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FACULDADE DE MEDICINA DENTÁRIA
UNIVERSIDADE DO PORTO

DENTOALVEOLAR AND SKELETAL EFFECTS ON BONE BORNE MARPE VS HYBRID MARPE APPLIANCES

A THREE DIMENSIONAL RETROSPECTIVE COMPARATIVE STUDY

CAROLINA PACHECO VEIGA DIAS DA SILVA

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“Sê todo em cada coisa. Põe quanto és
No mínimo que fazes”

Ricardo Reis, *in* “Odes”
Heterónimo de Fernando Pessoa

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A todos, serei para sempre agradecida.

Abstract

Introduction: The most common way to correct the maxillary transverse deficiency is through Rapid Palatal Expansion. However, due to the bone maturation of the midpalatal suture, the use of this device becomes impracticable.
Miniscrew Assisted Rapid Palatal Expansion (MARPE), aims to provide maxillary expansion through the opening of the suture using four screws placed in the hard palate. During the years that this treatment is being performed, several MARPE devices have been used in orthodontics, such as the bone borne and the hybrid appliances.

Objective: The aim of this study is to determine whether there are statistically significant differences between hybrid MARPE and bone borne MARPE appliances concerning dentoalveolar and skeletal effects.

Methodology: The sample consisted of eight patients with maxillary transverse deficiency, who underwent treatment with MARPE. Four of the patients were treated with a hybrid appliance (G1), and the other four with a bone borne appliance (G2). Cone Beam Computer Tomography (CBCT) data acquired before (T0) and after (T1) treatment was compared using predetermined skeletal and dentoalveolar points.

Results: There were no statistically significant differences between the two groups in any of the evaluated distances and angles. Comparison between T0 and T1 showed an increase in the average values of all distances in both groups, with significant differences ($p < 0.05$) or close to statistical significance ($0.05 \leq p < 0.10$) in almost all distances, with exception for the N, J and IM parameters, in G2. Comparisons between T0 and T1 showed that, regarding the angles, there were only statistically significant differences in A°TR, both in G1 ($p = 0.025$) and in G2 ($p = 0.012$).

Conclusion: Skeletal and dentoalveolar measurements obtained before and after a bone borne MARPE appliance or a hybrid MARPE appliance in adults and young adults do not differ significantly. Therefore, the null hypothesis was confirmed.

KEYWORDS: “MARPE”, “Bone Borne”, “Maxillary transverse deficiency”, “Miniscrew-assisted rapid palatal expansion”, “SARPE”, “Midpalatal Suture”, “BAME”.

Resumo

Introdução: A forma mais comum de corrigir o défice transversal é através da expansão rápida do maxilar. No entanto, devido à maturação óssea da sutura palatina mediana, este tratamento torna-se inviável.
O "*Miniscrew Assisted Rapid Palatal Expansion*" (MARPE) visa a expansão maxilar pela abertura da sutura palatina mediana recorrendo a quatro mini-implantes colocados no palato duro. Desde que esta abordagem tem vindo a ser utilizada em ortodontia, vários dispositivos têm sido descritos, como os dento-ósteo-suportados e os ósteo-suportados.

Objetivo: O objetivo deste trabalho é determinar se existem diferenças estatisticamente significativas entre os dispositivos de MARPE dento-ósteo-suportados e ósteo-suportados em relação aos efeitos dentoalveolares e esqueléticos.

Metodologia: A amostra foi constituída por oito pacientes com défice transversal do maxilar, que foram submetidos ao tratamento de MARPE. Quatro destes foram sujeitos ao dispositivo dento-ósteo-suportado (G1), e os outros quatro ao aparelho ósteo-suportado (G2). Os dados de Tomografia Computadorizada de Feixe Cónico (TCFC) adquiridos antes (T0) e após (T1) os tratamentos foram comparados utilizando pontos esqueléticos e dentoalveolares.

Resultados: Não houve diferenças estatisticamente significativas entre os dois grupos em nenhuma das distâncias e ângulos avaliados. A comparação entre T0 e T1 mostrou um aumento nos valores médios de todas as distâncias em ambos os grupos, com diferenças significativas ($p < 0.05$) ou perto da significância estatística ($0,05 \leq p < 0,10$) em quase todas as distâncias, com exceção dos parâmetros "N", "J" e "IM", em G2. Comparações entre T0 e T1 mostram que, em relação aos ângulos, houve apenas diferenças estatisticamente significativas no ângulo "A°TR", tanto no G1 ($p = 0.025$) quanto no G2 ($p = 0.012$).

Conclusão: As medidas esqueléticas e dentoalveolares obtidas antes e depois de um aparelho MARPE ósteo-suportado ou um aparelho MARPE híbrido em adultos e jovens adultos não diferem significativamente. Deste modo, a hipótese nula foi confirmada.

PALAVRAS - CHAVE: "MARPE", "Défice Transversal da Maxila", "*Miniscrew-assisted rapid palatal expansion*", "SARPE", "Sutura Palatina Mediana", "BAME".

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List of Terms and Acronyms

RPE	Rapid Palatal Expansion
SARPE	Surgically Assisted Rapid Palatal Expansion
MARPE	Miniscrew Assisted Rapid Palatal Expansion
CBCT	Cone Beam Computed Tomography
BAME	Bone Anchored Maxillary Expansion
3D	Three Dimensional
PRO	Professional
CT	Computed Tomography
2D	Two Dimensional
FOV	Field of View
mm	Millimeters
IEC	International Electrotechnical Commission
kV	Kilovolts
mA	Milliamps
HU	Hounsfield
kJ	Kilojoules
AI	Aluminum
CMOS	Complementary Metal Oxide Semiconductor
µm	Micrometer
HxW	Height versus Width
DICOM	Digital Imaging and Communications in Medicine
IBM	International Business Machines
SPSS	Statistical Package for the Social Sciences
SD	Standard deviation
p	Significance value of statistical tests
MSE	Maxillary Skeletal Expander

INTRODUCTION

1. Introduction

The relationship between maxilla and mandible is of particular importance, being determinant for the muscular, occlusal and dental balance of each individual. Insufficient maxillary-mandibular relationship in the transverse plane is a relatively common situation for orthodontists and has several clinical implications. The selection of the most appropriate treatment depends on the grade of correction that is required, the difference between skeletal and/or dentoalveolar changes and the effectiveness of the treatment in relation to the patient's age at the time of the procedure. These considerations should be carefully considered when planning each treatment.

Maxillary transverse deficiency is an occlusal discrepancy in the transverse plane commonly diagnosed as an isolated problem or as part of a complex dentofacial deformity. Its prevalence is 8% to 23% in the deciduous and mixed dentitions and less than 10% in adult orthodontic patients [(1)]. The diagnosis of maxillary transverse deficiency can be exigent since there are minimal soft tissue changes associated with it and the discrepancy is easily masked by other skeletal or dental discrepancies [(2)]. It can manifest clinically as unilateral or bilateral cross bite, crowding, narrow nasal cavity and arch length discrepancy [(3-5)].

