported during the expansion of dental arches with the use of self-ligating brackets.

The stability of the orthodontic treatment in anterior region is directly related to the type of arch expansion, either bodily or tipping teeth movements' type.⁸ Therefore, tipping movements are typically impermanent and could present negative esthetic connotations when excessive maxillary incisor proclination happens.⁹ Considering the above problematic, clarifying the real role of self-ligating brackets in arch expansion could bring a better direction for the correct application of these appliances. Thus, to fully assess dental changes occurring during treatment, a three-dimensional (3D) analysis by cone-beam computed tomography (CBCT) is needed. The CBCT presents several advantages compared to other imaging methods, such as low radiation dose and good precision for linear measurements.¹⁰

This study general objective was to evaluate if a passive self-ligating brackets is able to produce dental arch expansion by bodily tooth movement. Specifically, the aim of this study was to evaluate and compare, by the means of CBCT, changes in linear distance and inclination of lower incisors and canines and intercanine distance after a 30 months period of orthodontic treatment with self-ligating

* Corresponding author at: Rua Cesário Galeno, 448/475, Tatuapé, São Paulo, SP 03071-000, Brazil.
E-mail address: tarcilatrivino@uol.com.br (T. Triviño).

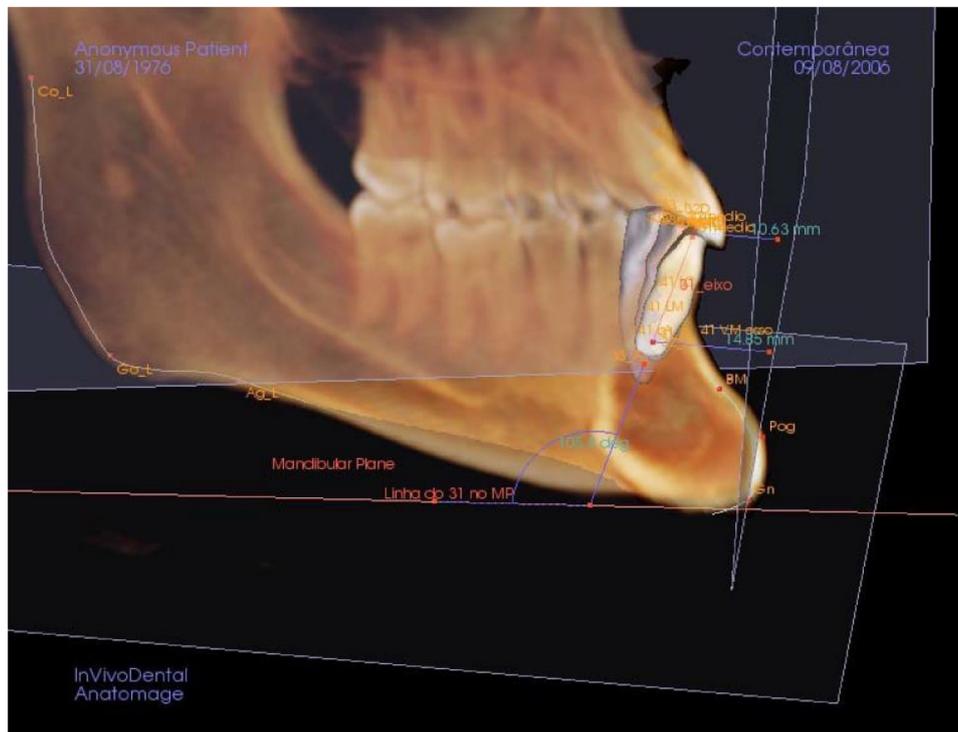


Fig. 1. Markers, lines and planes used to define tooth inclination in relation to mandibular plane and distance to POGM plane.

Table 1
Error and reliability of the method.

Variable of interest	Error of the method	Lin's coefficient	p-value*
Canines inclination (°)	-1.52	0.866	0.057
Canine apical distance to POGM (mm)	0.20	0.356	0.482
Canine incisal distance to POGM (mm)	0.16	0.969	0.396
Incisors inclination (°)	-0.67	0.941	0.109
Incisors apical distance to POGM (mm)	-0.04	0.942	0.662
Incisors incisal distance to POGM (mm)	0.12	0.975	0.282
Inter canine distance (mm)	0.05	0.496	0.899

* Student's *t*-test.

