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ASSESSMENT OF DENTAL CHANGES AFTER RAPID MAXILLARY EXPANSION

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ABSTRACT

Objective: This study aimed to evaluate the angle of pre transverse projection and after rapid maxillary expansion (RME) in central incisors and first molars.

Methods: They were assessed by computed tomography (CT) 30 patients in the existing database, aged 7 and 14 years of both sexes (mean age of 9.7 years Patients were treated with breaker banded Hyrax type and activations were monitored and completed after the cross-compatibility of the upper bone base with Wala edge of the lower basal bone. patients underwent tests pre-expansion computed tomography (T1) and after 3 months ended expansion (T2) respecting the ALARA index. Data were coleados through the OsiriX imaging program. We evaluated two dental structures, central incisor and First Molar Permanent Superior, which evaluated the degree of tilt after RME. We evaluations of individual changes, intra-group, inter-group.

Results: the result after comparing the data showed that almost all suffered no significant changes except ANGLE INCISOR in 6 PALATE 6 RIGTH and 6 PRSPs 6 LEFT.

Conclusion: in short-term changes occur in the direction of the long axis of the molars and maxillary central incisors after RME.

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INTRODUCTION

Rapid maxillary expansion (RME) is a procedure that is used to treat the transverse malocclusion seen in patients with maxillary constriction, resulting in sagittal and vertical changes to the maxilla's position in relation to the mandible (Smith *et al*., 2012). In RME, the mechanism of action is not only achieved through separation of the midpalatal suture, but also by the additional buccal rotational force to which the maxillary alveolar processes are subjected (Silva *et al*., 2007; CappelletteJúnior *et al*., 2012). The priority must be the transverse discrepancy when correcting orthodontic problems in which an adequate transverse maxillary dimension is a prerequisite for functional and stable occlusion (Capelozza Filho and Silva Filho Od, 1997). The term "mouth breather" refers to a person in whom the correct nasal breathing pattern has been substituted by either oral or mixed breathing. This inappropriate respiratory pattern can have a progressive impact on children's physical and psychological development, with consequences for facial development and occlusion (Barros *et al*., 2006). Many different factors may be associated with mouth breathing, including a narrowed nasal cavity, nasopharyngeal atresia or obstruction, hypertrophy of the nasal concha, hypertrophic palatine or pharyngeal tonsils, nasal septum deviations, choanal atresia, and nasal or nasopharyngeal tumors (Zinsly *et al*., 2010). Treatment of young patients with a transverse maxillary deficiency can prevent these possible disorders of facial growth and development from manifesting. Many factors may be involved in such malocclusions, such as, for example: prolonged retention of deciduous teeth or residual roots, dental eruption pattern, unhealthy habits, sleeping position, respiratory problems, genetically determined deficiency of lateral maxillary growth, atypical tongue pressure, congenital malformations of the lips and/or palate, and occlusal interferences (Klontz, 1998; Barreto *et al*., 2005). The force generated by the expansion device produces areas of compression on the periodontal ligaments of the support teeth. After this, resorption of alveolar bone continues to move the tooth in the same direction. Tooth-borne expanders that concentrate the force on the dentoalveolar area may be more iatrogenic from the periodontal perspective and may cause greater root resorption from the supporting teeth. The impact

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on the buccal bone plate can be extremely important (Starnbach *et al*., 1966; Greenbaum and Zachrisson, 1982; Gonçales, 2011). Traditionally, two-dimensional radiographic images have been used to identify specific anatomic landmarks from which dental and skeletal dimensions can be measured. More recently, three-dimensional (3D) radiographic images have been used for the same purposes, with several advantages (CappelletteJúnior *et al*., 2012; Alqerban *et al*., 2011; Alqerban *et al*., 2013; Alqerban *et al*., 2014). Computed tomography (CT) offers rapid and precise acquisition of thin slices that can be used for 3D multiplanar reconstruction. This capacity increases the utility of CT as a diagnostic method (Ghoneima *et al*., 2010). Computed tomography therefore makes it possible to measure transverse, vertical and sagittal dimensions in any part of the maxilla, in addition to changes to the axial angles of anterior and posterior teeth (Capelozza Filho and Silva Filho Od, 1997; Barreto *et al*., 2005; Bazargani *et al*., 2013). The objective of this study is to assess the transverse projection angle of central incisors and maxillary first molars before and after rapid maxillary expansion.