In the treatment of maxillary transverse deficiency, especially among adolescents, orthopedic expansion of the maxilla holds an important place [(3)]. This typically follows the protocol of Rapid Palatal Expansion (RPE), where the two maxillary bones are separated by a rapid transverse force at the midpalatal suture, followed by skeletal orthopedic expansion [(1, 6, 7)]. This technique has been applied for over a century in orthodontics, and its beneficial outcomes have been extensively documented and described [(8-11)]. However, age is considered to be a significant factor in rapid palatal expansion, as structures show greater resistance to expansion with time, leading to unwanted effects such as alveolar bone dehiscence, buccal crown tipping, root resorption, reduction in buccal bone thickness, marginal bone loss [(6)] and often a downward and backward rotation of the mandible [(4, 12, 13)]. Therefore, the optimal age for this treatment would be under 13 to 15 years of age, when growth at the midpalatal suture would have ceased [(14)].

To overcome the increased resistance to expansion caused by the ossification of the structures, a different treatment modality was introduced by Brown in 1938 [13, 15]. Surgically assisted rapid palatal expansion (SARPE) is a surgical technique developed to correct transverse discrepancies in skeletally mature patients. It is generally performed early in the treatment, after orthodontic decompensation of the two arches has occurred [16]. Although the results this technique offers are the intended, SARPE has several limitations, including high cost, a complex treatment process, and that most patients are reluctant to undergo this surgical procedure [6].

In recent years, miniscrew assisted rapid palatal expansion (MARPE) has been developed to avoid unwanted dental effects and achieve noninvasive pure skeletal results [17], providing a new alternative treatment modality to clinicians and patients with maxillary transverse deficiency [13] and advanced stages of skeletal maturation. This technique features a rigid element that connects to four screws inserted into the para-midsagittal area, with bicortical engagement [7, 18, 19]. The incorporation of screws aims to ensure a more effective force transmission directly to the basal bone maximizing the skeletal effect and allows to anchor the device to a more robust bone structure increasing primary stability and keeping hemimaxyls separated during the consolidation period. Under the name MARPE, several devices exist with differences in anchor location, size and number of the screws, expansion screw position, activation protocols, along with others, offering different results. Even so, disadvantages include maintaining the appliance clean, as well as the area around it, the invasiveness of the screws, and the increased risk of infection.

The aim of the present study was to evaluate the following null hypothesis: short-term skeletal and dentoalveolar measurements obtained before and after a bone borne MARPE appliance or a hybrid MARPE appliance in adults and young adults do not differ significantly. To test the hypothesis, CBCT data acquired before and after the treatments was compared using skeletal and dentoalveolar points.

MATERIALS AND METHODS

2. Materials and Methods

2.1. Type of study

This is a three dimensional retrospective comparative study.

2.2. Period of the study

The present study was made between January 2020 and May 2020.

2.3. Bibliographic research method

For the methodology on behalf of the bibliographic research it was used the data base Medline (PubMed), Google Scholar and Scopus.

The keywords used were: “MARPE”, “Bone Borne”, “Maxillary transverse deficiency”, “Miniscrew-assisted rapid palatal expansion”, “SARPE”, “Midpalatal Suture”, “BAME”.

There were no exclusion criteria concerning the bibliographic research. All of the articles found with the keywords mentioned before were eligible to be used.

2.4. Ethical considerations

This study was approved by the Ethics Committee of “*Faculdade de Medicina Dentária da Universidade do Porto*” (Attachment 7.1.).

Throughout the investigation process, the patient's anonymity was maintained and a numeric code was assigned to each one of them. This prevented access, disclosure or involvement of third parties to the personal data of the patients. The procedure of assigning the numeric code was made by the person responsible for the patient's information, and it was only provided to the main investigator when in anonymity.

The investigation did not add any risk or discomfort to the patient. All necessary exams to the study, such as Cone Beam Computed Tomography (CBCT), were previously executed by the dentist in context of orthodontic treatment. No financial costs were added to perform any exams or procedures for the purpose of the investigation.

2.5. Subjects

This retrospective study included eight patients, with ages between 16.2-38.7 years, all at stage D or E of Angelieri et al. [20], that at the time of this study had already completed orthodontic treatment in a private practice. All selected patients had maxillary transverse deficiency. The patients were divided into two groups, depending on the appliance that was used.

Table I. Distribution of patients by groups, according to the appliance used.

	Group 1 *(Hybrid MARPE)*	*Group 2* *(Bone Borne MARPE)*
Age, y	21.7 ± 5.3	24.2 ± 9.9
Sex	2 male, 2 female	2 male, 2 female

2.6. Eligibility criteria

2.6.1 Inclusion criteria

The inclusion criteria were the following: stage D or E of Angelieri et al. [20]; maxillary transverse deficiency; permanent dentition; availability of CBCT images acquired before MARPE (T0) and after MARPE (T1); and the cases were chosen in a consecutive order.

2.6.2. Exclusion criteria

The exclusion criteria were the following: previous orthodontic treatment; previous extractions; trauma; systemic diseases that influence cranial maturation; craniofacial syndromes; and more than 1mm of gingival retraction before the treatment.

2.7. Cone Beam Computer Tomography (CBCT)

2.7.1. CBCT Images

Pretreatment and post treatment CBCT images were obtained by using the ORTHOPANTOMOGRAPH™ OP 3D Pro, by KaVo™[1]. This CT scanner offers the ability to include 2D / 3D Combo upgradeable with Cephalometry. Other advantages of this technological tool are the very low radiation doses it emits with Low Dose Technology™, the flexibility with 5 volume sizes up to FOV 13 x Ø 15 cm* and 4 resolutions, and the ability to compensate for incorrect patient positioning and difficult anatomies with a multilayer feature providing 5 panoramic images with only one scan. In Table II it is possible to analyze the technical specifications of the previous mentioned scan.

[1] ORTHOPANTOMOGRAPH™ OP 3D Pro, released in 2017 by KaVo™

Figure 1. ORTHOPANTOMOGRAPH™ OP 3D Pro.

Table II. Technical Specifications of the ORTHOPANTOMOGRAPH™ OP 3D Pro.

Technical Specification	
Focal Spot	0.5mm, IEC 336
Tube Voltage	57 – 90 kV
Tube Current	3.2 – 16 mA
HU Capacity	35 kJ, 49 000 HU
Minimum Total Filtration	3.2 mm Al
3D Large Panel	
Image Detector	CMOS
Image Voxel Size	85 – 420 µm
Scan Time	11 – 42 seconds
Exposure Time	1.2 – 8.7 seconds
Image Volume Sizes (HxW)	130x150 mm
DICOM Support	Yes
Min. room height	2050 – 2450 mm

2.7.2. CBCT Data Orientation

The CBCT 3D model was reconstructed in the DTX Studio Implant™ Software. Later, reference planes and points were established to adjust the 3D model.

Table III. Reference points and reference planes for CBCT Data orientation.