Table 2
Comparisons of the T1 and T2 for the variables of interest.

Variable of interest	Period	Mean	Standard Deviation	p-value*
Canines inclination (°)	T ₁	89.9	5.4	0.835
	T ₂	89.5	5.8	
Canine apical distance to POGM (mm)	T ₁	12.2	1.0	0.049
	T ₂	13.3	1.2	
Canine incisal distance to POGM (mm)	T ₁	14.5	2.9	0.423
	T ₂	15.0	2.8	
Incisors inclination (°)	T ₁	88.5	6.4	0.149
	T ₂	92.6	8.1	
Incisors apical distance to POGM (mm)	T ₁	9.4	1.4	0.002
	T ₂	10.9	1.7	
Incisors incisal distance to POGM (mm)	T ₁	10.5	2.7	0.966
	T ₂	10.4	2.7	
Inter canine distance (mm)	T ₁	25.5	0.9	0.022
	T ₂	26.3	1.2	

* One-way ANOVA repeated measures and paired Student's *t*-test.

appliances.

2. Material and methods

Consent to undergo the CBCT examinations and to use the material for the present study was obtained for all the patients by the ethical committee from University of São Paulo City in the number 310.194. The initial sample for this study was composed of 14 patients, with age ranged from 12 to 15 years, from the orthodontic clinic, University of São Paulo City, São Paulo – SP, Brazil. This initial sample was selected over 100 patients that were in agreement to the following inclusion criteria:

- angle class I malocclusion;
- lower anterior dental crowding greater than 4 mm (clinical evaluation);
- general good health;
- no need of orthognathic surgery;
- good oral hygiene;
- absence of periodontitis.

All the patients were treated orthodontically with a Roth prescription passive self-ligating bracket (Portia®, 3 M Unitek, Brazil) with a 0.022" × 0.028" slot size. Brackets bonding was done using the resin composite Transbond XT® (3 M Unitek, Brazil). The archwire sequence adopted was: (1) thermally activated wire 0.016", (2) Ni-Ti .020", (3) stainless steel 0.020", (4) thermally activated wire 0.019" × 0.025" and (5) stainless steel 0.019" × 0.025".

Three measurements were evaluated before the start of the orthodontic treatment (T₁) and after a period of 30 months treatment (T₂). These measurements were: (1) the lower incisors and canines inclination in relation to the mandibular plane, (2) intercanine linear distance in millimeters and (3) linear distance in millimeters of the incisal and apical part of lower anterior teeth to a plane (POGM) passing through pogonion point and perpendicular to the mandibular plane. Tooth inclination and linear distance to POGM plane were measured separately for each type of lower anterior tooth (i.e., canines and incisors).

To perform the described measurements, CBCT scans (i-CAT™ Classic, Imaging Sciences, USA) were taken in T₁ and T₂ with a 0.4 mm voxel dimension and then submitted to the software InVivoDental 5 (Anatomage Inc., USA) to reconstruct the 3D digital image. Using the reconstructed 3D images, markers were placed in the center of incisal board for central and lateral lower incisors, in the cusp apex for canines and in the apical part of the root canal for all these teeth. Therefore, a line passing through the markers established teeth long axis. Tooth inclination was defined in degrees by the angle formed when the line of tooth long axis intercepted the mandibular plane (Fig. 1).

All the measurements were performed twice in the software InVivoDental 5 and the error of the method was calculated and defined as the difference between the two measures. In addition, the reliability of the method was evaluated by Lin's coefficient of concordance and Student's *t*-test. The obtained data for tooth inclination and linear distance of the incisal and apical part of lower anterior teeth to POGM plane were submitted to a one-way ANOVA, considering the period of evaluation (T₁ and T₂) a factor with repeated measures. For the intercanine distance, the obtained data were submitted to a paired sample Student's *t*-test. All statistical tests presented a significance level of 5% ($\alpha = 0.05$).

3. Results

From the original 14 patients, 7 had to be excluded due to the interruption of the treatment and absence of final tomographic image.