MATERIALS AND METHODS

Sample

Prospective cohort studies, which were evaluated helical computed tomography (CT) of 30 patients of both sexes aged between 7 and 14 years. All patients were in the process of mixed or young permanent dentition and clinically diagnosed as mouth breathers and patients with maxillary atresia indicating ERM. Diagnostics and tomographic examinations were performed after otorhinolaryngological evaluation (Mouth Breathing).

Inclusion criteria

Inclusion criteria for the patient to become research subject, it was necessary that it presented aged 7 to 14, deciduous dentition and early transient, unilateral maxillary atresia or bilateral without orthodontic treatment, poor Class I occlusion, II or III, permanent maxillary central incisor, permanent maxillary first molar and mouth breathing clinically proven by evaluation by clinical examination, radiographic and tomographic multidisciplinary team.

Exclusion criteria

Were excluded syndromes or craniofacial patients (Pierre Robin, Treacher Collins, Appert and others) that are associated with maxillary atresia, patients with dental changes or periodontal problem sand deficient oral hygiene.

Method

Once selected patients were asked an orthodontic documentation and after that were sent to perform the initial CT scan (TC1) multislice (Philips® Brilliance CT scanner 64 channels), with tomographic making face jaw. After the examination was carried out to manufacture the rapid maxillary expansion appliance Hyrax type of Morelli ® with screw 13mm and, after installation, there were 6/4 of initial activations by the orthodontist, and these activations, explained in practice, professional, legal guardian by the patient. The tutor or guardian, who was instructed to do 2/4 of daily activations, no interval between them, carried out subsequent activations. This procedure included the weekly monitoring charge orthodontist was performed until the required amount of expansion for each patient was obtained. Activations were finished when there was the cross-compatibility of the upper bone base with Wala edge of the lower bone base (Andrews, 2015). Completed the activation process, the devices were kept in place and removed after an average period of 3 months from the radiographic finding of bone formation of the sutures. After removal of the apparatus the patients were again referred to the Department of Diagnostic Imaging (DDI) for holding the second (TC2) and subsequent comparison to the first TC1. Comparisons between CT1 and CT2 were carried out with the aid of the OsiriX MD image manipulation program (FDA approved, version 1.4.2; Pixmeo, Geneva, Switzerland).From 3D tools MPR (Multi Planar Reconstruction). Staff cuts were the sagittal, coronal and axial (Figure 1) and to improve levels of detail images were modified from the contrast options (WL 300-350 x WW 3000-3500), opacity, zoom, spin and tissue types provide the program. The images were observed by using specific tools to measure the desired action, with the possibility of using different filters that allow better differentiation between different densities tissues and even the application of transparency, enabling the display of the scrim through the fabric soft. To standardize the position of the head of patients in the CT images prior to the implementation of the measures, the orientation of these images were taken in accordance with the vertical and horizontal lines of program reference, correcting any deviations from the head position remained during realization of CT scans that could interfere with measurements of interest. To this, were used as basis, the methods recommended by Cevidanes *et al*. 2009 and Hassan *et al*. 2003, in order to guide the axial, coronal and sagittal images, using some anatomical structures and cephalometric reference points. Thus the head is positioned in cephalometric standard, based on the Frankfurt horizontal plane.

Analysis of the measures

For analysis of the initial position and the end of the molars were established localized points in the first upper molars that through an angular tool program in which we obtained the degree of inclination of the pre molars and post RME locating points on the tip of palatal cusp and apex the palatal root of the upper first molar right and left. To evaluate the convergence or divergence of the upper central incisors were drawn straight on the long axis of which was obtained points in the center of the incisal edge and root apex, where through the intersection of lines got ANGULO INCISOR.