	Reference Points
Porion (Po)	Most superior and lateral point of the external auditory meatus
Orbital (Or)	Most inferior point of the inferior margin of the orbit
	Reference Planes
Frankfurt Plane (FH)	Horizontal plane passing through the right Po and the right Or
Infraorbital Plane (IO)	Plane passing through the orbital point of each orbits

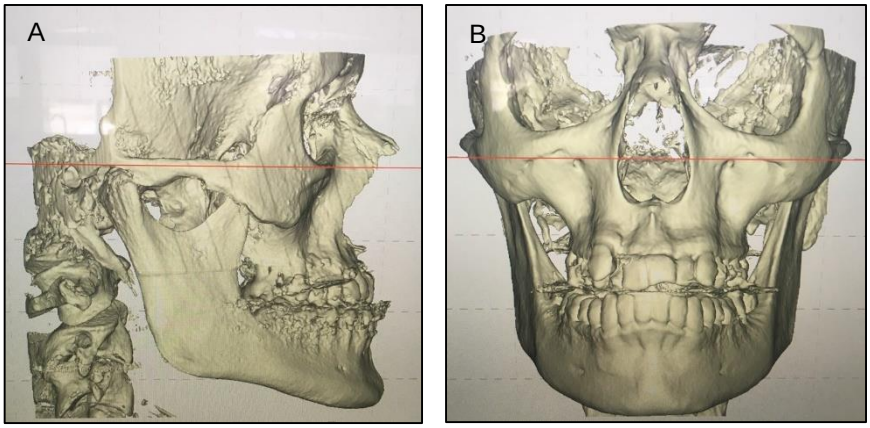

Figure 2. CBCT Data orientation according to the reference planes. A – Frankfurt Plane; B – Infraorbital Plane.

2.7.3. CBCT Measurements

All measurements were performed by the main investigator in the DTX Studio Implant™ Software. To assess the error, they were repeated 1 week later, following the same protocol.

2.8. Measurements

In order to determinate the skeletal and dentoalveolar changes with the different appliances, CBCT measurements were made in specific points. These points are illustrated in Table IV.

Table IV. Measured points in the CBCTs.

Points		*Description*
Skeletal points	*N¹*	Most lateral point of the right side of the nasal cavity
	N²	Most lateral point of the left side of the nasal cavity
	J¹	Right junction in the middle of the maxillary tuberosity outline and the zygomatic process
	J²	Left junction in the middle of the maxillary tuberosity outline and the zygomatic process
	ANS	Anterior Nasal Spine
	ANS¹	Right side of the anterior nasal spine
	ANS²	Left side of the anterior nasal spine
	PNS	Posterior Nasal Spine
	PNS¹	Right side of the posterior nasal spine
	PNS²	Left side of the posterior nasal spine
Dental points	*II¹*	Most mesial point of the cemento-enamel junction of the maxillary right central incisor
	II²	Most mesial point of the cemento-enamel junction of the maxillary left central incisor
	IM¹	Mesiobuccal cusp tip of the right first upper molar
	IM²	Mesiobuccal cusp tip of the left first upper molar
	IPM¹	Buccal cusp tip of the right first upper pre molar
	IPM²	Buccal cusp tip of the left first upper pre molar
	IA¹	Buccal root apex of the right first upper molar
	IA²	Buccal root apex of the left first upper molar
Screw´s points	*SH*	Centre of the screw's head
	ST	Screw's tip
	T	Torsion point of the screw
	P1	Centre of the anterior right screw
	P2	Centre of the anterior left screw
	P3	Centre of the posterior right screw
	P4	Centre of the posterior left screw

Table V. Reference planes for the measurements in the CBCTs.

Reference Planes	*Description*
Frankfurt Plane (FH)	Horizontal plane passing through Po and Or
Mid-sagittal Plane	Perpendicular to FH, passing through ANS and PNS
Coronal Plane	Perpendicular to the FH and the sagittal plane
AR	Plane passing through the cusp and the apex of the mesiobucal root of the right first molar
AL	Plane passing through the cusp and the apex of the mesiobucal root of the left first molar
HP	Horizontal plane
SP	Plane passing through “SH” and “ST”
TP	Plane passing through “ST” and “T”

2.8.1. Skeletal Linear Measurements

The “N” parameter is the distance between “N¹” and “N²”, initially described by Park et al.[6]. These represent the most lateral points of the nasal cavity in the coronal plane, established between the Anterior Nasal Spine and the maxillary sinus [6].

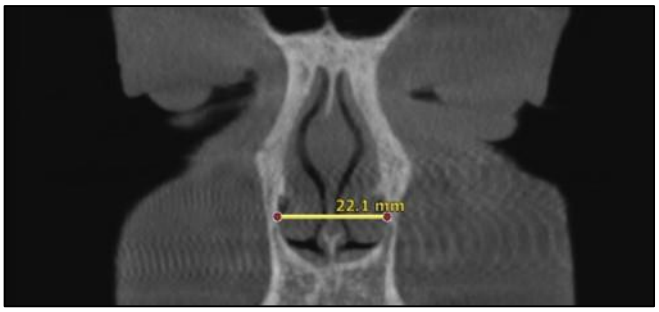

Figure 3. “N” parameter: CBCT image in the coronal plane.

The “J” landmark is an adaptation of Park et al.[6] and represents the distance between points “J¹” and “J²” in the coronal plane. They indicate the right and left junction in the middle of the maxillary tuberosity outline and the zygomatic process.

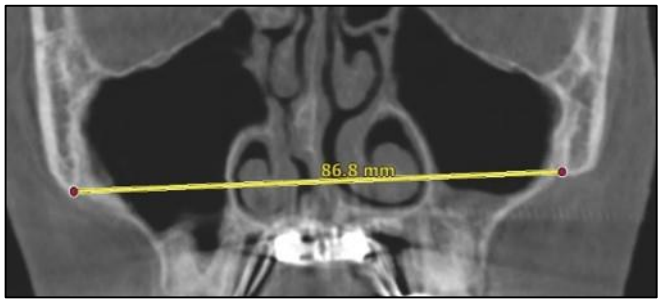

Figure 4. "J" parameter: CBCT image in the coronal plane.

The "ANS¹" and "ANS²" points represent the Anterior Nasal Spine and the "PNS¹" and "PNS²" points the Posterior Nasal Spine. The "WANS" and "WPNS" parameters are the distance of "ANS¹" to "ANS²" and "PNS¹" to "PNS²", respectively, in the axial plane.

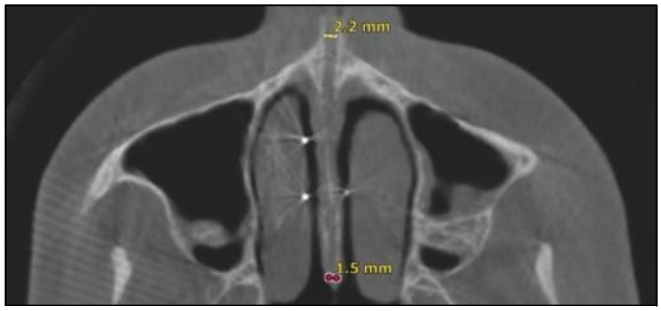

Figure 5. "WANS" and "WPNS" parameters: CBCT image in the axial plane.

2.8.2. Dental Linear Measurements

The "II" parameter is an adaptation of the "C6" parameter described by Park et al.[6] and it is measured from "II¹" and "II²". It is the distance between the most mesial points of the cemento-enamel junction of the maxillary central incisors in a 3D image.

