Iran J Ortho. 2018 March; 13(1):e8324. doi: 10.5812/ijo.8324.

Published online 2017 February 28. **Original Article**

A Retrospective Study to Evaluate the Intra-Arch Dimensional Changes in Moderate Crowding Cases Treated Non Extraction with a Passive Self-Ligation Appliance

Vishal Bharadwaj,[1] Gurkeerat Singh,[2] Sridhar Kannan,[3] Raj Kumar Singh,[4,*] Ashish Gupta,[5] Gaurav Gupta,[6] and Abhishek Goyal[6]

[1]Post Graduate Student, Department of Orthodontics and Dentofacial Orthopedics, Sudha Rustagi College of Dental Sciences and Research, Faridabad, Haryana, India
[2]Professor and HOD, Department of Orthodontics and Dentofacial Orthopedics, Sudha Rustagi College of Dental Sciences and Research, Faridabad, Haryana, India
[3]Professor and HOD, Department of Orthodontics and Dentofacial Orthopedics, Manav Rachna Dental College, Faridabad, Haryana, India
[4]Assistant Professor, Department of Orthodontics and Dentofacial Orthopedics Sudha Rustagi College of Dental Sciences and Research Faridabad, Haryana, India
[5]Professor, Department of Orthodontics and Dentofacial Orthopedics Sudha Rustagi College of Dental Sciences and Research Faridabad, Haryana, India
[6]Reader, Department of Orthodontics and Dentofacial Orthopedics Sudha Rustagi College of Dental Sciences and Research Faridabad, Haryana, India

[*]*Corresponding author*: Dr Raj Kumar Singh, Assistant Professor, Department of Orthodontics and Dentofacial Orthopedics Sudha Rustagi College of Dental Sciences and Research Faridabad, Haryana, India. E-mail: rajortho2010@gmail.com

Received 2016 August 16; **Accepted** 2016 December 09.

Abstract

Background: Non-extraction treatment protocols are better accepted by patients as well as clinicians. Among the techniques and mechanics with the potential to facilitate non-extraction treatment includes headgears, fixed sagittal correctors, transverse expansion screws and self-ligating systems.
Objectives: To evaluate the intra-arch dimensional changes in moderate crowding cases, treated non-extraction with a passive self-ligating (Damon 3MX) appliance using digitized models and lateral cephalograms.
Methods: A total of 20 patients (age group of 15 - 18 years) who had undergone non extraction orthodontic treatment with the Damon 3MX appliance were selected. All the pre-treatment and post-treatment dental stone models of maxillary and mandibular arches were scanned using 3D digital scanner (Maestro 3D, Greatlakes, USA) and were converted into digital models. Various parameters undertaken were measured digitally on the computer in millimetres. Cephalometric tracings of pre and post treatment cephalograms were performed using digital cephalometrics (Nemo Ceph, version 6.0, Spain). Statistical analysis was performed using t-test.
Results: More transverse expansion was observed in the region of 1st and 2nd premolars as compared to the inter-canine and inter molar region in maxillary and mandibular arch. However a decrease in arch depth was observed in maxillary arch but arch depth of mandibular arch was found to be increased. There was significant increase in anterior proclination in both maxillary and mandibular arches.
Conclusions: Passive self-ligating system causes a significant increase in transverse width in both maxillary and mandibular dental arches.

Keywords: Passive Self Ligation Brackets, Arch Width, Digitisation, Non-Extraction

1. Background

Irregularly placed front teeth is one of the most frequently encountered chief complaint in day to day orthodontic practice. The etiology for which may be tooth size-arch length deficiency (1-4). This condition can be treated, either by reducing tooth size and/or by increasing arch width and/or arch depth (5-7). In other words, Orthodontists can gain space by expanding the arch anteroposteriorly or transversely along with other conventional means, depending on the treatment plan.

Non-extraction treatment protocols are better accepted by patients as well as clinicians. Among the techniques and mechanics with the potential to facilitate nonextraction treatment includes headgears, fixed sagittal correctors, transverse expansion screws and self-ligating systems. Although each of these approaches necessitates an increase in arch length to facilitate alignment without extraction, it has been purported that passive self-ligating brackets can induce specific, uniquely stable arch dimensional changes when used with thermalloy archwires (8).