The error of the method varied greatly among the considered variables of interest (Table 1), however there were no significant difference between the two measures for any variable.

The comparisons between T₁ and T₂ of the variables of interest, along with the mean and standard deviation, are presented in Table 2. No significant difference were observed between T₁ and T₂ for canine inclination ($p = 0.835$) and canine incisal distance to POGM ($p = 0.423$), however canine apical distance to POGM was lower ($p = 0.049$) at T₁ than at T₂. Considering the incisors, also no significant difference were observed between T₁ and T₂ for inclination ($p = 0.149$) and incisal distance to POGM ($p = 0.966$), however the apical distance to POGM was lower at T₁ than at T₂. The intercanine distance was significantly lower ($p = 0.022$) at T₁ when compared to T₂.

4. Discussion

This study's results show the possibility of a dental arch expansion by bodily movement of the teeth when using self-ligating brackets. However, the small sample size of this study is an important limitation, which has to be carefully considered to not reject the hypothesis above. Therefore, the data obtained in this study are limited to support a concrete affirmation of a dental arch expansion without buccal tipping of the teeth. Nevertheless, the possibility is demonstrated in this study and should be considered in further researches.

Dental arch expansion by bodily movement of the teeth using self-ligating brackets has been widely evaluated in the literature.^{4,7,11,12} The results of this study shows that an expansion of the lower dental arch was achieved, since the 4 mm tooth crowding for all the subjects was resolved and intercanine distance was significantly greater after 30 months. This arch expansion seems to have

happened by a bodily movement of the teeth, once there were not found statistical differences in teeth inclination after the treatment period. Although the incisors inclination before and after the treatment was not found statistically different, a lingual inclination of approximately 4° was observed. Based in apical and incisal distance of the incisors to the POGM plane measured in this study, it is possible to describe this event not as lingual tipping, but as a distalization of the incisors roots. During the dental arch expansion to dissolve the 4 mm anterior tooth crowding, the teeth were being accommodated to the

arch and, consequently, their roots were placed to the distal once crowns were aligned.¹³ This fact explain why the incisal distance of all the teeth to the POGM plane remained the same since the beginning of the treatment. Expansion of the dental arch without tipping teeth has been reported, when using self-ligating brackets associated to cooper-nickel-titanium archwires.¹⁴ However, this claim is controversial, since several studies reported that the conventional and self-ligating brackets resolve the orthodontic treatment in the same manner, also with some buccal tipping to gain space.^{5,7,12,15}

The use of CBCT in this study was chosen instead of conventional 2D radiographic techniques. Conventional radiographic techniques are not able to provide full information of teeth and bone structure positions in a 3D plane, making them unreliable to define whether the orthodontic treatment performed a dental arch expansion by tipping or bodily movement of the teeth. For an analysis of that precision, computed tomography should be the right choice.¹⁶ Furthermore, the levels of radiation is not a main issue, since CBCT presents a reasonably lower radiation when compared to medical computed tomography.¹⁷ In addition, CBCT could also provide information about dehiscence of buccal bone in anterior region and roots resorption. Root resorption and dehiscence of mandibular buccal bone in anterior region has been associated with dental arch expansion^{18,19} and, access this information in a study similar to this can show if the assumptions defined for self-ligating brackets are true. The assumptions that say: the forces applied by these brackets are more physiological and bone neoformation occurs following bodily movement of the teeth.²⁰

This study stands out as one that showed the possibility of expanding the dental arch without teeth tipping using self-ligating brackets. However, this is a possibility that has to be further investigate, since the sample of this study is small. One should considered the results presented in this paper as an initial screening of self-ligating brackets behavior during dental arch expansion, that is different from several studies discussed.^{5,7,12,15} Whereas, it shows that there are other variables that must be considered nowadays, which are influencing self-ligating brackets mechanisms of action, such as: precision of the manufacturing process and surface finishing that slots are currently receiving,²¹ that could increase the low friction performance by these appliances.²²

5. Conclusion

The use of passive self-ligating brackets in orthodontic treatment to solve 4 mm tooth crowding were able to produce dental arch expansion by bodily tooth movement.

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