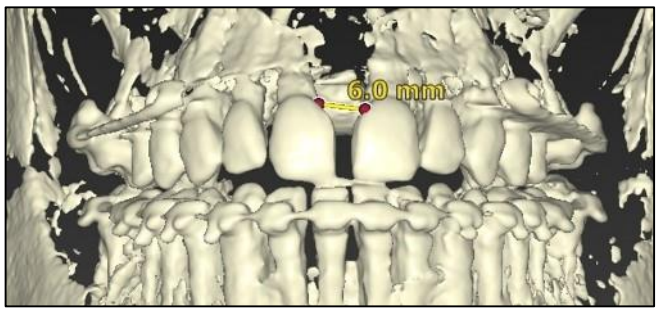

Figure 6. “II” parameter: 3D image.

The “IM”, “IPM” and “IA” landmarks were described by Lim et al.[14] and represent the distance between the right and left mesiobucal cusp tip of the first molar (from “IM¹” to “IM²”), buccal cusp tip of the first pre molar (from “IPM¹” to “IPM²”) and the mesiobuccal root apices of the first molar (from “IA¹” to “IA²”), respectively [14]. The “IM” and “IPM” parameters were measured in the axial plane whereas the “IA” parameter was in the sagittal plane, with assistance of the 3D image to do adjustments when needed.

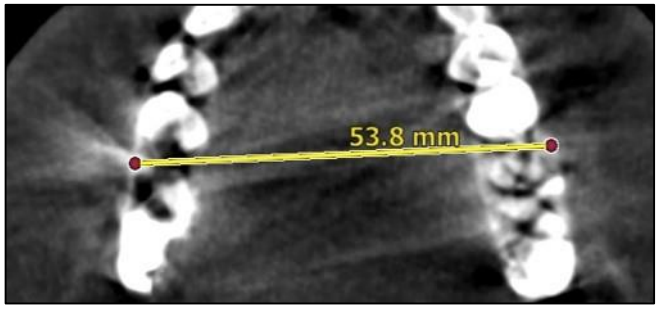

Figure 7. “IM” parameter: CBCT image in the axial plane.

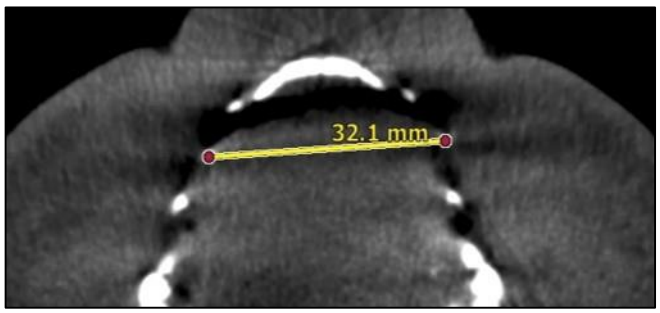

Figure 8. “IPM” parameter: CBCT image in the axial plane.

Figure 9. “IA” parameter: CBCT images in the sagittal plane.

2.8.3. Dental Angular Measurements

The angulation parameters “A°R” and “A°L” are an adaptation of the parameters described by Lim et al. in the coronal plane, and are the angle between the “AR” and “AL” planes and the horizontal plane (“HP”) [(14)].

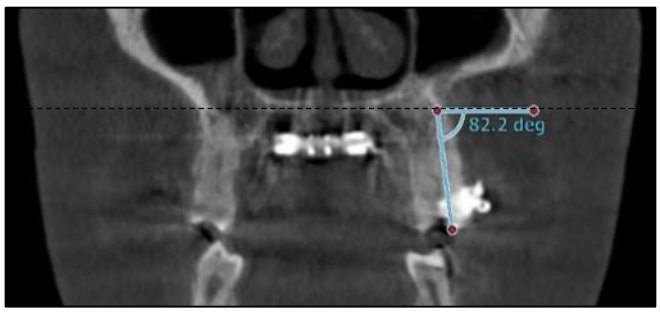

Figure 10. “A°L” parameter: CBCT image in the coronal plane.

2.8.4. Screw's Linear Measurements

The "P12" parameter is the distance between "P1" and "P2" in T0 and T1. The "P34" parameter represents the distance from "P3" and "P4" in T0 and T1. Both parameters were measured in the axial plane.

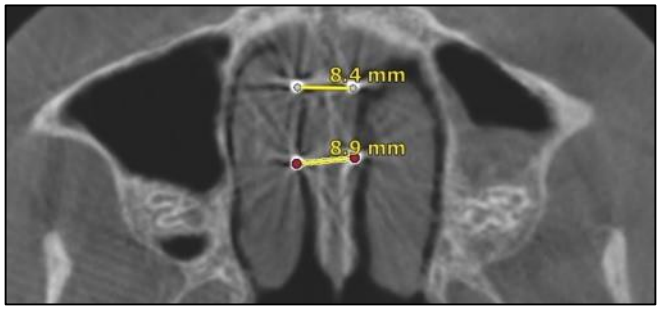

Figure 11. "P12" and "P34" parameters: CBCT image in the axial plane.

2.8.5. Screw's Angular Measurements

The "A°TR" parameter represents the inclination of the anterior right screw after the expansion in the coronal plane. It is determined by the difference of the angle between "SP" and the horizontal plane ("HP") in T0 and T1. The "A°TL" is the analog parameter for the left side.

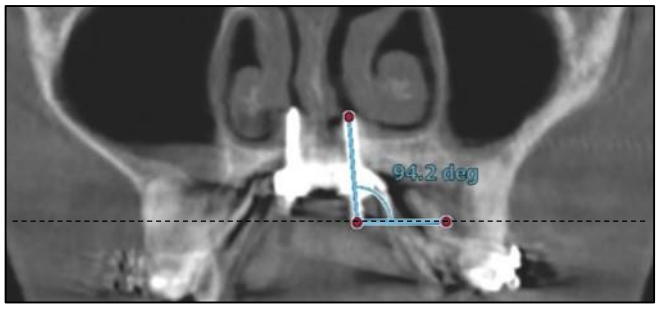

Figure 12. "A°TL" parameter: CBCT image in the coronal plane.

The “A°T” landmark determines the torsion of the screws. It is measured by the difference of angulation between “SP” in T0 and “TP” in T1, in the coronal plane. There are four "A°T" parameters depending on the screw: "A°T1" represents the anterior right screw, "A°T2" the anterior left, "A°T3" the posterior right and "A°T4" the posterior left screw.

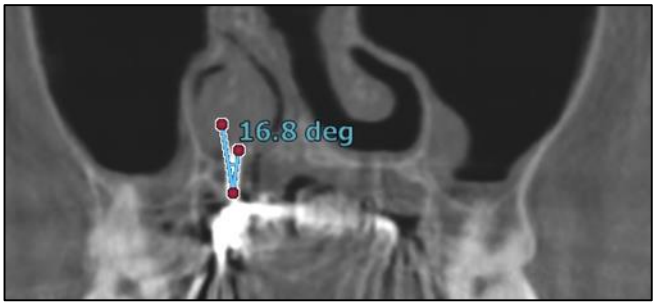

Figure 13. “A°T3” parameter: CBCT image in the coronal plane.