Self-ligating brackets (SLB) are not new in orthodon-

tics. They were introduced to the specialty nearly a century ago, with the Russell Lock (9) edgewise attachment being described in 1935. The Damon SL bracket (10) were introduced in 1996 and have been modified over the years. In the past two decades, there has been an increase in the manufacturing and release of self-ligating brackets with active or passive ligation modes. The basic advantage of these brackets involves the elimination of certain utilities or materials such as elastomeric modules along with the process or tools associated with their application. This is supposed to bring about several favorable features to the treatment including, the elimination of potential cross-contamination with elastic ligatures, consistently full engagement without the undesirable force relaxation of elastomeric modules, reduced risk for enamel decalcification from the elimination of the retentive site for plaque accumulation, reduced friction in sliding mechanics, and assumed low-magnitude forces resulting in fewer side effects (11).

2. Objectives

The Objective was to retrospectively evaluate the intra-arch dimensional changes in moderate crowding cases, treated non-extraction with a passive self-ligating (Damon 3MX) appliance by assessing the pre treatment and post treatment digitized models and lateral cephalograms.

The study was formulated as a double blind study.

3. Methods

A total of 20 patients between the age group of 15 - 18 years who had undergone non extraction orthodontic treatment with the Damon 3MX (Ormco, San Diego, Calif) appliance were selected. Patients with a full complement of teeth up to erupted second permanent molars with moderate crowding in the maxillary and/or mandibular arch, with skeletal Class I jaw base relation treated with non-extraction treatment plan were included in the study. Orthodontically retreated cases, congenital absence of teeth, aberration in tooth size/shape were excluded.

Only those pretreatment and post treatment models and lateral cephalograms were selected for scanning which met all the inclusion and exclusion criteria as well who were treated according to the passive self ligation philosophy as well with the standard wire sequencing. The following arch wire sequencing were used:

0.013" / 0.014" Copper Nickel-Titanium (Cu Ni-Ti) was in place for 2 - 4 months

Followed by 0.016" x 0.016" Cu Ni-Ti for a minimum period of 2 months or a 0.014" x 0.025" Cu Ni-Ti for a minimum period of 2 months

0.016" x 0.025" Cu Ni-Ti for minimum of 2 months

0.017" x 0.025" SS, 0.019" x 0.025" Titanium Molybdenum alloy (TMA) finishing wire for minimum period of 2 months

All the pre-treatment and post-treatment dental stone models of maxillary and mandibular arches were scanned using 3D digital scanner (Maestro 3D, Great lakes, USA) and converted into digital models which could be examined in all the 3 planes of space.

Parameters undertaken for study were measured digitally on the computer in millimeters which included Inter-canine width (C) of maxilla and mandible, Inter-1st premolar width (PM1) of maxilla and mandible, Inter-2nd premolar width (PM2) of maxilla and mandible, Inter-molar width (M1) of maxilla and mandible, Arch depth of maxilla and mandible, Maxillary incisor inclination and Mandibular incisor inclination (Figures 1 - 4).

Inter-canine width: Measurements were made from the cusp tips of the right and left canine.

Inter-first premolar width: Measurements were made between the buccal cusp tips of right and left first premolars.

Inter second premolar width: Measurements were made between the buccal cusp tips of right and left second premolars.

Inter first molar width: Measurements were made between the mesio-buccal cusp tips of right and left first molars.

3.1. Arch Depth

First line is drawn connecting the central fossa of first molars on the right and left sides. A second line was drawn perpendicular to the first, bisecting the contact point between the central incisors.

Cephalometric tracings were performed using digital cephalometrics (Nemo Ceph, version 6.0, Spain). Pretreatment and post-treatment readings of each patient were evaluated from the software and pre treatment and post treatment superimposition was also carried out.

3.2. Upper Incisor Inclination

U1 to SN plane angle: It is the inferior inside angle formed between the long axis of the upper incisor and Sella-nasion plane.

U1 to Palatal plane angle: It is the inferior inside angle formed between the long axis of the upper incisors and palatal plane (formed by line joining the anterior nasal spine and posterior nasal spine)

U1 to N-A (Angular):- It is the angle formed by the intersection of the long axis of the upper central incisors and the line joining the nasion to point A.