Statistical methodology

The measurements of the angles are characterized by the mean (M), standard deviation (SD), the minimum value (Min) and maximum (Max). The unit of measurement of angles is the degree. To study the normality of the data was used the Shapiro-Wilk test. Having checked the normality of the data ($P > 0.05$ in the Shapiro-Wilk test), we used the Student's t test for paired samples - to compare the pre-ERM measurement and post-ERM - and the T Test Student for independent samples - for comparison of changes between EG and CG. The study of intra-rater and inter-rater errors was performed with the Student's t test for paired samples (systematic error) and the formula of Dahlberg (random error) (Dahlberg, 1940). To study the adequacy of the sample was calculated the effect size that statistical tests can detect, considering a power of 80% and a significance level of 5% (Cohen, 20003; Hair *et al*., 2010). The calculations were performed with the G * Power (Faul *et al*., 2007) program. Statistical analysis was performed with the Statistical Package for Social Sciences (SPSS) version 22 for Windows. a 5% significance level for the decision on the results of the statistical tests was considered.

Acronyms

- GE - Experimental Group
- CG - Control Group
- M - Average
- SD - standard deviation
- Min - Minimum
- Max - Maximum
- p - significance of value of statistical tests
- NAME OF VARIABLE
- ANGLE INCISOR - Convergence and divergence angle of the upper central incisors. (Figure 2)
- 6 PALATE 6 DRT - Tilt angle between the First Molars Upper Right. (Figure 3)
- 6 PALATE 6 ESQ - Tilt angle between the First Molars Upper Left. (Figure 4)
- 6 PRSPs 6 DRT - First slope angle Molar Upper Right related to a perpendicular line that crosses the Frankfurt Plan. (Figure 5)
- 6 PRSPs 6 ESQ - First slope angle Molar Upper Left referring to a perpendicular line that crosses the Frankfurt Plan. (Figure 6)

Calculation sample

To determine the adequacy of the sample there are three factors to consider: the effect size (magnitude of differences in study), the test power (1 - β, and β Type II error) and the significance level (α, Type I error). The usual values for the potency of the test and the significance level is 80% (1 - β = 0.80) and 5% (α = 0.05), respectively (Cohen, 20003; Hair *et al*., 2010). Setting these values, the larger the sample size more likely will detect small effects. Thus, a small sample differences (effects) will only be significant if were great dimensão (Hair *et al*., 2010). In this research to verify the adequacy of the sample, it was calculated the effect size that statistical tests can detect with a power of 80% and a 5% significance level. The ratings for the size of the effect proposed by Cohen (Cohen, 20003) were considered: d = 0.2 - small effect; d = 0.5 - average effect; d = 0.8 - high effect. The calculations were made taking into account the sample size and statistical tests to be used: Student's t test for independent and Student's t test for paired samples samples. The calculations were performed with the G * Power (Faul *et al*., 2007) program. Student's t test for paired samples to detect differences of medium / large size (d = 0.67) in the sample, with a 80% test power and 5% significance level.

Normalcy DATA

The normality of the variables to consider in the research, which include not only the initial measurements, but also the intraobserver and interobserverrepetitions was tested with the Shapiro-Wilk test (Table 1).

Tabela 1. **Normality (Shapiro-Wilk test)**

VARIABLE	1st Measurement		Repetition(Sameevaluator)		Assessor Second
	Pre RME (p)	Post RME (p)	Pre RME (p)	Post RME (p)	Pre RME (p)
ANGULO INCISOR	0.052	0.336	0.065	0.511	0.394
6 PALATO 6 DRT	0.419	0.139	0.424	0.362	0.897
6 PALATO 6 ESQ	0.200	0.278	0.758	0.534	0.130
6 PERP 6 DRT	0.357	0.063	0.374	0.948	0.986
6 PERP 6 ESQ	0.823	0.207	0.935	0.048	0.256

p – Significance value of the Shapiro-Wilk test.