2.9. Statistics

Statistical analysis was performed using the IBM SPSS program, version 26 for Windows (IBM Corp. Released 2018) [21].

The variables under study were characterized by means and standard deviation.

To respond to the objectives of the study, the following statistical tests were used:

- Variables with normal distribution:
  - Student's T test for independent samples for the comparison between the 2 groups (G1 and G2);
  - Student's T test for paired samples for comparison between T0 and T1.

- Data without normal distribution:
  - Mann-Whitney test for independent samples for the comparison between the 2 groups (G1 and G2);
  - Wilcoxon test for paired samples for the comparison between T0 and T1.

The normality of the data was assessed using the Shapiro-Wilk test.

A significance level of 5% was considered, that is, the differences were considered statistically significant when the significance value was less than 0.05 ($p < 0.05$). Also highlighted were the cases in which the test results were close to statistical significance ($0.05 \leq p < 0.10$) [21].

RESULTS

3. Results

After all data was measured, it was processed. All calculations were performed according to the formulas described above and the results organized and grouped according to the group where they belong.

3.1. Sample

The sample consists of 8 patients divided into 2 groups, each with 4 patients: G1 (HYBRID MARPE) and G2 (BONE BORNE MARPE). G1 had 2 female patients and 2 male patients and mean age at T0 of 21.7 years (SD = 5.3). The G2 was also composed of 2 female and 2 male patients and the mean age at T0 was 24.2 years (9.9). The average treatment time (difference between T1 and T0) was 44.5 days (SD = 30.5) in G1 and 67.3 days (SD = 32.6) in G2 (Table VI).

Table VI. Characterization of the 2 groups regarding age, treatment time and sex (N = 49).

	G1 – HYBRID MARPE (n = 4)		**G2 – BONE BORNE MARPE (n = 4)**	
	Mean	***SD***	***Mean***	***SD***
Age in T0 (years)	21.7	5.3	24.2	9.9
T1-T0 (days)	44.5	30.5	67.3	32.6
Sex (M:F)	2:2		2:2	

3.2. Characterization and comparison of distances

Table VII and figures 14 and 15 show the results of the characterization of the distances (in mm) and the comparison between groups (in T0 and T1) and between T0 and T1, within each group.

There were no statistically significant differences between the two groups in any of the evaluated distances, neither in T0, nor in T1, nor in the differences between T0 and T1 ($p > 0.05$).

The comparison between T0 and T1 showed an increase in the average values of all distances in both groups, with significant differences ($p < 0.05$) or close to statistical significance ($0.05 \leq p < 0.10$) in almost all distances. The only exceptions were the distances N ($p = 0.618$), J ($p = 0.306$) and IM ($p = 0.106$) in G2.

Table VII. Characterization and comparison of distances (in mm) between groups and between T0 and T1.

		T0			*T1*			*T1-T0*			
	Group	***Mean***	***SD***	***p(1)***	***Mean***	***SD***	***p(1)***	***Mean***	***SD***	***p(1)***	***p(2)***
N	G1	21.58	1.22	0.485	23.35	1.26	0.848	+1.78	0.22	0.140	**0.001**
	G2	22.57	2.28		23.20	0.80		+0.50	1.48		0.618
J	G1	78.83	3.93	0.403	81.78	3.84	0.342	+2.95	0.53	0.383	**0.002**
	G2	82.03	5.45		84.18	2.62		+1.83	2.33		0.306
WANS	G1	0.00	0.00	-	2.23	0.53	0.451	+2.23	0.53	0.451	**0.004**
	G2	0.00	0.00		3.13	2.17		+3.13	2.17		0.064
WPNS	G1	0.00	0.00	-	1.55	0.33	0.745	+1.55	0.33	0.745	**0.003**
	G2	0.00	0.00		1.78	1.28		+1.78	1.28		0.070
IM	G1	46.53	1.37	0.182	50.80	1.54	0.457	+4.28	0.67	0.937	**0.001**
	G2	49.35	3.49		53.48	6.56		+4.13	3.60		0.106
IPM	G1	36.70	1.53	0.501	40.10	2.19	0.753	+3.40	2.07	0.612	**0.046**
	G2	38.43	4.57		41.13	5.82		+2.70	1.61		**0.044**
IA	G1	46.08	2.81	0.451	49.00	2.55	0.443	+2.93	1.28	0.761	**0.020**
	G2	47.25	0.79		50.65	3.10		+3.40	2.69		0.086
P12	G1	8.10	3.19	0.378	12.70	3.66	0.302	+4.60	1.28	0.788	**0.006**
	G2	9.85	1.84		14.93	1.48		+5.08	3.12		**0.048**
P34	G1	8.00	3.65	0.101	13.98	5.32	0.148	+5.98	1.94	0.709	**0.009**
	G2	11.95	1.84		18.75	2.19		+6.80	3.74		**0.036**
II	G1	2.00	0.23	0.113	4.70	2.00	0.713	+2.70	2.21	0.987	0.092
	G2	2.48	0.46		5.20	1.64		+2.73	1.93		0.066

G1 – HYBRID MARPE (n = 4); G2 – BONE BORNE MARPE (n = 4);

(1) comparison between groups; (2) comparison between T0 e T1 within each group.

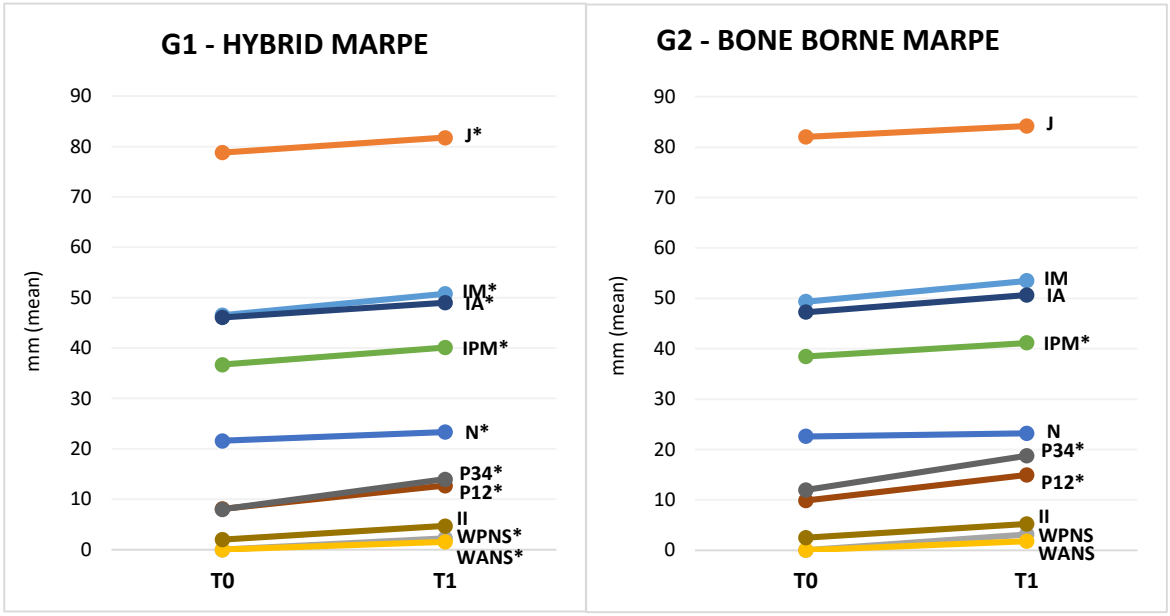

Figure 14. Mean of distances in T0 and T1, in G1 – hybrid MARPE and in G2 – bone borne MARPE (* p <0.05 in the comparison between T0 and T1).