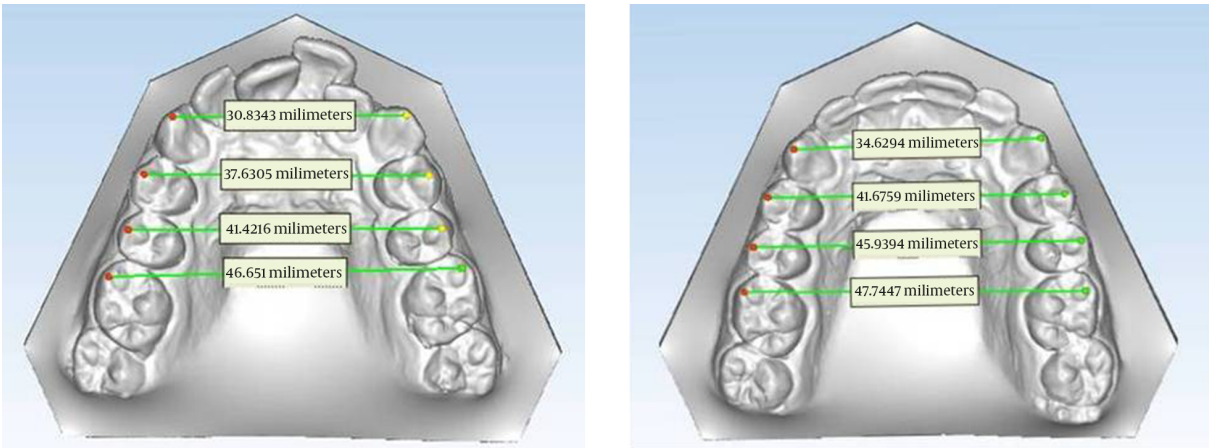

Figure 1. Scanned Digital Image of Pretreatment and Post Treatment Archwidth of Maxillary Arch

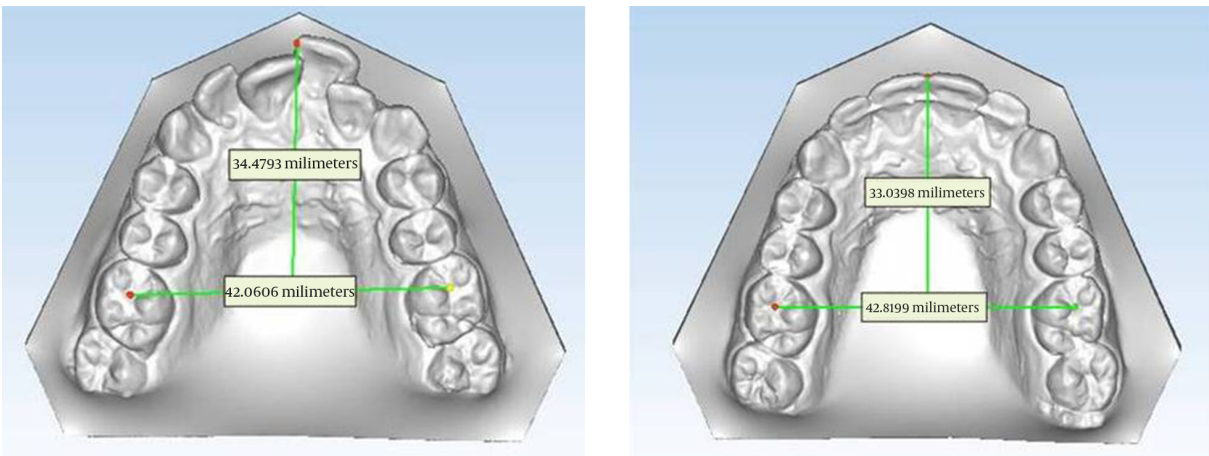

Figure 2. Scanned Digital Image of Pretreatment and Post Treatment Arch Depth of Maxillary Arch

3.3. Lower Incisor Inclination

L1 to Mandibular plane angle: It is the angle formed by the intersection of the long axis of the lower incisor with the mandibular plane. It indicates the inclination of the lower incisors.

L1 to Occlusal plane angle: It is the inferior inside angle formed by the intersection of the long axis of the lower incisor with the occlusal plane. This angle is read as a positive or negative deviation from the right angle.

