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Original Article

CHANGES IN THE ARCH SHAPE IN PATIENTS TREATED WITH ELASTODONTIC DEVICES

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ABSTRACT

Reformed devices made of elastomeric materials are widely integrated into contemporary orthodontic practices, showcasing documented success in the literature. Principally employed to address Class II Division 1 mandibular deficiencies, these devices play a key role in correcting the sagittal relationship between arches. They contribute to enhancing patients' profiles by fostering mandibular growth and resolving issues like oral breathing, finger or pacifier-sucking, and atypical swallowing. Comparative studies with established functional appliances such as Twin Block, Andresen's Activator, and Frenkel emphasize the effectiveness and viability of these preformed devices in the interceptive therapy of Class II malocclusions. Their advantages extend to both patient comfort and economic feasibility, rendering them a compelling alternative. Examining previous research, findings reveal comparable outcomes in the treatment of Class II Division 1 malocclusion with various functional appliances, indicating no statistically significant differences in the correction of Overjet, Overbite, and molar relationship. This study shifts the focus to the Equilibrator (Eptamed), a novel preformed device, diverging from the conventional emphasis on Class II malocclusion resolution. Instead, we investigate changes in arch shape and size during early and late mixed dentition in Equilibrator-treated patients. Through rigorous comparative analysis with an age- and gender-matched control sample devoid of orthodontic intervention, this study aims to elucidate the distinct impact of the Equilibrator on arch morphology. By exploring the broader implications of preformed orthodontic devices, particularly the Equilibrator, beyond conventional Class II malocclusion management, this research contributes a nuanced perspective to the existing literature.

KEYWORDS: *elastodontic devices, Class II mandibular deficiency, Equilibrator (Eptamed), Prefabricated Functional Appliances-Myobrace, (PFA)®*

INTRODUCTION

Preformed devices made of elastomeric materials are now widely used in orthodontic clinical practice, and their success is largely documented by literature (1). These devices are mainly used in the treatment of Class II Division 1 mandibular deficiency cases to correct the sagittal relationship between the arches and improve the patient's profile by

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promoting mandibular growth and helping to solve problems such as oral breathing, finger or pacifier-sucking-related issues, and atypical swallowing (2).

Numerous comparisons with functional appliances such as Twin Block (3), Andresen's Activator (4), or Frenkel (5) have been conducted by various authors, demonstrating how performed devices can be considered a valid alternative in the interceptive therapy of Class II malocclusions, both in terms of patient comfort and in economic terms, given the affordable cost of these appliances.

In 2015, Čirgić et al. examined two groups of patients with Class II Division 1 malocclusion respectively treated with modified Andresen's Activator and Prefabricated Functional Appliances-Myobrace (PFA)® (4). No statistically significant differences were found between the two devices in the correction of overjet, overbite and molar relationship. A previous study conducted by Usumez et al. (2) evaluated the effects of early treatment with PreOrthodontic Trainers on a group of patients with Class II Division 1 malocclusion by comparing the results with a control group. The trainer-treated group experienced an improvement in Overjet, proclination of the lower incisors, and an increase in total facial height compared to the untreated group (6).

In this study, a new preformed device, known as the Equilibrator (Eptamed)®, was examined. Literature thus far has mainly focused on the efficacy of preformed devices in treating and resolving Class II malocclusions, evaluating the relationship between the arches by considering Overjet, Overbite, and molar relationship (6). On the other hand, the purpose of this study is to analyze changes in the shape and size of arches in early and late mixed dentition in patients treated with the Equilibrator by comparing obtained results with those of a control sample, homogeneous in age and gender, of subjects who did not undergo any orthodontic treatment.

MATERIALS AND METHODS

The following is a retrospective study collecting data from a group of patients treated with a preformed device (Equilibrator Eptamed)® at the Tor Vergata Department of Orthodontics in Rome from 2017 to 2019 (Fig. 1).

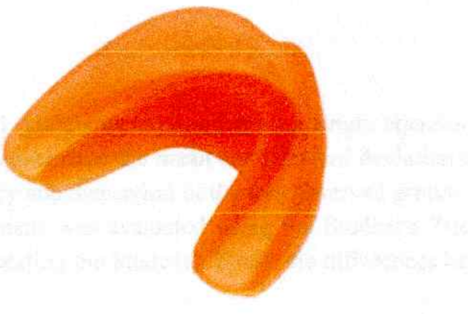

Fig. 1. *Preformed device, Equilibrator Eptamed®.*

Patients with early or late mixed dentition, aged between 6 and 10, were selected. The average duration of treatment was 18±2 months. The results were then compared with data collected from a control group of subjects not undergoing orthodontic treatment.

