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DENTOSKELETAL ANALYSIS OF ANTEROPOSTERIOR AND VERTICAL CHANGES AFTER USE OF MARPE IN PATIENTS IN FINAL STAGES OF PALATAL SUTURE FUSION: DOUBLE-BLIND, CONTROLLED, RANDOMIZED CLINICAL TRIAL

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ABSTRACT

Background: The adverse effects of anteroposterior and vertical changesafter mini-implant assisted rapid palatal expansion (MARPE) may compromise the indication of this treatment for dolicofacial and Class II patients. The aim of this study was to use cone beam computed tomography to evaluate the anteroposterior and vertical dentoskeletal alterations that occurred after palatal expansion with MARPE in patients in the final stages of midpalatal suture maturation. **Methods**: The sample was composed of 20 volunteers of both sexes, with maxillary atresia, mean age of 24.8 (±7.1) years, allocated to two groups (n= 10) according to suture maturation stage "D" or "E". The following anteroposterior craniometric (SNA, SNB, A-Nperp, Pog-Nperp, 11.APog, 21.APog, 41.APog, 31.APog, 11-APog, 21-APog, 41-APog, 31-APog, 16-PtVr, 26-PtVl, 46-PtVr, 36-PtVl) and vertical (SN.PP, SN.MP, PP.MP, N-Me, N-ANS, S-PNS, ANS-Me, 16-PP, 26-PP, 46-MP, 36-MP). The measurements were evaluatedbefore treatment (T_0) and immediately after transverse correction with maxillary expansion (T_1) with VistaDent 3D software. The parametric data were submitted to the ANOVA test, and the non parametric type were analyzed by generalized linear models ($\alpha=0.05$). **Results:** No statistically significant differences between the groups were observed, except for slight extrusion of the first molars in Group E ($p<0.05$). In both groups, the maxilla moved forward and the mandible, backwards and downwards, with retroinclination of the mandibular central incisors ($p<0.05$). In Group D, the maxillary first molars retracted ($p<0.05$). In Group E, the maxillary central incisors inclined towards the vestibular direction ($p<0.05$). **Conclusion:** Treatment with MARPE generated anteroposterior and vertical effects inherent to rapid maxillary expansion, irrespective of the level of suture fusion; however, the treatment does not lead to a significant clinical repercussion of increase in vertical height or posterior displacement of the mandible.

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INTRODUCTION

Transverse deficiency of the maxilla affects an important number of patients, generating different degrees of malocclusion. For the treatment of this deficiency, patients must be submitted to rapid maxillary expansion (RME) that produces the transverse opening of the midpalatalsuture (1). RME supported on teeth must be performed in patients who are still at the stage of growth. Particularly, with progressive fusion of the palatal suture, RME may produce undesirable effects such as bone dehiscense, gingival recession and root resorption (2). Moreover, pain, edema, ulceration, opening of the bite and limitations may occur, such as insufficient expansion or relapse in the long term(3). In order to define the degree of midpalatal suture fusion, maturation indexes have been proposed in a classification of 5 stages (A, B, C, D, E), with "A" being an initial stage of fusion that gradually increases up to complete fusion in stage "E"(4). For patients with final stages of fusion, surgically assisted palatal expansion is indicated, which is invasive and highcost treatment, associated with surgical risks (5, 6). As an alternative, the MARPE (Miniscrew Assisted Rapid Palatal Expander) technique was developed. In this technique a hybrid appliance is banded to the first molars and connected to the palate by four mini-implants, crossing its two corticals, parallel to the palatal suture, exerting an expansion force on the basal bone, maximizing the orthopedic effect (7–9). Clinical trials with MARPE have not shown significant side effects when compared with conventional expansion, in patients with a mean age of 18 years (10, 11). In addition to the transverse orthopedic effect in conventional RMEs supported on teeth, vertical and anteroposterior changes also occur, such as: downward and forward movement of the maxilla, with rotation in the down ward and backward movement of the mandible, inclination and extrusion of the molars that support the appliance, increasing the dimension of the face and changing the position of the incisors (12). These effects may be undesirable in patients with excessive anterior inferior (dolicofacial) facial height, aggravating the relationship between the dental arches in cases of Class II (13). Nevertheless, in the literature, few studies are found about the anteroposterior vertical effects of RME, particularly with MARPE since these few evaluated cephalometric variables in an isolated manner, had reduced sample sizes, and did not consider the stages of palatal suture fusion (14). In addition, various findings of evidence about the dentoskeletal effects of this therapy may be limited by the two-dimensional nature of the images used for measuring them (15). Three dimensional cone beam computed tomography (CBCT) scans have made the measurement of craniofacial structures more precise, because there are no bilateral structure superimpositions, thus allowing the same scan to be visualized in the sagittal, coronal and axial planes (16). The null hypothesis of this study was that the level of palatal suture maturation would not modulate the anteroposterior and vertical dentoskeletal changes resulting from the use of MARPE. Therefore, the aim was to evaluate the anteroposterior and vertical effects of the use of MARPE in CBCT images, and correlate them with final stage of fusion of the midpalatal suture.

