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Original Article

Changes in the Mandibular Arch after Rapid Maxillary Expansion in Children: A Three-Dimensional Analysis Using Digital Models

Ariel Adriano Reyes Pacheco[1,2], Ademir Franco[3], Oscar Mario Antelo[2,4], Matheus Melo Pithon[5,6], Orlando Motohiro Tanaka[2,6]

[1]Pontifícia Universidad Católica Madre and Maestra, [2]Pontifícia Universidade Católica do Paraná, School of Life Sciences, [3]Department of Stomatology, Federal University of Paraná (UFPR), Curitiba, Brazil, [4]Master in Orthodontics, Universidad Intercontinental, Cidade de Mexico, Mexico, [5]Southwest Bahia State University – UESB, Bahia, [6]Diplomate of Brazilian Board of Orthodontics and Dentofacial Orthopedics, Vitória da Conquista, Bahia, Brazil

Abstract

Objective: This retrospective study quantitatively evaluated and compared the change in distance between mandibular first molars before and after rapid maxillary expansion (RME) using digital models. **Materials and Methods:** Twenty-seven (n = 27) plaster models (16 females and 11 males, between 6 and 9 years old) from patients treated at the Interceptive Orthodontic Clinic of the Pontifical Catholic University of Paraná (PUCPR, Curitiba, Brazil) were used. The initial (T1) and final (1 year after, T2) dental casts were scanned. The distances between the mandibular first molars were measured and compared using Geomagic Foundation software (Rock Hill, SC, USA). The central fossa of each mandibular molar was used as the reference point. The mandibular arch perimeter was measured using Orthoviewer (3Shape, Copenhagen, Denmark). **Results:** The intermolar width increased by 0.23 mm and by 0.75 mm in the arch perimeter. In two patients the intermolar width increased more than 2 mm, and in five patients the values from the initial measurements decreased. **Conclusions:** RME does not increase mandibular intermolar width distance or the mandibular arch perimeter in growing patients treated with Haas-type palatal expanders when evaluated using digital models.

Keywords: Digital model, posterior crossbite, rapid maxillary expansion

Introduction

Maxillary posterior crossbite is detectable in the deciduous dentition of nearly 20.81% of the child population.[1,2] This transverse discrepancy does not self-correct, whether it is functional or skeletal, unilateral, or bilateral.[3-5]

Rapid maxillary expansion (RME) is indicated in patients with posterior crossbite to correct the transversal discrepancy between arches by opening the midpalatal suture and expanding the maxillary molars.[6] The effects of this procedure on the mandibular arch are not well understood. Some researchers believe that the intermolar width and arch perimeter increase due to better positioning of the tongue over the mandibular arch, leading to a physiological expansion as a result of the RME. Others contend that no association exists between the procedures.

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Measurements performed on digital casts have been described as reliable for orthodontic purposes, with the advantages of consuming less storage space and being easy to manipulate for the study.[7,8] The advantages of digital casts include the possibility of more precise analysis, the reduced need for storage, and the ease of handling, sharing, and forwarding them.[9]

The objective of this retrospective study was to evaluate and compare the changes in distance between mandibular first molars and mandibular arch perimeters, before and after RME, using digital models.[9]

Address for correspondence: Dr. Orlando Motohiro Tanaka, Pontifícia Universidade Católica Do Paraná, R. Imaculada Conceição, 1155, Curitiba, PR, Brazil.
E-mail: tanakaom@gmail.com

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Materials and Methods

Fifty-four ($n = 54$) dental casts of initial (T1) and 1 year later (T2) representations from 27 ($n = 27$) patients (16 females and 11 males, between the ages of 6 and 9 years) who received RME treatment were digitized with a 3shape R700 model scanner (3shape A/S, Copenhagen, Denmark).

All the patients presented mixed dentition, with permanent maxillary and mandibular first molars and central incisors erupted before the start of treatment. All cases were treated with banded Haas-type expanders on the maxillary first molars to correct the maxillary posterior crossbite. Treatment took place at the Interceptive Orthodontic Clinic of the Pontifical Catholic University of Paraná (PUCPR, Curitiba, Brazil). The activation protocol comprised two turns at the installation appointment and later, the patient's parents were instructed to activate the appliance twice a day, with 1/4 turn in the morning (0.25 mm) and 1/4 turn (0.25 mm) in the evening, until correction of the posterior crossbite was achieved, that is, when the palatal cusps of the maxillary first molars occluded buccally of the mandibular first molars, as stated in previous studies.[10,11] An occlusal X-ray was used to assess suture opening and bone formation in the retention period.

The appliance was left in place for 6 months for retention, and T2 documentation was performed 1 year after the initial record, T1.

