MAXILLARY ARCH WIDTH CHANGES DURING ORTHODONTIC TREATMENT WITH FIXED SELF-LIGATING AND TRADITIONAL STRAIGHT-WIRE APPLIANCES

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Aim: *To evaluate the transverse dimensions of the maxillary arch induced by fixed self-ligating and traditional straight-wire appliances during orthodontic therapy.* ***Patients and Methods:*** *Forty consecutive patients (age range 14 to 30 years) with normal or low mandibular plane angle, normal overbite, and mild crowding were included. The traditional appliance was composed of Victory Series MBT brackets (3M Unitek), and the self-ligating appliance of Damon-3MX brackets (Ormco). The leveling and aligning phase with round archwires lasted 6 months and was followed by another 6 months of rectangular archwires. The archwire sequence with the MBT appliance was 0.016-inch and 0.019 × 0.025-inch Ni-Ti form II (3M Unitek), while in the Damon-3MX, it was 0.014-inch and 0.016-inch followed by 0.016 × 0.025-inch copper nickel-titanium (Ormco). Intercanine, first and second interpremolar, and intermolar widths in the maxilla were recorded before treatment (T0) and 12 months later (T1).* ***Results:*** *In both groups, a significant increase from T0 to T1 was recorded for all transverse measurements, but no significant difference was observed between groups.* ***Conclusion:*** *Within 12 months of treatment, both appliances increased maxillary dentoalveolar widths.* World J Orthod 2009;10:290–294.

Key words: *arch width, dentoalveolar width, maxillary expansion, MBT brackets, self-ligating brackets*

Nonextraction treatment is often accompanied by dentoalveolar expansion.[1–5] Dental arch width plays an important role in smile esthetics[1] because a small dental arch is typically associated with an increase of blind buccal corridors.[6] In addition, dental arch width seems to be an important aspect of posttreatment stability.[7]

During fixed orthodontic treatment, intercanine width increases between 0.55 mm[1] and 2.13 mm,[2] the interpremolar width (at the second premolars) between 2.10 mm[1] and 4.94 mm,[2] and the intermolar width between 1.53 mm[1] and 2.96 mm[2] (as reported by Franchi et al[8] and Bennet and McLaughlin[9]).

New low-friction self-ligating brackets are reported to induce (a significant) maxillary arch expansion during the initial therapy phase when superelastic nickel-titanium archwires are used.[8,10–12] Generally, three hypotheses exist in connection with bracket systems and arch expansion: *(1)* light wires produce an efficient expansion of the dental arch, *(2)* with less buccal tipping, and *(3)* less incisor protrusion because the light forces cannot overrule the labial/buccal musculature.

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Fig 1 Maxillary occlusal view of a patient in group 1 (MBT brackets) with a 0.019 × 0.025-inch Ni-Ti form II archwire after 12 months of treatment.

Fig 2 Maxillary occlusal view of a patient in group 1 (Damon-3MX brackets) with a 0.016 × 0.025-inch copper Ni-Ti archwire after 12 months of treatment.

In the Franchi et al[8] study, low-friction ligatures were evaluated so it seemed reasonable to conduct a similar investigation with self-ligating brackets that also produce low friction. According to Harradine,[13] compared to conventional ones, self-ligating brackets have a lower friction coefficient, which leads to a more rapid tooth alignment, and better anchorage management.[10,14–17]

The aim of this study was to investigate the changes of the maxillary transverse dimensions produced by self-ligating and traditional preadjusted brackets with conventional elastic ligatures after using rectangular archwires.

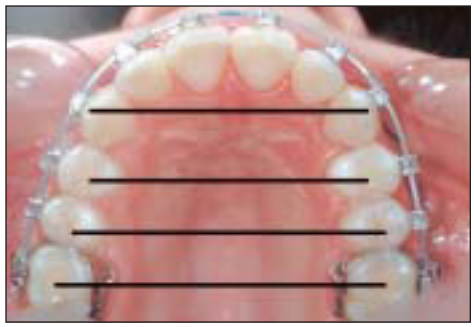

Fig 3 The reference points used to measure intercanine, interpremolar (at the first and second premolar), and intermolar widths. Actual measurements were performed on study casts (compare to Fig 4).