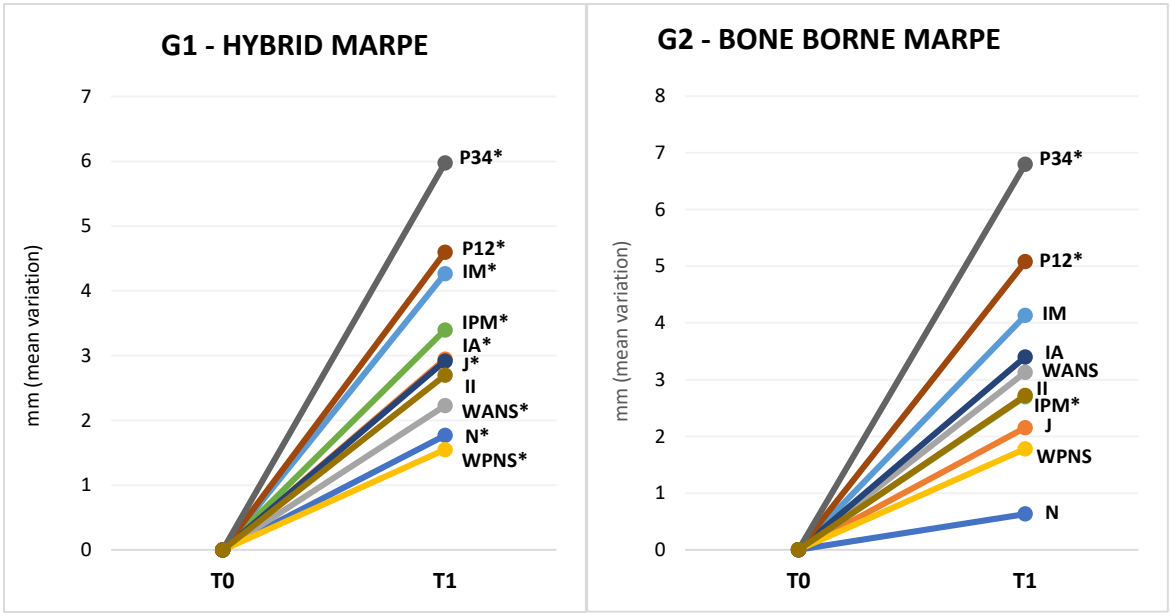

Figure 15. Variation of the means of the distances between T0 and T1, in the G1 – hybrid MARPE and in the G2 – bone borne MARPE (* p <0.05 in the comparison between T0 and T1).

3.3. Characterization and comparison of angles

Table VIII and figures 16 and 17 show the results of the characterization of the angles (in degrees) and the comparison between groups (in T0 and T1) and between T0 and T1, within each group.

There were no statistically significant differences between the two groups in any of the evaluated angles, neither in T0, nor in T1, nor in the differences between T0 and T1 ($p > 0.05$).

Comparisons between T0 and T1 show that there were only statistically significant differences in the angle A°TR, both in G1 ($p = 0.025$) and in G2 ($p = 0.012$).

Table VIII. Characterization and comparison of angles (in degrees) between groups and between T0 and T1.

		T0			*T1*			*T1-T0*			
	Grupo	***Média***	***DP***	***p(1)***	***Média***	***DP***	***p(1)***	***Média***	***DP***	***p(1)***	***p(2)***
A°R	G1	86.45	5.47	0.820	85.68	4.13	0.489	-0.78	1.90	0.199	0.474
	G2	87.58	7.70		81.95	9.24		-5.63	6.45		0.180
A°L	G1	90.13	1.74	0.370	86.18	7.89	0.929	-3.95	6.22	0.584	0.294
	G2	86.88	6.49		85.63	8.75		-1.25	6.96		0.743
A°TR	G1	84.33	3.21	0.541	95.28	4.55	0.572	+10.95	5.23	0.238	**0.025**
	G2	82.38	5.09		98.53	9.89		+16.15	5.97		**0.012**
A°TL	G1	86.48	10.83	0.985	92.50	6.60	0.894	+6.03	10.40	0.886	0.330
	G2	86.35	7.19		93.43	11.51		+7.08	9.49		0.233
A°T1	G1	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-	-
	G2	0.00	0.00		0.00	0.00		0.00	0.00		-
A°T2	G1	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-	-
	G2	0.00	0.00		0.00	0.00		0.00	0.00		-
A°T3	G1	0.00	0.00	-	3.73	7.45	0.317	+3.73	7.45	0.317	0.391
	G2	0.00	0.00		0.00	0.00		0.00	0.00		-
A°T4	G1	0.00	0.00	-	4.20	8.40	0.317	+4.20	8.40	0.317	0.391
	G2	0.00	0.00		0.00	0.00		0.00	0.00		-

G1 – HYBRID MARPE (n = 4); G2 – BONE BORNE MARPE (n = 4);
(1) comparison between groups; (2) comparison between T0 e T1 within each group.

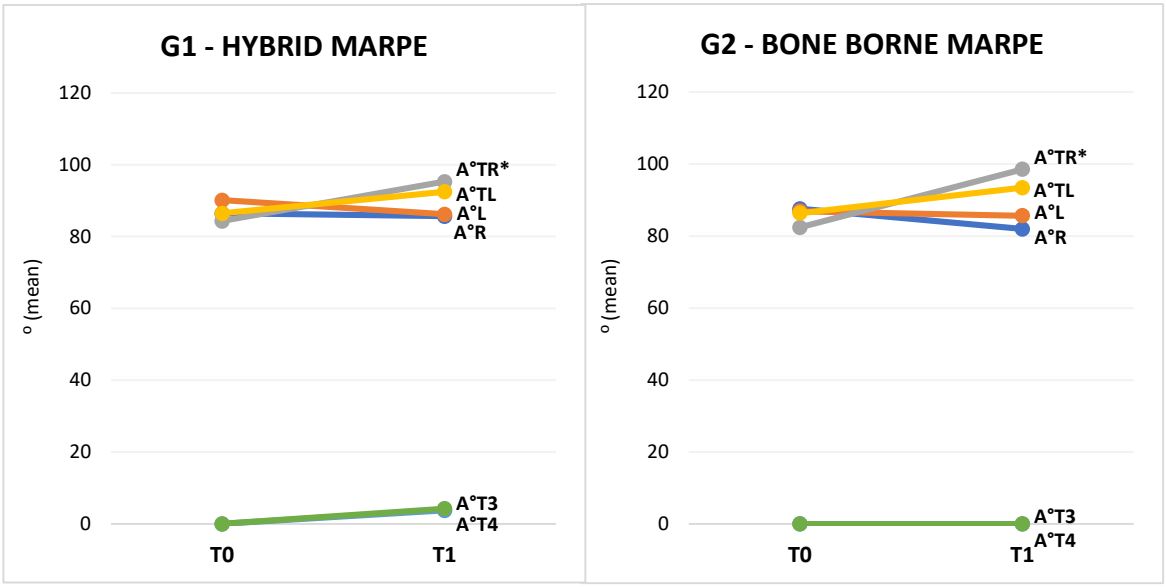

Figure 16. Mean angles in T0 and T1, in G1 – hybrid MARPE and in G2 - bone borne MARPE (* p <0.05 in the comparison between T0 and T1).