Table 2. Intra-ratererror (Student's t test for pairedsamples and Dahlberg formula)

Variable	1st Measurement (M±DP)	Repetition(Secondevaluator) (M±DP)	p(1)	DahlbergDahlberg
PRE-ERM				
ANGULO INCISOR	9.38±4.90	10.20±6.37	0.179	1.63
6 PALATO 6 DRT	100.69±4.80	102.50±4.47	0.063	2.70
6 PALATO 6 ESQ	100.63±6.75	101.89±6.42	0.075	1.94
6 PERP 6 DRT	11.59±3.97	12.42±3.64	0.083	1.32
6 PERP 6 ESQ	11.02±6.52	11.70±5.34	0.343	1.90
POST-ERM				
ANGULO INCISOR	1.32±9.12	1.60±8.61	0.523	1.14
6 PALATO 6 DRT	104.77±6.30	106.92±6.09	0.089	3.46
6 PALATO 6 ESQ	103.51±12.06	106.35±10.31	0.077	4.42
6 PERP 6 DRT	12.41±7.12	14.83±5.77	0.063	3.59
6 PERP 6 ESQ	15.65±10.18	17.40±9.64	0.186	3.54

(1) **p** – Test significance value T for paired samples.

Table 3. Inter-rater error (Student's t test for paired samples and Dahlberg formula)

VARIABLE	1st MEASUREMENT (M±DP)	REPETITION (Secondevaluator) (M±DP)	p(1)	Dahlberg
PRE-ERM				
ANGULO INCISOR	11.40±5.30	12.26±5.69	0.074	1.71
6 PALATE 6 DRT	102.00±6.65	102.75±5.55	0.303	2.54
6 PALATE 6 ESQ	101.27±6.66	102.31±6.04	0.136	2.45
6 PERP 6 DRT	11.89±4.96	11.94±5.02	0.922	1.57
6 PERP 6 ESQ	11.84±6.61	12.27±5.64	0.420	1.82

p – Test significance value T for paired samples.

TABLE 4 – Characterization of the angles and pre-and post-change RME

VARIABLE	PRE RME				POST RME				DIFFERENCE		p[(1)]
	Min	Max	M	DP	Min	Max	M	DP	M	%	
ANGULO INCISOR	4.30	18.39	9.38	4.90	-18.41	17.77	1.32	9.12	-8.06	-85.9%	< 0.001
6 PALATE 6 DRT	91.88	109.25	100.69	4.80	92.54	113.51	104.77	6.30	+4.08	+4.1%	0.021
6 PALATE 6 ESQ	87.82	114.79	100.63	6.75	81.45	129.72	103.51	12.06	+2.88	+2.9%	0.277
6 PERP 6 DRT	2.40	16.07	11.59	3.97	-3.51	20.05	12.41	7.12	+0.82	+7.1%	0.655
6 PERP 6 ESQ	-4.97	22.10	11.02	6.52	-6.90	37.38	15.65	10.18	+4.63	+42.0%	0.023

(1) **p** – Test Significance Value T for paired samples.

The significance values are greater than 0.05 (p> 0.05) in all variables, leading to not reject the null hypothesis test, considering a 5% significance level. Thus it is concluded that all variables the study has normal distribution, making it possible the use of parametric tests Student's t test for independent samples and paired samples.

Error intra-assessor and inter-assessor

The results of intra-rater and inter error-evaluator study are shown in Tables 2 and 3, respectively. The results of Student t test for paired samples are presented (systematic error) and Dahlberg formula (random error). All Student t test for comparison of paired samples were not significant (p> 0.05), indicating that there are no statistically significant differences between the measurements and the repetitions, or the same examiner (intra assessor) or the second evaluator (inter rater). The value of the Dahlberg formula varies between 1:14 and 4:42 in the intra-rater measurements, and between 1:57 and 2:54 in the inter-rater measurements.

Characterization of angles and changes pre and post-RME

At GE we observed statistically significant changes between pre and post measurements RME in ANGULO INCISOR (p <0.001) at 6 PALATE 6 DRT (p = 0.021) and the PERP 6 6 ESQ (p = 0.023). The angle INCISOR decreased from 9:38 to 1:32 (-85.9%) 6 6 PALATE DRT increased from 100.69 to 104.77 (+ 4.1%) and 6 PRSP 6 ESQ increased from 02.11 to 15.65 (+ 42.0%). The angles 6 PALATE 6 ESQ (p = 0277) and 6 PRSPs 6 DRT (p = 0.655) no significant changes between pre-and post-measurements RME (Table 4).