METHODS

Experimental Design and Sample: The present study was a controlled, double-blind cluster randomized clinical trial, with two parallel groups. The independent variable was the ossification level of the maxillary sagittal suture. The dependent variables were the dental and skeletal cephalometric variables. The study was conducted after approval from the Research Ethics Committee of the HermínioOmetto Foundation University Centerwith the Certificate of Presentation for Ethical Appreciation (CPEA) Number 06229018.3.0000.5385. Initially, 187 patients from a specialized center of Orthodontics (North postgraduation, Florianópolis, SC, Brazil) were evaluated. For sample selection the inclusion criteria were as follows: presence of maxillary atresia with need for skeletal correction[7] and midline palatal suture in the final stages of fusion “D” and “E” in accordance with the classification of Angelieri (4). The exclusion criteria were as follows; presence of any type of pathological condition or craniofacial syndrome (17), individuals with previous craniofacial fractures (18), absence of teeth or presence of carious teeth, extensively restored, with periodontal disease (3). After application of the eligibility criteria, 26 participants were included and allocated to two groups according to their classification of the midpalatal suture (4). The flow of the sample universe up to formation of the groups is exhibited in Figure 1. Random allocation of the groups of patients for the intervention were defined by the simple random allocation process. The participants were coded by an assistant researcher, who did not participate in the other phases of the study. A draw was used among those of the cluster and afterwards random allocation was done for performing the interventions (MARPE). Because they did not show successful treatment, 6 volunteers were excluded. Therefore, with a total of 20 participants, considering a level of significance of 5%, test power of 80%, an effect size of over 0.58 was calculated, which was sufficient for inferential analyses considering the pre-treatment (T_0), and immediate post treatment (T_1) evaluation (19). Therefore, the sample was made up of individuals of both sexes (8 men and 12 women) not orthodontically treated, with a mean age of 24.8 ± 7.1 years. The patients were informed about the object of the research and signed the Term of Free and Informed Consent - TFIC.

MARPE Therapy: Separators (Morelli®, Sorocaba, SP, Brazil) were inserted in the mesial and distal regions of the right and left maxillary first molars with the aid of dental floss, by a trained orthodontist. Five days after the separates were inserted, these teeth were banded and a transfer impression was taken with Hydrogum alginate (Zhermack®, Badia Polesine, RO, Italy). After this, the molds were poured with Durone type IV plaster (Dentsply®, Sirona, York, PA, USA) and the casts were sent to the laboratory for fabrication of the appliances with expander screws (Peclab®, Belo Horizonte, MG, Brazil), of the MARPE type. The appliances were cemented with glass ionomer cement Meron (Voco®, Cuxhaven, Germany) and subsequently, bone anchorage was performed with 4 mini-implants (Peclab®, Belo Horizonte, MG, Brazil) inserted with the aid of a 20:1 contra-angle handpiece and surgical electric motor (NSK®, Shinagawa, Tokyo, Japan) standardized at 30N. The mini-implant lengths and diameters were selected individually for each patient, by observing the palate bone thickness in the region of the maxillary first molars shown in the initial tomographic images (T_0). In some cases, the insertion was concluded with the aid of a manual ratchet key (Neodent®, Curitiba, PR, Brazil) (20). As a means of facilitating orthopedic expansion with MARPE, cortico-puncture therapy perforations along the palatal suture were performed, to reduce resistance to the rapid expansion process (21).