The study group's inclusion criteria were as follows: Caucasian origins, Class I or Class II molar relationship, early or late mixed dentition stage, high degree of compliance, and no prior orthodontic treatment.

The inclusion criteria for the control group were Caucasian origins, early or late mixed dentition stage, and no prior orthodontic treatment. Based on the mentioned criteria, a group of 21 patients, 6 males and 15 females, with late or early mixed dentition and a mean age of 8.6±1.1 years, was selected.

The study group was compared with a control group of 23 subjects, 9 males and 14 females, homogeneous in age and gender. The study group treated patients using the Eptamed-preformed Equilibrator Conformature model device. Patients were required to wear the device at least 14 hours a day, and it was distributed as follows: all night and a few hours during the day. After the first month, patients were shown exercises to be performed for 3-5 minutes daily. They were asked to place the tongue in a retro incisive position (at the level of the palatine spot) and perform a rhythmic tongue thrust on the spot.

Time T0 (start of treatment) and time T1 (end of treatment) were identified for the study group. For the control group, a time lag equal to the average treatment duration of the study group (18±2 months) was established between time

T0 and T1. At time T0 and time T1, alginate impressions of both arches were taken for each subject in both samples and corresponding plaster study models were developed.

To analyze the shape of the arches, the plaster models were scanned to obtain three-dimensional images using an OrthoScan extraoral scanner (Dentaurum 6mmbh E Co®, Ispringen Germany) with a resolution of less than 20 microns. The three-dimensional models obtained were measured and analyzed using specific software (Viewbox 4 dHAL® software, Kifissia, Greece). For this purpose, a template was constructed for each scanned model to record the transverse and sagittal dimensions of the upper and lower arch, as described in previous research by Pavoni et al. (7). The template used in this study was designed as follows:

A midpoint (MP) was identified as the one between the most mesial point on the incisal edge of both central incisors. On the other hand, all two-dimensional linear measurements were taken at the level of a horizontal plane passing between the cuspal apices of the right and left deciduous canines and the midpoint. The examined variables included (Fig. 2):

- torque of the permanent first molar of the first quadrant (1.6);
- torque of the permanent first molar of the second quadrant (2.6);
- torque of the permanent first molar of the third quadrant (3.6);
- torque of the permanent first molar of the fourth quadrant (4.6);
- anterior length of the left arch (AntSx): distance between the midpoint and the cusp of the left deciduous canine;
- anterior length of the right arch (AntDx): distance between the midpoint and the cusp of the right deciduous canine;
- posterior length of the left arch (PostSx): distance between the cusp of the left deciduous canine and the mesial marginal ridge of the left first permanent molar;
- posterior length of the right arch (PostDx): distance between the cusp of the right deciduous canine and to mesial marginal ridge of the right first permanent molar;
- intercanine distance (InterC): distance between the cuspal apices of the canines;
- Intermolar distance (InterM): the distance between the points of intersection of the transverse grooves with the buccal grooves of the first permanent molars of the maxillary arch and between the apices of the bucco-distal cusps of the permanent first molars of the mandibular arch.

Statistical analysis

All measurements on the digital models were recorded by a single operator and repeated a second time after about two weeks. The statistical analysis evaluated the mean and standard deviation of the variables considered at time T0 and T1 to describe the central tendency and dispersion of the two observed groups.

The difference between each group's means was evaluated using the Student's *T*-test (the difference was considered significant for $p<0.05$). Successively, repeating the Student's *T*-test, the differences between the two investigated groups were compared.

The Student's *T*-test was used to evaluate whether the changes recorded in the study group were statistically significant compared to those in the control group. The test was carried out for each examined variable, comparing the differences between the measurements at time T1 and those at time T0 of the two groups.

RESULTS

Measurements recorded on the study group's digital models showed no statistically significant torque changes in the first permanent molars in any of the four quadrants ($p>0.05$) (Table I-IV). At the upper arch level, the left anterior length (AntSx) and the right anterior length (AntDx) experienced statistically significant changes, with an average increase of 0.9 mm (Fig. 2).