DISCUSSION

The aim of this study was to compare the axial and transverse changes in anterior and posterior teeth, by analyzing the angle of the pre and post cross RME projection, the central incisors and first molars in which patients used the jaw breaker apparatus Hyrax (Ludwig *et al*., 2013; Adkins *et al*., 1990). In addition to the desired skeletal effects, RME can induce dental changes. Numerous studies have now evaluated aspects of RME with CT in an attempt to overcome conventional methods of evaluation, such as overlapping of anatomical structures and reproducibility of head position. (Garib *et al*., 2005; Garib *et al*., 2007; Rungcharassaeng *et al*., 2007; Christie *et al*., 2010; Akyalcin *et al*., 2013; Podesser *et al*., 2007). It is of extreme importance the early intervention in the deciduous and mixed dentition due to the greater orthopedic effect of SMR, thus avoiding periodontal problems that could occur in the permanent dentition. Another aspect observed is that in the future eruption of permanent teeth will be followed by new alveolar bone, thus restoring the integrity of the area. Plain films such as cephalometric and panoramic x-rays, are not appropriate to examine bone defects or oral changes during and after therapy RME (Garib *et al*., 2005; Rungcharassaeng *et al*., 2007; Timock *et al*., 2011). In the present study, we used the CT technology, which allows us to analyze the changes in the direction of the long buccal and palatal axis after RME, this may not be possible with 2D technical analysis or model. The image acquired by CT provides accuracy and reliability in the dimensions of the crowns and roots, but must consider the voxel size and soft tissue conditions can affect the accuracy of measurements (Wood *et al.,* 2013; Garib *et al.,* 2014). Virtually none of the cited studies assessed the convergence and divergence of the upper first molars and maxillary central incisors. Most only studied cross changes, thickness of the buccal bone plate, palatal and individualized inclination of the first molar superior (Rungcharassaeng *et al*., 2007; Christie *et al*., 2010; Akyalcin *et al*., 2013; Podesser *et al*., 2007; Figueiredo *et al*., 2014).

In this study, we evaluated the angle of convergence and divergence of the upper central incisors, the inclination angle between the first upper molars left and right and the angle of inclination of the upper first molar right and left refers to a perpendicular line through the Plan Frankfurt different Garib *et al* which used a line passing through the tip palatal cusp and the palatal root apex, relative to a perpendicular to the bottom edge of the picture and Figueiredo*et al* (Toklu *et al*., 2015) where the first line was perpendicular to the axial plane passing through the apex and the second was drawn passing through the tip of the palatal cusp and the apex of the palatal root. Toklu *et al* tilt angle of the upper first molar right and left refers to a vertical line parallel to the median sagittal plane in the same coronal section used for dental inclination measurements. The results shown in Table 1 demonstrate that there was a great degree of intra-examiner reliability of measurements at a significance level of 5%, which shows that the data showed an excellent normalcy analysis for all variables. The results of intra-rater and inter error-evaluator study are shown in Tables 2 and 3, respectively. A comparison of paired samples was not significant (p> 0.05), indicating that there were no statistically significant differences between measurements. It can be seen that the RME incisor angle decreased from 9:38 to 1:32 (-85.9%) 6 6 PALATE DRT increased from 100.69 to 104.77 (+ 4.1%) and 6 PRSP 6 ESQ increased from 11.02 to 15.65 (+42.0 %). In amendments by ANGULO INCISOR were found close to statistically significant differences (p = 0.068). In the sample this angle decreased on average 8:06 and the other angles no significant differences (p> 0.05) in the pre and post RME changes.

Conclusion

Results obtained through the material and methodology employed, it can be concluded that:

a) Maxillary expansion moved the anchor teeth (molars and premolars for college entrance, with a tilt component and associated translation;

b) Occurred a decrease of the convergence and divergence angle of the central incisor and an increase in the inclination of the first molar permanents.

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