The therapy was carried out according to a single protocol for the two groups, so that the appliance would be submitted to 2 daily activations of 1/4 of a turn until the appearance of interincisor diastema, and then 1 activation of 1/4 of a turn per day until overcorrection of the transverse problem was attained (palatal cusp of the maxillary molars almost on top of the vestibular cusp of the mandibular molars) predicting a certain degree of relapse (17). On conclusion of the activations the appliance was locked with 0.70 mm brass wire (Morelli®, Sorocaba, SP, Brazil), and remained in this way for 6 months for the purpose of splinting (22). The researchers responsible for the intervention were blinded with regard to the level of ossification of the midline palatal suture.

Craniometric Analysis by means of CBCT: TheiCAT™tomography system/apparatus (Imaging Science International, Hatfield, Pa) used, was adjusted to 120 kVp, 36.12 mA, exposure time of 40 s and Fov of 13 cm to capture the segments with a voxel size of 0.25 mm.During scanning all the patients remained seated in an upright position, with the Frankfort horizontal (lateral) and Camper (frontal) planes parallel to the ground. Tomographic images were captured before treatment (T_0) and immediately after locking the appliance on conclusion of the RME (T_1). The tomographic data were reconstructed as Digital Imaging and Communications in Medicine (DICOM) files, and digitally analyzed by means of VistaDent 3D® software (Dentsply GAC, Nova York, USA) (23).The analyses were performed by a trained, calibrated researcher, in a room with artificial lighting, with a monitor placed in an ergonomic position, and adjusted to an adequate contrast setting. The natural position of the head was verified and corrected, based on the following points of reference: porion, orbital and nasion, with the purpose of standardizing the analyses in the 3 planes of space. The axial plane was defined by the Frankfort plane, obtained by the straight lines of the right and left orbital points up to the right and left porion points. Perpendicular to the axial plane, the coronal plane was obtained by the straight line between the right and left porion points. Lastly, the median sagittal plane (MSP) was determined orthogonally to the axial and coronal planes, passing through the nasion point. At $T_{0,}$ an axial evaluation of maturation level of the midpalatal suture was made to enable its classification, with a view to selecting volunteers with fusion of the palatal suture only in the posterior portion of the palatine bone (stage “D”), or complete fusion throughout the palate (stage “E”) (4). Thus, the Groups D and E were determined, respectively.

Subsequently, landmarks were defined at the anatomical points, with 0.25 mm in diameter, using volumetric rendering and multiplanar reconstruction (Figure 2).According to Baratieri et al. (13) points, planes and lines were established according to the description presented in Chart 1.

Method Error: To verify the intraexaminer calibration, all the tomographic images of the sample were measured by the same researches, in 2 different time intervals, with an interval of 2 weeks between each measurement (13). The results were submitted to statistical analysis using the R software (R Foundation, Vienna,