L1 to N-B (Angular): It is the angle formed by the intersection of the long axis of the lower central incisors and the line joining the nasion to point B.

4. Results

All the pretreatment and post treatment measurement of scanned digital models and the measurement obtained from the scanned cephalograms were subjected to statistical analysis using software SPSS (statistical package for social sciences) version 21.0 and Epi-info version 3.0 and Paired t-test was applied to see the statistical significance

- It was used for comparison of 2 mean values obtained from a same group or a pair of values obtained from the same sample.

The P-value was taken significant when less than 0.05 ($P < 0.05$) and Confidence interval of 95% was taken.

The following results were obtained after the statistical analysis:

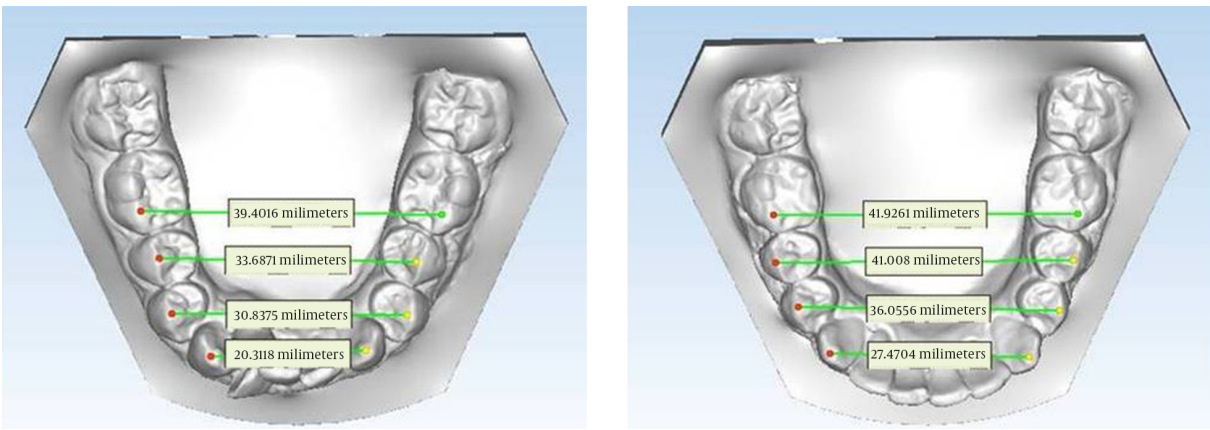

Figure 3. Scanned Digital Image of Pretreatment and Post Treatment Arch Width of Mandibular Arch

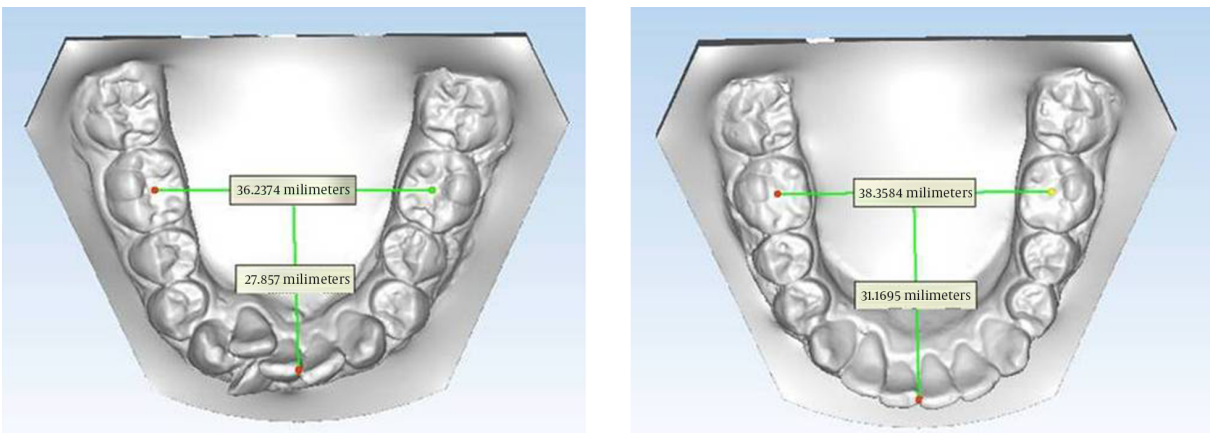

Figure 4. Scanned Digital Image of Pretreatment and Post Treatment Arch Depth of Mandibular Arch