PATIENTS AND METHODS

The sample consisted of 40 nonextraction patients (23 females, 17 males) with a mean age of 15 years 8 months (age range 14 to 30 years), consecutively treated at the Department of Oral Science, University G. D'Annunzio, Chieti/Pescara, Italy.

The inclusion criteria were permanent dentition, normal or low mandibular plane angle, normal or increased overbite, straight or concave profile, and at least 2-mm crowding in the maxillary arch. All subjects gave informed consent to participate in this study.

According to the treatment protocol, the 20 patients of group 1 wore preadjusted brackets (MBT Victory Series, 3M Unitek) with conventional ligatures (Alastik, 3M Unitek) coupled with 0.016-inch superelastic nickel-titanium archwires (Nitinol archwire, 3M Unitek), followed by 0.019 × 0.025-inch Nitinol (Orthoform II, archform selection, 3M Unitek, Fig 1).

The 20 patients in group 2 received self-ligating brackets (Damon-3MX, Ormco) and copper nickel-titanium 0.014-inch archwires (copper Ni-Ti, Ormco) followed by 0.016-inch and 0.016 × 0.025-inch copper Ni-Ti archwires (Fig 2).

Leveling and aligning with the respective round wires lasted an average of 6 months. Thereafter, the round wires were replaced by rectangular ones. Dental casts were produced at T0 (immediately before treatment) and T1 (after 1 year). The following measurements were made on the maxillary casts at both time points (Fig 3):

Fig 4 Width measurement on a dental cast using a fine-pointed digital calliper; approximation of all readings was made to the second decimal place.

Table 1 Descriptive statistics and comparison of maxillary measurements at T0 and T1

	MBT (n = 20)							Damon-3MX (n = 20)						
	T0		T1		ΔT (T1–T0)			T0		T1		ΔT (T1–T0)		
Measurements (mm)	Mean	SD	Mean	SD	Mean ± SD	ΔT (T1–T0)	Paired *t* test, significance	Mean	SD	Mean	SD	Mean ± SD	ΔT (T1–T0)	Paired *t* test, significance
Intercanine	32.3	2.0	34.3	1.5	2.6 ± 2.4	6.2%	$t = 2.6$, $P < .05$	31.1	2.3	34.1	1.4	3.3 ± 2.6	10.0%	$t = 2.6$, $P < .05$
Interpremolar (first)	31.2	1.8	35.6	1.6	4.3 ± 2.1	14.1%	$t = 5.8$, $P < .05$	30.8	1.9	35.2	0.5	4.4 ± 2.5	14.3%	$t = 5.9$, $P < .05$
Interpremolar (second)	36.4	1.4	40.5	2.1	4.1 ± 2.1	11.3%	$t = 5.0$, $P < .05$	36.2	1.9	40.4	0.5	4.2 ± 1.8	11.6%	$t = 6.8$, $P < .05$
Intermolar	43.9	2.3	46.0	1.8	2.4 ± 2.0	4.8%	t = 2.2, P < .05	42.9	1.5	44.8	0.9	2.3 ± 1.5	4.4%	$t = 3.2$, $P < .05$

There was no significance in the unpaired *t* test MBT vs Damon at T0 or unpaired *t* test MBT vs Damon at T1 for any measurement.

- *Intercanine width:* distance between the maxillary canine tips or between the centers of the surfaces in case of worn cusps
- *First interpremolar width:* distance between the central fossae on the occlusal surfaces of the maxillary first premolars
- *Second interpremolar width:* distance between the central fossae on the occlusal surfaces of the maxillary second premolars
- *Intermolar width:* distance between the mesial ends of the central fissures on the occlusal surfaces of the maxillary first molars

The individual reference points on the dental casts were digitized in accordance with other researchers,[18–20] using a fine-pointed digital calliper (Tresna, Guilin Guanglu Measuring Instrument); the measurements were approximated to the second decimal place (Fig 4).