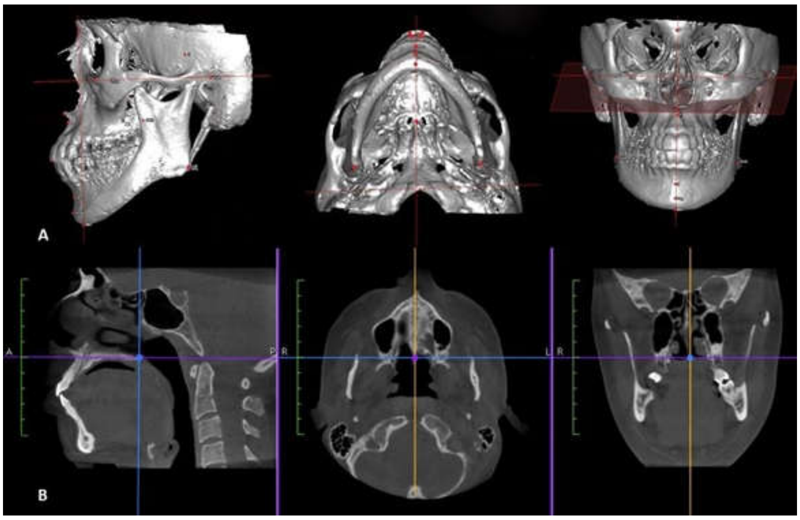

Figure 2. (A) Volumetric rendering; (B) Multiplanar reconstruction

Chart 1. Anatomical references

LANDMARKS		
Initials	Definition	Location
S	Sella	midpoint of Sella Turcica
N	Nasion	most anterior of the frontonasal suture in internasal suture
Or	Infraorbital	mostlower of the infraorbital border on each side
Po	Porion	most superior of the external auditory canal entrance on each side
A	Subspinal	in MSP, deepest of the maxillary anterior curvature
B	Supramental	in MSP, deepest of the mandibular anterior curvature
Pog	Pogonion	in MSP, most anterior of Menton
Me	Menton	in MSP, most lower of Menton
Go	Gonion	most outward midpoint of the mandibular angle on each side
Pt	Pterygoid	intersection of the foramen rotundum lower border and the pterygomaxillary fissure posterior border on each side
ANS	Anterior Nasal Spine	anterior nasal spine center
ENP	Posterior Nasal Spine	posterior nasal spine center
IF	Incisive Foramen	incisive foramen entrance center
GPF	Greater Palatine Foramen	greater palatine foramen entrance center on each side
OB	Occlusal Border	most occlusal of the each first molar cusp
DB	Distal Border	most posterior of the each first molar distal surface
IB	Incisal Border	midpoint most incisal of the each central incisor
AB	Apical Border	midpoint most apical of the each central incisor
PLANS		
Initials	Definition	Conformation
FP	Frankfort Plan	union of Po e Or points, both on each side
PP	Palatine Plan	union of IF e GPF points on each side
MP	Mandibular Plan	union of Me e Go points on each side
LINES		
Initials	Definition	Conformation
LA	Long Axis	pass by IB e AB of each central incisor
PtV	Pterygoid Vertical	pass by Pt of each side, perpendicular to the FP
Nperp	Nasion perpendicular	pass by N, perpendicular to the FP
APog	Subspinal to Pogonion	pass by A and Pog

From the planes and lines, linear measurements were made, in millimeters (mm), and angular measurements in degrees (º) in order to evaluate the dentoskeletal positions in the sagittal view, in the two time intervals (6). Twenty-seven variables (Chart 2) were used for analyzing the anteroposterior and vertical bone and dental measurements. All the measurements were made in duplicate, and the arithmetic mean of the two measurements made, by the same evaluator, were used for the inferential analysis. The angles considered were the smallest between the meeting of two straight lines. Whereas the linear measurements obtained were the shortest distances between the point and planes or lines (23, 24, 10, 1, 12). In $T_{1,}$ a new axial evaluation was made to confirm opening of the mid-palatal suture. The researcher who performed the measurements was blinded in T_1 with regard to the group to which the volunteers belonged.

Austria), with a level of significance of 5%. The interclass correlation coefficients showed values of over 0.998, considered excellent because they were higher than 0.75(25). The largest Dahlberg error for the angular measurements was 0.33º (SN.MP) and 0.66 mm (36-MP) for the linear measurements, both within acceptable limits of up to 1.5° and 1 mm (26). The absence of statistical differences between the measurements was confirmed by means of the t-test (p>0.05).

Statistical Analysis: The data that he presupposition of normality (SNA, SNB, A-Nperp, Pog-Nperp, 41.APog, 11-APog, 21-APog, SN.PP, 16-PP) were submitted to the ANOVA test. The nonparametric data (11.APog, 21.APog, 31.APog, 41-Apog,31-APog, SN.MP, PP.MP, N-ANS, S-PNS, ANS-Me, 26-PP, 46-MP, 36-MP, 16-PtVr, 26-PtVl, 46-PtVr e 36-PtVl) were analyzed by generalized linear models.