5. Discussion

Self ligation appliances regained popularity since the early nineties because of the certain advantages which were claimed such as: increased patient comfort, better oral hygiene, increased patient cooperation, less chair time, shorter treatment time, greater patient acceptance, expansion, and less dental extractions (10, 12, 13). Self ligation appliances achieved significant amount of expansion with no apical root resorption and with increase in buccal bone thickness. Self ligation appliance also offer precise control of tooth during translation, reduce overall anchorage demands, rapid alignment and more certain space closure.

Alleviating dental crowding without extractions requires an increase in arch perimeter or interproximal reductions to attain good teeth alignment (14). In the absence of distalization, the changes in arch dimensions involve transverse expansion and increased proclination of teeth.

Passive self-ligation treatment philosophy (10) is based on providing optimum force levels for orthodontic tooth movement which should be just high enough to stimulate cellular activity without completely occluding the blood vessels in the PDL. Light continuous forces will produce continuous, frontal resorption and will not overpower the periodontal and orofacial muscltature, and will prevent proclination of anteriors and causes more expansion in the transverse direction. Photoelastic model showed lower stress in periodontal tissue with self-ligating appliance as compared to conventional bracket system (15).

Intra arch dimensional changes in both maxillary and mandibular arches in moderate crowding cases treated non-extraction with a passive self ligation appliance (Da-

mon 3MX) were analyzed using digitized models and digital cephalograms.

This study showed an increase in maxillary intercanine width, inter 1st premolar width, inter 2nd premolar width and inter molar arch width (Table 1). More transverse expansion was observed in the region of 1st and 2nd premolars as compared to the inter-canine and inter molar region. More expansion in the premolars region can be because of lip bumper effect which minimizes the proclination of anterior teeth and allow more expansion in posterior region. Previous study also showed majority of transverse changes in the premolar areas in both upper and lower arches, with less expansion in the canine and molar region (16, 17).

While assessing maxillary arch depth, the study showed (Table 1) a decrease in arch depth which can be because of more of transverse expansion, which created space and helped in unraveling of crowding in upper anteriors and less proclination. Overlapping because of crowding in anteriors was reduced with minimal proclination. Because of lateral expansion and derotation in posterior segment, some amount of mesial movement of molars could also have occurred, to improve molar relation.

The inclination of upper incisors was evaluated using U1 to N-A (Angular), U1 to palatal plane angle and U1 to SN plane angle (Table 2). Results showed an increase in proclination which was statistically significant. Similar studies done in past also showed significant amount of arch expansion in the maxillary arch (8).

In the mandibular arch also an increase in mandibular intercanine width, inter 1st premolar width, inter 2nd premolar width and inter molar arch width was observed (Table 1) similar to maxillary arch. Study also showed an increase in the mandibular arch depth (Table 1). Change in inclination of lower incisors was evaluated using L1 to N-B (Angular) values, L1 to mandibular plane angle and L1 to occlusal plane angle (Table 2). Results showed increase in proclination which was statistically significant. Insufficient interproximal reduction can be one of the cause of increased proclination of lower anteriors and increase in arch depth in mandibular arch.

Results of the study also showed more increase in the mandibular intercanine and interpremolar widths as compared to the inter molar width with increase in arch depth and increase in proclination. Previous studies showed transverse expansion and incisor proclination, and more expansion in the inter molar region (11, 18).

5.1. Conclusion

Study showed increase in inter-canine width, inter 1st premolar width, inter 2nd premolar width and inter molar width in both maxillary and mandibular arches, with more expansion in premolar area. Arch depth was found to be decreased in upper arch it was found to be increased in lower arch however the passive self-ligation appliance can be used as a valuable tool because it minimizes the proclination which could have been produced during unraveling of crowding in both the arches without the space which have been gained with passive self ligation appliance by posterior expansion.