The distances between the first mandibular molars were measured and compared using Geomagic Foundation (3D Systems, Rock Hill, SC, USA). The central fossa of each mandibular molar was used as the reference point. The mandibular arch perimeter was measured using Orthoviewer (3Shape, Copenhagen, Denmark) [Figures 1-3]. The entire sample was remeasured 4 weeks later, to perform the intraclass correlation of the two variables.

Statistical analysis

The Shapiro-Wilks test was performed to evaluate the normal distribution of the data. The mean and standard deviations were calculated as descriptive statistics. Paired Student's *t*-tests of the means were performed to evaluate the intermolar width and arch perimeter changes, before and after RME treatment (T1–T2). The significance level was set at 5% ($P < 0.05$).

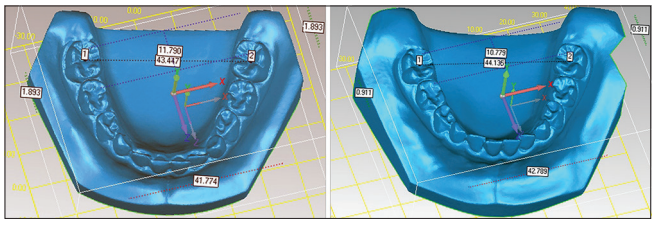

Figure 1: Measurement of intermolar width

Results

In this study, 16 females and 11 males (aged 6–9 years) were treated with RME. After treatment, the intermolar width and mandibular arch perimeters of T1 and T2 presented a strong correlation, as shown in Table 1. The intermolar width predominantly increased by 0.23 mm (±0.02 mm), with two patients presenting an increase of more than 2 mm and five presenting decreased values compared to the initial measurements. The mandibular arch perimeter predominantly increased by 0.38 mm (±0.48 mm) in 11 patients, remained the same in eight, and decreased in eight. We found no statistically significant difference in the mean changes of the variables [Table 2]. Figures 4 and 5 show the similarity between the before and after RME measurements of the samples.

Discussion

In recent years, digital casts have been widely used for studying the outcomes of RME. The average differences in measurements performed on plaster models versus digital images have been reported as 0.27 mm, ranging between 0.16 and 0.38 mm. This can be explained by operator error during both manual measurement or when placing the point of the measuring tool used in the software. Consequently, casts can be used effectively as research specimens for orthodontic purposes.[8]

Table 1: Intraclass correlation of the studied variables

Measurement	T1	T2
Intermolar width	0.8	0.9
Mandibular arch perimeter	0.9	0.9

Table 2: Comparison of changes in mandibular intermolar width and mandibular arch perimeter after rapid maxillary expansion

Measure (mm)	(T1)		(T2)		*t*-test
	Mean	SD	Mean	SD	
Intermolar width	41.88	1.44	42.11	1.42	0.18
Mandibular arch perimeter	71.75	2.25	72.13	2.73	0.08