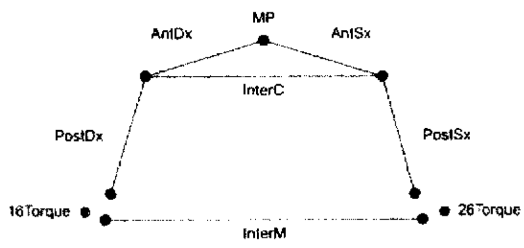

Fig. 2. *Upper Arch Template.*

By contrast, the Left Posterior Length (PostSx) and Right Posterior Length (PostDx) showed an average decrease of 0.5 mm. The Intercanine Distance (InterC) and Intermolar Distance (InterM) of the upper arch in the study group significantly increased ($p<0.05$) by a mean value of respectively 2 mm and 3.7 mm ± standard deviation.

Table I. *Statistical measurements on the upper arch of the study group.*

Variables	t0		t1		t1 – t0	
	Mean	DV	Mean	DV	Mean	t Test
16Torque	26.63	6.17	24.80	5.81	-1.82	0.06
26Torque	18.72	8.15	17.12	8.11	-1.47	0.40
AntSx	21.20	1.88	22.28	2.06	1.07	**0.003**
AntDx	21.27	1.79	22.10	1.44	0.82	**0.03**
PostSx	15.90	0.89	15.49	1.00	-0.41	**0.0003**
PostDx	16.15	0.76	15.60	0.85	-0.55	**0.00002**
InterC	31.62	2.93	33.71	2.13	2.08	**0.0004**
InterM	44.84	3.41	48.54	2.56	2.70	**0.0001**

Table II. *Statistical measurements on the lower arch of the study group.*

Variables	t0		t1		t1 – t0	
	Mean	DV	Mean	DV	Mean	t Test
36Torque	42.80	8.90	41.86	7.31	-0.90	0.50
46Torque	44.77	6.63	42.96	6.94	-1.80	0.30
AntSx	13.53	1.30	14.24	0.87	0.70	**0.01**
AntDx	13.23	1.47	14.21	1.23	0.98	**0.001**
PostSx	22.08	5.05	21.19	5.08	-0.89	**0.0004**
PostDx	22.59	5.00	21.70	4.55	-0.89	**0.02**
InterC	26.98	2.04	29.52	1.55	2.54	**0.00001**
InterM	42.80	2.97	44.57	2.46	1.75	**0.0003**

Table III. *Statistical measurements on the upper arch of the control group.*

Variables	t0		t1		t1 – t0	
	Mean	DV	Mean	DV	Mean	t Test
16Torque	21.12	5.87	22.52	7.97	1.40	0.30
26Torque	16.61	9.26	14.08	6.99	-2.53	0.30
AntSx	21.95	1.36	22.41	1.34	0.46	**0.002**
AntDx	22.29	1.38	22.63	1.33	0.34	**0.05**
PostSx	15.90	1.02	15.57	1.07	-0.32	**0.003**
PostDx	15.81	1.10	15.39	1.13	-0.42	**0.02**
InterC	32.73	1.92	33.28	1.85	0.55	0.1
InterM	47.85	2.48	48.54	2.68	0.68	**0.006**

Table IV. *Statistical measurements on the lower arch of the control group.*

Variables	t0		t1		t1 – t0	
	Mean	DV	Mean	DV	Mean	t Test
36Torque	44.64	7.00	43.60	6.04	-1.04	0.3
46Torque	45.90	8.22	45.46	5.87	-0.44	0.8
AntSx	14.26	1.27	14.12	0.92	-0.13	0.5
AntDx	14.54	0.99	14.26	1.24	-0.27	0.2
PostSx	20.99	1.36	20.66	1.45	-0.33	0.1
PostDx	14.54	0.99	14.26	1.24	-0.27	0.2
InterC	28.78	1.51	28.99	1.67	0.24	0.2
InterM	44.37	2.57	44.93	2.21	0.55	0.1

Moreover, the study group observed a significant increase in Left Anterior Length (AntSx) and Right Anterior Length (AntDx) at the lower arch, revealing an average of 0.8 mm. By contrast, the values of Left Posterior Length (PostSx) and Right Posterior Length (PostDx) relevantly decreased by 0.9 mm on average. At the level of the lower arch, the values of Intercanine Distance (InterC) and Intermolar Distance (InterM) significantly increased ($p<0.05$) respectively by 2.5 mm and 1.7mm.

Statistical results from the measurements taken on the control group showed no significant torque changes at the permanent first molar level in any of the four quadrants ($p>0.05$).
Additionally, in the upper arch, Left Anterior Length (AntSx) and Right Anterior Length (AntDx) significantly increased by a mean value of 0.4 mm, while Left Posterior Length (PostSx) and Right Posterior Length (PostDx) reduced considerably by a mean value of 0.4 mm. The change in Intercanine Distance (InterC) was not statistically significant, unlike Intermolar Distance (InterM), which increased significantly by 0.7 mm on average.