5.2. Limitations of Study

Present study had the limitations of small sample size of twenty patients and retrospective in nature. As retrospective studies are always subject to various types of bias because of the lack of randomization. Hence, the results obtained from the current study should be further strengthened using a larger sample size and preferably using a prospective study model.

References

1. Brunelle JA, Bhat M, Lipton JA. Prevalence and distribution of selected occlusal characteristics in the US population, 1988-1991. *J Dent Res*. 1996;**75 Spec No**:706–13. doi: 10.1177/002203459607502S10. [PubMed: 8594094].
2. Infante PF. An epidemiologic study of deciduous molar relations in preschool children. *J Dent Res*. 1975;**54**(4):723–7. doi: 10.1177/00220345750540040501. [PubMed: 1057556].
3. Kerosuo H. Occlusion in the primary and early mixed dentitions in a group of Tanzanian and Finnish children. *ASDC J Dent Child*. 1990;**57**(4):293–8. [PubMed: 2373787].
4. Gabris K, Marton S, Madlena M. Prevalence of malocclusions in Hungarian adolescents. *Eur J Orthod*. 2006;**28**(5):467–70. doi: 10.1093/ejo/cjl027. [PubMed: 16923783].
5. Damon D. Treatment of the face with biocompatible orthodontics. In: Graber TM, Vanarsdall Jr RL, Vig KWL, editors. *Orthodontics: current principles and techniques*. 4th ed. Philadelphia: Elsevier; 2005. p. 753–831.
6. 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**(3):237–42. [PubMed: 18661061].
7. McNally MR, Spary DJ, Rock WP. A randomized controlled trial comparing the quadhelix and the expansion arch for the correction of crossbite. *J Orthod*. 2005;**32**(1):29–35. doi: 10.1179/146531205225020769. [PubMed: 15784941].
8. Fleming PS, Lee RT, Marinho V, Johal A. Comparison of maxillary arch dimensional changes with passive and active self-ligation and conventional brackets in the permanent dentition: a multicenter, randomized controlled trial. *Am J Orthod Dentofacial Orthop*. 2013;**144**(2):185–93. doi: 10.1016/j.ajodo.2013.03.012. [PubMed: 23910199].
9. Stolzenberg J. The Russell attachment and its improved advantages. *Int J Orthod Dent Dent Child*. 1935;**21**(9):837–40. doi: 10.1016/s0097-0522(35)90368-9.
10. Damon DH. The Damon low-friction bracket: a biologically compatible straight-wire system. *J Clin Orthod*. 1998;**32**(11):670–80. [PubMed: 10388398].

Table 1. Descriptive Statistics of Pre-Treatment and Post Treatment Arch Width and Arch Depth Values Are Shown (mm)[a]

Variable	Mean	Std. Deviation	Std. Error Mean	Mean Difference	T-Test Value	P Value
Maxillary Inter-canine width						
Pre treatment	32.97	1.27	0.29	-1.27	-4.194	0.001[b]
Post treatment	34.24	1.08	0.25			
Mandibular Intercanine width						
Pre treatment	24.10	2.25	0.52	-2.57	-4.404	< 0.001[b]
Post treatment	26.67	1.30	0.30			
Maxillary Inter 1st PM width						
Pre treatment	39.29	1.73	0.40	-1.88	-3.980	0.001[b]
Post treatment	41.17	1.76	0.40			
Mandibular Inter 1st PM width						
Pre treatment	31.87	1.12	0.26	-2.48	-6.705	< 0.001[b]
Post treatment	34.35	1.26	0.29			
Maxillary Inter 2nd PM width						
Pre treatment	43.88	2.03	0.47	-2.15	-3.645	0.002[c]
Post treatment	46.03	1.53	0.35			
Mandibular Inter 2nd PM width						
Pre treatment	37.11	2.48	0.57	-2.77	-3.687	0.002[c]
Post treatment	39.88	1.57	0.36			
Maxillary Inter molar width						
Pre treatment	48.29	2.90	0.67	-1.39	-2.599	0.018[d]
Post treatment	49.68	2.02	0.46			
Mandibular Inter molar width						
Pre treatment	42.86	1.60	0.37	-0.29	-0.804	0.432
Post treatment	43.15	1.54	0.35			
Maxillary arch depth						
Pre treatment	33.23	2.67	0.61	1.25	4.029	0.001[b]
Post treatment	31.97	1.47	0.34			
Mandibular arch depth						
Pre treatment	30.43	3.06	0.70	-0.59	-1.268	0.221
Post treatment	31.03	1.82	0.42			

[a]P-value $\geq$ 0.05 Non-significant difference.
[b]P-value < 0.001 - Very Highly Significant difference.
[c]P-value < 0.01 - Highly Significant difference.
[d]P-value < 0.05 Significant difference.