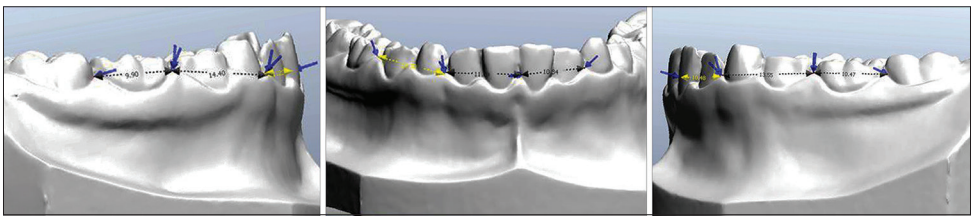

Figure 2: Measurement of mandibular arch perimeter

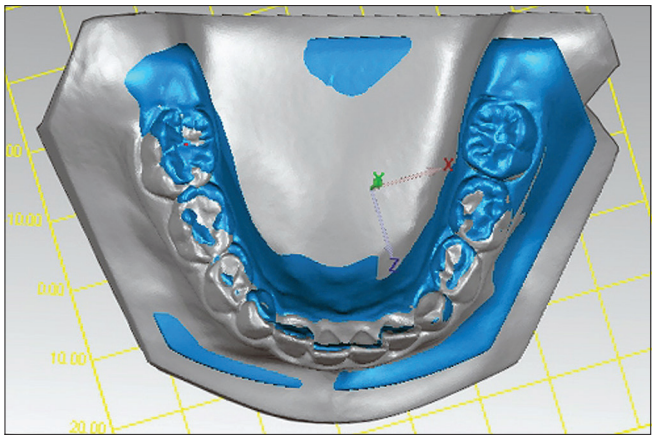

Figure 3: Superimposition of models T1 and T2

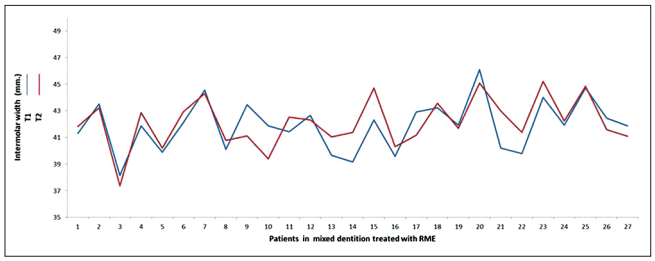

Figure 4: Changes in initial (T1) and 1 year later (T2) mandibular intermolar width

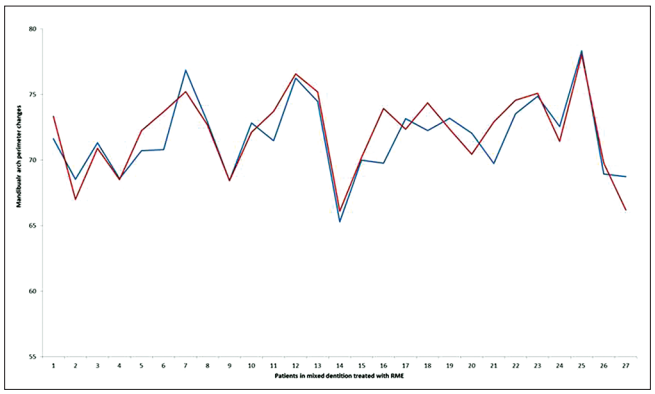

Figure 5: Changes in initial (T1) and 1 year later (T2) mandibular arch perimeter

McNamara *et al*.[12] found greater orthopedic results in growing patients treated with Haas appliances before the growth spurt, rather than in those treated a short time after. In the present study, all of the patients were growing patients treated with Haas expanders, which could have led to a more pronounced orthopedic result in the maxillary arch, with a greater amount of expansion of the mandibular arch, but this was not observed, at least not 1 year after the initial record, and after RME treatment.

McNamara *et al*.[12] evaluated the effects of treatment using RME on growing patients who were subsequently treated with fixed appliances and compared them to a control group. They found an increase of 1–2 mm in the arch width. In the present study, the patients did not receive any active expansion appliances on the mandibular arch during the study, which is different to McNamara *et al*. study, where their treated patients were submitted to fixed orthodontic treatments after RME, after which comparisons were made. They found an overall increase in the mandibular arch perimeter of 1.5 mm after RME. In our sample, the mandibular arch perimeter increased by only 0.75 mm after RME treatment, half of what had previously been reported, probably because our sample did not receive fixed appliance treatment after RME, during the follow-up.

A previous study used the centroid and mesial buccal cusps as references in photographs of cast models to evaluate changes in mandibular arch width in patients treated with bonded and banded appliances. The centroid-centroid distance increased by 1.35 mm in the banded group.[13] The present study also used the centroid as the reference in the digitized models; we found an increase of only 0.23 mm, which was not statistically significant (according to the paired *t*-test), and in contrast to the results from the photographic study.

The buccal and lingual alveolar surfaces, near the dentition, seem to be inappropriate as reference areas for superimposing three-dimensional mandibular digital models of patients without a mandibular torus.[14]

In this study, intermolar width did not significantly increase, although this was expected to occur because the support of a more vestibular force vector should have produced a vertical position of the mandibular molars, as has been described in other studies.[10,11,15] The present study did not find such an increase; however, our retention period was 6 months, and the T2 documentation was performed 1 year after the initial record-sufficient time for the maxillary arch to expand the lower teeth. The same conclusion was reached by Wertz,[16,17] who found that, after measuring the intermolar distance in frontal radiographs in a 60-patient sample, the measurements of 35 patients remained stable, 12 increased between 0.5 and 2 mm, and 1 decreased. Gryson[17] also found no association between maxillary molar expansion and mandibular intermolar distance.

Nowadays, by incorporating the use of intraoral scanners and digital dental models in surface measurements along curved lines, and in three dimensions,[18] and applying these in clinical practice, the time and cost of making impressions and sending them to the laboratory are minimized. The limitation of this study is, however, that a correlation between the amount of maxillary expansion and the intermolar distance was not performed. This procedure was performed by Gryson[17] on plaster models; the results showed no differences between T1 and T2, and this variable did not correlate with maxillary expansion.

Conclusions

Observations from the present study suggest that RME does not increase the mandibular intermolar width distance, or the mandibular arch perimeter, in growing patients treated with Haas-type appliances, as evaluated using digital models.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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