Chart 2. Craniometric Variables

ANTEROPOSTERIOR			
BONE	ANGULAR (º)	SNA	angle between S to N and N to A
		SNB	angle between S to N and N to B
	LINEAR (mm)	A-Nperp	distance form A to Nperp
		Pog-Nperp	distance from Pog to Nperp
DENTAL	ANGULAR (º)	11.Apog	angle between 11LA and A to Pog
		21.Apog	angle between 21LA and A to Pog
		41.Apog	angle between 41LA and A to Pog
		31.Apog	angle between 31LA and A to Pog
	LINEAR (mm)	11-APog	distance from APog to 11IB
		21-APog	distance from APog to 21IB
		41-APog	distance from APog to 41IB
		31-Apog	distance from APog to 31IB
		16PtVr	distance from 16DB to PtV right
		26PtVl	distance from 26DB to PtV left
		46PtVr	distance from 46DB to PtV right
		36PtVl	distance from 36DB to PtV left
VERTICAL			
BONE	ANGULAR (º)	SN.PP	angle between S to N and PP
		SN.MP	angle between S to N and MP
		PP.MP	angle between PP and MP
	LINEAR (mm)	N-Me	distance from N to Me
		N-ANS	distance from N to ANS
		S-PNS	distance from S to PNS
		ANS-Me	distance from ANS to Me
DENTAL	LINEAR (mm)	16-PP	distance from 16OB to PP
		26-PP	distance from 26OB to PP
		46-MP	distance from 46OB to MP
		36-MP	distance from 36OB to MP

Table 1. Measurements for Stages D and E of palatal suture fusion (Mean ± sd)

Variable			D Group (D Stage)		E Group (E Stage)	
			T_0	T_1	T_0	T_1
Anteroposterior	Bone	SNA	80.58 ± 4.36	80.82 (4.80)	79.52 (3.83)	79.31 (3.59)
		SNB	80.04 (5.25)	80.28 (5.23)	76.83 (4.79)	*75.97 (4.65)
		A-Nperp	4.66 (2.49)	*5.06 (2.45)	4.72 (2.37)	*4.97 (2.12)
		Pog-Nperp	10.26 (3.98)	*9.73 (4.41)	9.02 (5.19)	*8.05 (5.26)
	Dental	11.APog	21.55 (6.56)	21.48 (6.51)	20.94 (8.84)	*21.80 (9.40)
		21.APog	23.01 (6.34)	22.97 (5.93)	22.26 (8.32)	*23.76 (9.03)
		41.APog	21.51 (4.76)	*21.28 (4.95)	22.69 (4.62)	*21.66 (4.87)
		31.APog	21.34 (6.43)	21.32 (6.13)	22.21 (3.78)	*21.01 (3.91)
		11-APog	5.86 (1.95)	6.09 (2.21)	6.56 (2.64)	*7.33 (2.85)
		21-APog	6.90 (1.53)	*7.11 (1.51)	6.63 (2.62)	*7.20 (2.97)
		41-APog	4.64 (1.50)	4.39 (1.56)	4.43 (2.33)	4.47 (2.08)
		31-APog	3.28 (1.96)	3.64 (2.30)	3.91 (2.25)	3.79 (2.00)
		16-PtVr	27.83 (5.38)	27.28 (5.37)	28.63 (3.70)	28.93 (4.24)
		26-PtVl	28.53 (5.61)	*28.03 (5.51)	29.04 (3.04)	29.94 (3.90)
		46-PtVr	29.70 (4.88)	29.47 (4.60)	29.68 (3.98)	29.64 (4.35)
		36-PtVl	31.21 (5.00)	31.08 (4.67)	30.50 (4.92)	30.90 (5.30)
Vertical	Bone	SN.PP	28.20 (6.60)	28.45 (6.39)	30.00 (4.39)	31.00 (4.45)
		SN.MP	35.53 (5.94)	36.01 (6.96)	36.80 (5.21)	38.13 (5.42)
		PP.MP	7.51 (5.40)	7.28 (4.62)	7.14 (4.73)	7.66 (4.61)
		N-Me	115.44 (8.86)	*116.86 (9.71)	117.24 (6.30)	*118.77 (6.12)
		N-ANS	50.94 (3.32)	*52.00 (3.67)	51.49 (2.82)	51.74 (3,.08)
		S-PNS	43.58 (4.20)	*43.99 (4.31)	43.23 (4.64)	43.32 (4.67)
		ANS-Me	65.41 (6.91)	*66.11 (7,22)	67.29 (5.24)	*68.81 (5.17)
	Dental	16-PP	17.77 (3.09)	17.47 (2,85)	19.44 (1.23)	*19.93 (1.28)
		26-PP	17.85 (3.58)	17.49 (2,89)	19.05 (1.34)	$*19.52 (1.17)
		46-MP	27.06 (4.11)	27.03 (4,14)	28.38 (2.28)	28.36 (2.22)
		36-MP	26.24 (3.45)	26.48 (3,90)	28.17 (2.68)	28.19 (2.85)

*The initial time differed in the same condition of the stage ($p \leq 0,05$); $Differed from Stage D in the same condition of time ($p \leq 0.05$).