11. Pandis N, Polychronopoulou A, Eliades T. Self-ligating vs conventional brackets in the treatment of mandibular crowding: a prospective clinical trial of treatment duration and dental effects. *Am J Orthod Dentofacial Orthop*. 2007;**132**(2):208–15. doi: 10.1016/j.ajodo.2006.01.030. [PubMed: 17693371].
12. Fleming PS, DiBiase AT, Lee RT. Self-ligating appliances: evolution or revolution?. *J Clin Orthod*. 2008;**42**(11):641–51. [PubMed: 19075378].
13. Rinchuse DJ, Miles PG. Self-ligating brackets: present and future. *Am J Orthod Dentofacial Orthop*. 2007;**132**(2):216–22. doi: 10.1016/j.ajodo.2006.06.018. [PubMed: 17693372].
14. Weinberg M, Sadowsky C. Resolution of mandibular arch crowding in growing patients with Class I malocclusions treated nonextraction. *Am J Orthod Dentofacial Orthop*. 1996;**110**(4):359–64. doi: 10.1016/S0889-5406(96)70035-5. [PubMed: 8876484].
15. Sobral GC, Vedovello Filho M, Degan VV, Santamaria MJ. Photoelastic analysis of stress generated by wires when conventional and self-ligating brackets are used: a pilot study. *Dental Press J Orthod*. 2014;**19**(5):74–8. doi: 10.1590/2176-9451.19.5.074-078.oar. [PubMed: 25715719].

Table 2. Descriptive Statistics of Pre-Treatment and Post Treatment Upper Incisor and Lower Incisor Inclination Values Are Shown (Degrees)[a]

Variables	Mean	Std. Deviation	Std. Error Mean	Mean Difference	T-Test Value	P Value
U1 to N-A Angular						
Pre treatment	24.56	6.62	1.52	-2.79	-5.524	< 0.001***
Post treatment	27.35	5.58	1.28			
U1 to Palatal plane angle						
Pre treatment	112.16	6.99	1.60	-3.74	-6.853	< 0.001***
Post treatment	115.89	5.12	1.17			
U1 to SN plane angle						
Pre treatment	113.74	6.82	1.56	-3.00	-5.266	< 0.001***
Post treatment	116.74	5.03	1.15			
L1 to N-B (Angular)						
Pre treatment	24.27	2.71	0.64	-4.58	-9.320	< 0.001***
Post treatment	28.85	1.63	0.38			
L1 to Mandibular plane angle						
Pre treatment	96.13	3.43	0.81	-4.28	-6.898	< 0.001***
Post treatment	100.42	1.69	0.40			
L1 to Occlusal plane angle						
Pre treatment	8.05	3.41	0.80	-4.67	-6.477	< 0.001***
Post treatment	12.72	1.42	0.34			

[a] P-value $\geq$ 0.05 Non-significant difference, P-value < 0.05 Significant* difference, P-value < 0.01 - Highly Significant** difference, P-value < 0.001 - Very Highly Significant*** difference.

16. Maltagliati LA, Myiahira YI, Fattori L, Filho LC, Cardoso M. Transversal changes in dental arches from non-extraction treatment with self ligating brackets. *Dental Press J Orthod*. 2013;**18**(3):39–45. doi: 10.1590/S2176-94512013000300008. [PubMed: 24094010].
17. Lineberger MB, Franchi L, Cevidanes LH, Huanca Ghislanzoni LT, McNamara JJ. Three-dimensional digital cast analysis of the effects produced by a passive self-ligating system. *Eur J Orthod*. 2016;**38**(6):609–14. doi: 10.1093/ejo/cjv089. [PubMed: 26843516].
18. 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**(3):340–7. doi: 10.1016/j.ajodo.2007.08.030. [PubMed: 19732667].