At the level of the lower arch in the control group, no significant changes were observed in Left Anterior Length (AntSx) and Right Anterior Length (AntDx), as well as Left Posterior Length (PostSx) and Right Posterior Length (PostDx). Finally, the values of Intercanine Distance (InterC) and Intermolar Distance (InterM) did not show statistical significance either ($p>0.05$) (Fig. 3).

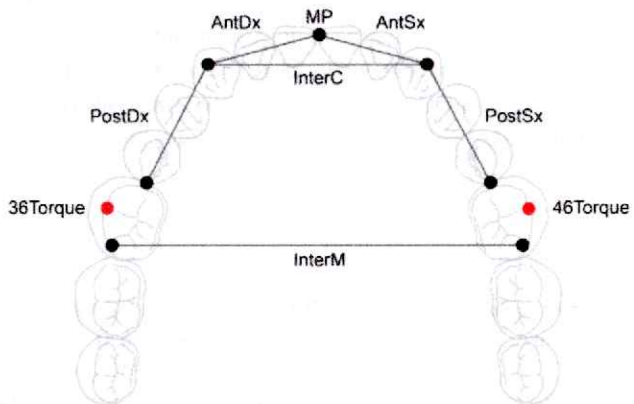

Fig. 3. *Lower arch template.*

DISCUSSION

This study, conducted on a sample of 23 patients, was designed to investigate the effect of using the Equilibrator model conformer device on arch shape and compare it with control group data. The changes observed during treatment reflect the combined effects of orthodontic treatment and individual growth. For this reason, a comparable control group was included in the study to identify growth-related changes.

What emerges from the study is that the use of the mentioned device drove statistically significant morphological changes in the arch shape of treated patients. Concerning the intercanine and intermolar distance variables, there was a significant transverse dimension increase of both the maxillary and mandibular arches by respectively 3.7 mm and 1.7 mm.

The study by McNamara et al. (8) examined data from 112 patients (mean age 11.2 years) with varying degrees of crowding. These patients were treated with an RME-type orthopedic device, which can be considered an alternative treatment to extraction and which would allow the perimeter of the maxillary arch to be increased. Furthermore, in the long term, the average expansion has been recorded as 6 mm in the upper transverse diameter (8). The changes described by McNamara were identified as stable, especially in the posterior area, with a recurrence of the intermolar diameter of 5%. In contrast, in the anterior area, there was a relapse of the intercanine diameter of 37%. These findings are confirmed by subsequent studies conducted by Lima et al. using measurements made on plaster models (9). Both authors report significant and stable transpalatal and mandibular amplitude increases compared to untreated control groups despite a small recurrence of dental transverse diameters offset by the overcorrection achieved during active treatment (9-11).

The increased relapse in the maxillary arch is to be related to the loss of anchorage of the upper first molars during the active phase of tooth-anchored expansion. Our study analyzed the torque values of the first molars of all four quadrants at time T0 and time T1. No statistically significant changes were found in the torque of the first molars despite increasing intermolar distance, suggesting that the dental movement obtained was body-like.

The posterior segments of the arches showed a sagittal reduction of 0.4 mm in the maxillary arch and 0.9 mm in the mandibular one. Such change can be attributed to the mesial sliding movement of the first permanent molars and to the distal sliding movement of the canines as a result of the exfoliation of the deciduous molars. Extra space gained, known as Leeway space, in the upper arch is about 0.9 mm per hemiarch. On the other hand, in the lower arch, the value is equal to about 1.7 mm per hemiarch.

The increase in anterior segments observable in both maxillary and mandibular arches of the study group is a direct consequence of the transverse expansion of the arches. By increasing the intercanine diameters, it is presumable that the anterior segments will necessarily increase as well.

CONCLUSIONS

The use of an Elastodontic device (Equilibrator Eptamed)® has proven to be an effective means at modifying the arch form of growing patients. Changes observed across treated patients essentially result in a transverse dental arch expansion. In line with the results obtained, the increase in the intercanine and intermolar distance of both the upper and lower arch and the measurements taken in the control group show no significant changes other than those associated with the physiological growth process. If the achieved expansion seems to be related to a bodily movement of the dental elements, we would require further in-depth studies to understand whether expansion is of an orthopedic or purely dento-alveolar nature.

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