Analyses were performed with use of R software (R Foundation for Statistical Computing, Vienna, Austria), with a level of significance of 5%.

RESULTS

All the volunteers included in this study had median palatal suture opening, confirmed after axial evaluation in T_1.

In Table 1, the results of the measurements in the initial and final time intervals are presented, for Stages E and D of palatal suture fusion. Anteroposterior and vertical changes occurred in T_1 for each group, however, between the stages, no statistically significant differences occurred, except for the increase in the variable 26-PP, in Group E ($p<0.05$). For the angular bone variables SNA, SN.PP, PP.MP, and linear dental variables 41-APog, 31-APog, 46-MP,36-MP, 46-PtVr and 36-PtVl there were no significant differences between the two groups and the two time intervals ($p>0.05$), demonstrating that no important displacements occurred in the vertical direction and in the relationship between the maxilla and mandible; moreover, there was no backward movement or extrusion of mandibular teeth. In both groups, the linear bone variables underwent statistically significant changes in T_1, and these were greater in Group E. Pog-Nperp was shown to be reduced, while A-Nperp, N-Me and ANS-Me increased, indicating that the maxilla moved forward and the mandible moved backwards and downwards, thus increasing the anterior facial height ($p<0.05$). In the same way as in the maxilla, the linear anterior posterior measurements of the maxillary central incisors, 11-APog and 21-APog were increased, however, only the latter showed statistical significance. The values of 41.APog and 31.Apog diminished, although only the former was statistically significant in the two groups, demonstrating retroinclination of the mandibular central incisors. In Group D, there was difference between the time intervals for the variables 26-PtVl, with reduction in T_1 ($p<0.05$), and for its homologous tooth 16-PtVr as well, but the latter was not statistically significant, indicating a backward movement of the maxillary first molars. However, the variables N-ANS and S-PNS showed significant increase in the measurements in T_1, demonstrating that the whole maxilla had undergone a downward displacement ($p<0.05$). In Group E, the variables SNB and 31.APog showed statistically significant reduction in T_1 ($p<0.05$), indicating that there was mandibular reconstruction and retroinclination of the mandibular central incisors since Pog-Nperp and 41.APog also diminished. Whereas statistically significant increase was observed in the measurements in T_1 ($p<0.05$) for the variable 11.APog, 21.Apog, 11-APog, demonstrating vestibular inclination and protrusion of the maxillary central incisors together with the maxillary central incisors together with the maxilla since 21-Apog also increased. The measurements of 16-PP (mm) and 26-PP (mm) increased, only in this group, indicating vertical extrusive displacement of the maxillary first molars.

DISCUSSION

The analyses made by CBCT showed greater definition of the measurements of which the marked points were superimposed by other anatomic structures (16). Therefore, with the evolution of programs for performing 3D cephalometric measurements (23), added the skill of a trained, experienced examiner, the findings in the analyses of this study were able to show a high rate of precision and reliability. The immediate analysis at the end of this stage of treatment was important because at this time interval, the possible differences in displacements resulting from RME with MARPE or conventional expansion could be observed. Measurements performed after the 6 months of splinting, were able to show changes with trends towards returning to the pre-treatment measurements (13,27,6). The final stages of palatal suture fusion (D and E) found in the volunteers of this study, who had a mean age of 24.8 years, was in agreement with the findings of the study of Angelieri et al. (4), which reported that there was a trend towards higher prevalence of these stages as from 18 years of age. Therefore, the MARPE technique was well indicated considering the risks of failure in opening the palatine suture and the significant side effects with conventional RME in young adults (7, 10, 11, 18),and as the less invasive and less expensive option to surgically assisted expansion(6). The success of RME with MARPE in the volunteers of this study, classified into stages D and E; that is, with almost or totally complete fusion of the midpalatal suture, confirmed the feasibility of non surgical orthopedic expansion treatment in cases that were previously contraindicated by Angelieri et al. (28). This success could be achieved due to the association with cortico-puncture, which could have reduced the resistance of the suture to expansion (21).