To avoid interoperator error, all measurements were carried out by a single investigator. To assess error due to landmark identification, double measurements were performed on 10 randomly selected dental casts. The data sets were compared using Dahlberg's formula[21]:

$$\delta = \sqrt{(\Sigma d^2/2N)}$$

in which δ is the difference between the two measurements and N is the number of double registrations.

Statistical analysis

All statistical computations were performed with SPSS 12 software (SPSS). Descriptive statistics were calculated for the measurements at T0 and T1 and for the T0-T1 comparisons (Table 1). The Kolmogorov-Smirnov test showed a normal data distribution at T0 and T1. Consequently, the means and standard deviations were computed.

The paired student *t* test was used to identify significant differences ($P < .05$) between T0 and T1, and the unpaired student *t* test was used to compare the data between the groups at both T0 and T1.

RESULTS

The variance of the intraoperator method error for the double measurements was less than 5% of the observed variance in the whole sample. Thus, all measurements were accepted.

From T0 to T1, the intercanine width showed a significant increase of 2.6 ± 2.4 mm (6.2%) and 3.3 ± 2.6 mm (10.0%) in the MBT and Damon-3MX groups, respectively.

The first interpremolar width increased significantly by 4.3 ± 2.1 mm (14.1%) and 4.4 ± 2.5 mm (14.3%) in the MBT and Damon-3MX groups, respectively.

Similarly, the second interpremolar width increased significantly by 4.1 ± 2.1 mm (11.3%) and 4.2 ± 1.8 mm (11.6%) in the MBT and Damon-3MX groups, respectively.

The changes in intermolar width were 2.4 ± 2.0 mm (4.8%) and 2.3 ± 1.5 mm (4.4%) in the MBT and Damon-3MX groups, respectively.

No significant difference between the two groups was observed at either time point.

DISCUSSION

In this study, the transverse dimensional changes of the maxillary arch produced by conventional and self-ligating brackets during orthodontic therapy were evaluated.

Damon observed a posterior expansion of the dental arch with self-ligating brackets and superelastic nickel-titanium 0.014-inch archwires.[10] The present findings showed significant increases in maxillary arch widths with no difference between the groups with conventional and self-ligating brackets when coupled with rectangular archwires. Obviously, expansion with round archwires can be achieved only when low-friction brackets are used as demonstrated by Franchi et al.[8] These authors further noted that after using round archwires, the arch widths were in the same range as after the entire orthodontic treatment,[1–5] confirming that low-friction systems obtain expansion during just the aligning phase. Conventional systems do the same only after rectangular archwires are used. Still, caution is indicated because Franchi et al[8] worked with low-friction elastic ligatures (slide ligatures).

The aforementioned three hypotheses could not be confirmed by this study because it did not consider buccal tipping or incisor protrusion. Instead, its emphasis was on whether rectangular archwires (after light round archwires) play a role in the final width of the maxillary dental arch. But even after the insertion of rectangular archwires, tipping and protrusion between the two systems could not be compared due to their different inclination prescriptions.

The two samples of the present investigation consisted of only patients with mild crowding. However, the amount of crowding could play an important role in the determination of the final arch width.

In this study, the greatest expansions were recorded for the premolars (14.1% and 14.3% for the first premolars; 11.3% and 11.6% for the second premolars). They were followed by the canines (6.2% and 10.0%), whereas the smallest increase was found for the first molars (4.8% and 4.4%). This is in accordance with Franchi et al,[8] who explained this as a possible result of the archwire form (Tru-Arch form), which is especially wide in the canine and first premolar region. It can be assumed that the form II archwires used in this study caused the same outcome.

CONCLUSIONS

The findings of this study indicate that a low-friction system consisting of self-ligating brackets produces a significant increase of maxillary transverse dentoalveolar width. When rectangular archwires are used, conventional brackets produce an arch width increase comparable to that of self-ligating brackets.

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