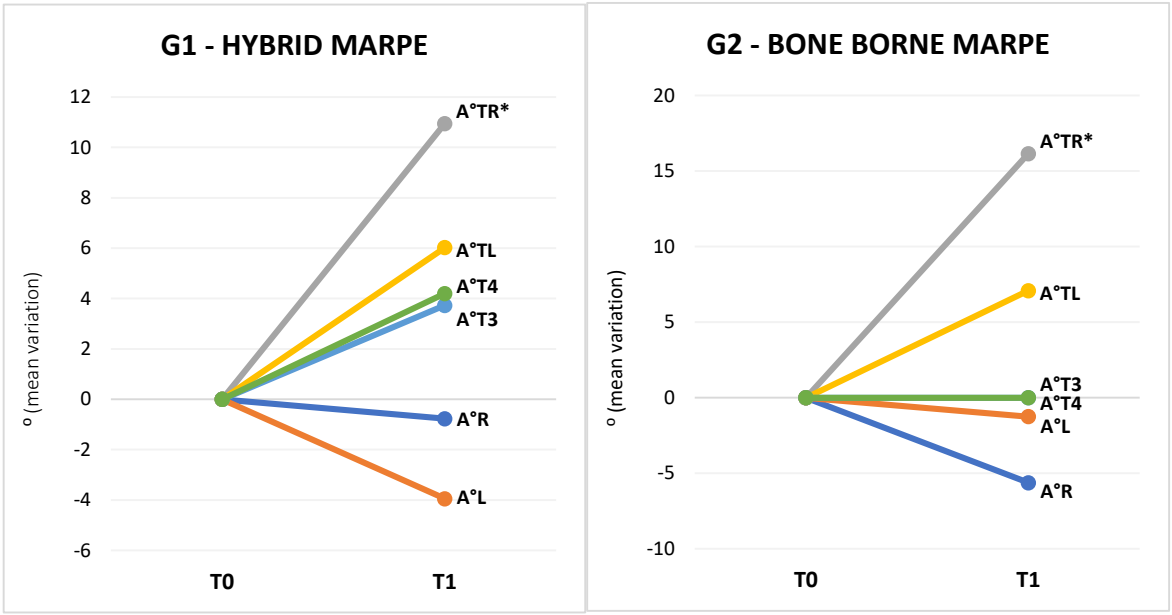

Figure 17. Variation of mean angles between T0 and T1, in G1 – hybrid MARPE and in G2 – bone borne MARPE (* p <0.05 in the comparison between T0 and T1).

DISCUSSION

4. Discussion

4.1. Subject

The present retrospective study compares clinical evidence on the potential differences of Bone Borne MARPE vs Hybrid MARPE appliances. Interest in this matter arose from the high prevalence of maxillary transverse deficiency in adults and young adults, associated with the diverse possible treatments for the indicated defect. This study includes eight patients, four of which submitted to a Bone Borne MARPE appliance and the other four to a Hybrid MARPE appliance. All patients were selected from a private practice, and had already completed treatment at the beginning of this study.

4.2. Midpalatal Suture

Treatment of maxillary transverse deficiency in adults and young adults with the conventional Rapid Palatal Expansion (RPE) becomes impossible due to the closure of the midpalatal suture. This is the suture localized in the middle of the palate joining the two maxillary bones, and its maturation classification was proposed by Angelieri et al. in a qualitative method, dividing it into five morphological stages, by observing the suture in the axial plane, in CBCT [20]. The maturation stages observed in the suture are represented in Figure 18.

Previous histological studies have proved that the midpalatal suture begins to obliterate during the juvenile phase, with a marked degree of closure observed in the third decade of life [6, 22, 23].

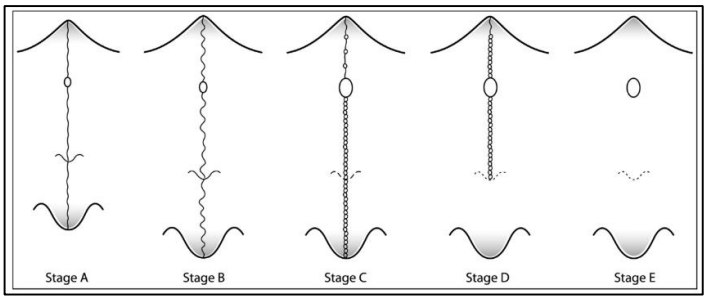

Figure 18. Maturation stages of the midpalatal suture. Adapted from Angelieri et al. Midpalatal suture maturation: classification method for individual assessment before rapid maxillary expansion. American journal of orthodontics and dentofacial orthopedics: official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics. 2013;144(5):759-69.

4.3. Miniscrew Assisted Rapid Palatal Expansion

MARPE was selected as being the treatment of choice for these patients. Initially, the most used MARPE appliances were the tooth-bone-borne ones, however these are being replaced by bone borne appliances, such as the Power Expander, as it is believed that this last one presents better skeletal results and less unwanted dental effects. This study pretends to conclude whether these appliances really present different results or not.

4.3.1. Hybrid MARPE appliance

For the first group, the hybrid MARPE group, a tooth-bone anchor appliance was used. They received a maxillary skeletal expander (MSE), developed by Moon et al. [24], with four screws inserted bicortically in the palate, allowing skeletal anchorage, and two bands for the first molars, providing dental anchorage (Figure 19-A). In the appliance's body there are four holes, 1.5 mm in diameter and 2 mm deep, named fixation rings. The fixation ring and the screw have the same diameter with the intention of minimizing unwanted lateral forces [14, 25, 26]. For the MSE, authors recommend the activation protocol described in Table IX as a reference based on a sample over 100 patients evaluated over 15 years by Brunetto et al. [25].

Table IX. Maxillary Skeletal Expander Activation Protocol.

Age	*Activation*
Beginning of adolescence	6x/week (0.80mm/week)
Final of adolescence	2x/day (0.27mm/day)
Early and mid-twenty	4-6x/day (0.53mm-0.80mm/day)
Adult	Minimal 4-6x/day
After opening the interincisive diastema	2x/day (0.27mm/day)

4.3.2. Bone Borne MARPE appliance

The subjects in the second group, the bone borne MARPE group, received a Power Expander, which consisted on a bone anchored appliance with four parallel bicortical screws, inserted 3mm from the palatine raphe (Figure 19-B). This appliance is placed with guide arms which thereafter are removed, offering a bone borne treatment. Activation protocol for this group patients is described in Table X.

Table X. Power Expander Activation Protocol.