There were anteroposterior and vertical changes in T_1 with the use of MARPE in both groups, however, no statistically significant differences occurred between them, except for increase in the 26-PP in Group E. Therefore, the hypothesis of this study that the effects would not differ between the levels of maturation of the suture was rejected, only for this measurement. The same measurement for the homologous tooth (16-PP) was also higher in T_1 in Group E, although its difference from Group D was not statistically significant. Therefore, the vertical behavior of the maxillary first molars was observed to have a tendency towards extrusion. This resulted from the forces applied by the appliance that was connected to these teeth, in spite of the skeletal anchorage provided by the mini-implants, because opening of the palatal suture was more difficult due to the more consolidated stage of fusion. This situation was contrary to those in cases reported by Canan and Şenişik(27), in which intrusion occurred in the molars, however, the age-range was composed of adolescents of approximately 13 years of age, whose palatal sutures were probably not yet fused. In Group D, the downward displacement in block of the maxilla was statistically significant; since there was an increase in the set of linear bone variables N-ANS and S-PNS, confirmed by the angular bone measurement SN.PP that had undergone no important change. This movement of the maxilla is inherent to successful expansion of the sutures in RME, and in this group, the influence on increase in the anterior inferior facial height (ANS-Me) was greater. This consequence of maxillary displacement has been observed in both studies with conventional RME (29) and in MARPE (18).

In Group E there was statistically significant retrusion of the mandible with retroinclination of the mandibular central incisors, and inversely, protrusion of the maxilla with vestibular inclination of the maxillary central incisors. In addition, there was vertical displacement of the maxillary first molars, exhibiting a trend towards increase in the anterior facial height, and this vertical change was directly influenced by extrusion of these teeth in this Group. These tooth movements were also obtained in patients treated by Lin et al. (10) and Kurt et al. (3) with conventional expanders on conclusion of adolescence. This indicated that extrusion of the teeth that provided anchorage of the expander appliance was more significant in cases in which there was greater difficulty with opening the midpalatal suture. This was due either because they had no bone anchorage, as occurred with the conventional expanders, or because the treatment was performed on fused sutures, even with expanders anchored in bone, as was observed in this study. In both Groups D and E, there was anterior displacement of the maxilla (A-Nperp), and posterior displacement of the mandible (Pog-Nperp) in addition to a statistically significant increase in inferior anterior (ANS-Me) and total (N-Me) facial height, in agreement with the results of previous studies with MARPE (30, 18). The vertical changes in the present study could also have been related to the temporary change in occlusion of the molars since the treatment was performed until there was transverse overcorrection with the cusps of the maxillary in contact with those of the mandibular molars, in the same way as was performed by Cantarellaet al.(17). However, in the present study, the anteroposterior and vertical changes were hardly clinically evident, in the same way as was observed in the study of Park et al. (30). Within the anteroposterior changes, the largest angular difference was 1.50º (21.Apog) and linear of 0.90mm (26-PtVl). Whereas in the vertical angular changes the difference was 1.33º (SN.MP) and linear of 1.53 mm (N-Me). Therefore, these alterations were lower than those considered minimal linear values (2 to 3 mm for vertical and 1 mm for anteroposterior changes) by Lagravère et al. (31) and angular (1.50º) changes by Lineberger et al. (32). According to the results obtained in this study, it is clinically important to emphasize that the anteroposterior and vertical dentoskeletal changes resulting from the use of MARPE do not produce adverse effects on the patients. Therefore, in the cases of dolicofacial and Class II adults, they would have no contraindications to being treated with MARPE, in agreement with the presuppositions of previous studies with MARPE, established by both evaluations with finite elements (33, 34) and with patients (17).

CONCLUSION

The findings of the present study suggested that the treatment with MARPE generated the effects inherent to RME, exhibiting a trend towards the extrusion of molars banded to the appliance, according to the stage of complete fusion of the midpalatal suture, however, without leading to a significant clinical repercussion of vertical increase or posterior displacement of the mandible in patients in the final stages of fusion of the palatal suture.

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