Treatment	*Age*	*Symptomatology*	*Activation*
MARPE	16-20 years	No pain/Tolerable pain	3-4 turns/day
		Significant pain	2 turns/day
	21-25 years	No pain/Tolerable pain	3 turns/day
		Significant pain	2 turns/day
	26-30 years	No pain/Tolerable pain	2 turns/day
		Significant pain	1 turn/day
	>31 years	No pain/Tolerable pain	2 turns/day
		Significant pain	1 turn/day

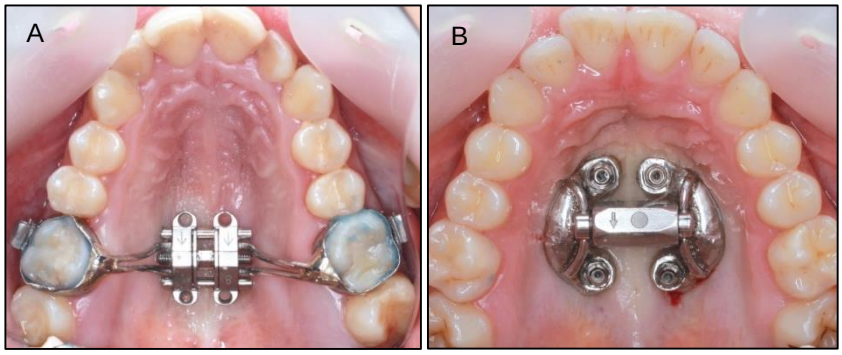

Figure 19. Two different MARPE appliances. A – Maxillary Skeletal Expander; B – Power Expander.

4.4. Statistical analysis

To perform the statistical analysis, a significance level of 5% was considered, however cases in which the test results were close to statistical significance were also contemplated ($0.05 \leq p < 0.10$). This was established due to the small number of patients submitted to this study and because of results very close to statistical significance.

4.5. Results

In this study, both groups showed similar skeletal and dentoalveolar changes, proving the two appliances to be equally successful in expanding the midpalatal suture. The Bone Borne MARPE group (G2) revealed the greatest amount of midpalatal suture opening, however when compared to G1, no statistically significant differences were found. In fact, comparison of the distance parameters between T1 and T0 within each group revealed that there were significant changes in almost all parameters, confirming that both the Hybrid appliance and the Bone Borne appliance can be used to perform this treatment successfully.

On the other hand, three parameters in G2 did not exhibit the expected results regarding the distances. No statistically significant differences were found in parameters “N”, “J” and “IM” in T1-T0. According to Lee et al., after treatment with MARPE, the nasal volume increases and the nose tends to widen and advance forward and downward [27]. Therefore, we would expect to see a significant change in the “N” parameter when comparing T1 to T0. However, due to the extreme difficulty to determine the “N^1” and “N^2” points with precision, error measurements might have occurred. A trial by Celenk-Koca et al. [28] indicates that Bone Borne MARPE is related with increased nasal cavity width at the first molar. This might be one reason why it was not identified significant changes in the “N” parameter in G2, since the measurements made in this study were at the canine.

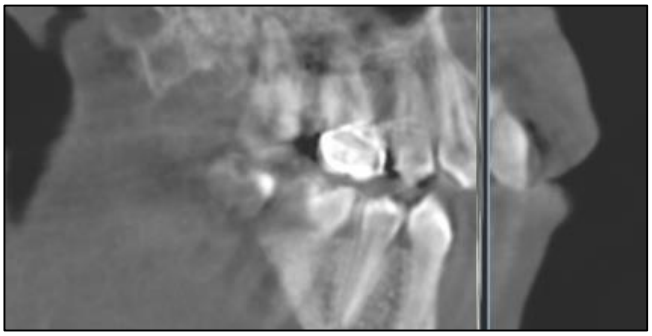

Figure 20. CBCT image of the sagittal plane, with the coronal plane placed were the “N” parameter was measured.

In regard of parameter “J”, statistically significant changes may not have been verified in G2 due to the pyramidal pattern of maxillary expansion. In other words, the maxilla undergoes its greatest expansion in the area of the palate, where the force is directly applied, and it decreases the expansion as the structures are located further away from the appliance. The hybrid MARPE group might have had a better expansion in this parameter due to forces being also transmitted through the teeth along with the bone in this appliance. However, the total expansion in G2 is almost the same as in G1. Concerning the measurements, the line that unites points “J^1” and “J^2” is not horizontal as it can be verified in Figure 4. This occurs due to the anatomy of the patient’s cranium not being symmetric. The same situation can be observed with parameters “IM” and “IPM” in Figures 7 and 8, respectively.

Concerning the “IM” parameter, no conclusions with the proper value could be taken. During the study, this proved to be a difficult parameter to measure as a consequence of the artifacts caused by the metal bands in the hybrid MARPE and due to the difficulty of accurately detecting where the correct cusp was, as a result of the quality of the CBCTs. It would be interesting to find a solution to overcome these obstacles in future studies.

A midpalatal suture opening pattern was identified during this study by analyzing parameters “WANS” and “WPNS”. Although the midpalatal suture opened anteriorly and posteriorly, it was verified that in almost all patients, both those of G1 such as the ones in G2, the suture opened more on the ANS, in a “V” shape, supporting previous studies [29-31]. However, Moon defended that if the screws were bicortically anchored in the posterior part of the palate, a more parallel expansion would have been seen [24]. According to Cantarella et al. who studied the zygomaticomaxillary modifications induced by the MSE [32], the center of rotation of the zygomaticomaxillary complex is located near the proximal portion of the zygomatic process of the temporal bone, and as the zygomaticomaxillary complex rotates outwards around the proximal portion of the zygomatic process of the temporal bone, the maxillary halves will move laterally and anteriorly [32]. In his study, he defended that the MSE could produce a parallel opening of the midpalatal suture if the screws were positioned in the posterior part of the palate, medial to the zygomatic buttress bones [32, 33], in contrast with tooth-borne expanders.

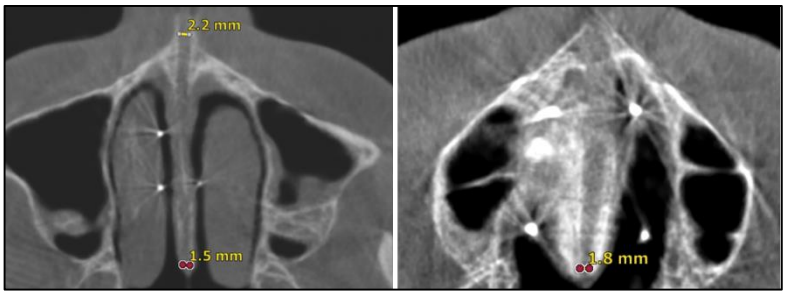

Figure 21. The “V” opening pattern of the midpalatal suture. A – MSE appliance; B – Power Expander.

Among the 8 patients submitted to this study, only one failed to open the midpalatal suture. This was due to a local inflammation of the soft tissues. There is not much evidence about the failures of MARPE and the possible reactions it can cause.

Developing a study on this matter would be useful in order to understand why, and to know how to resolve the non-successful treatments.

There were no statistically significant differences regarding tooth inclination, screw inclination or screw torsion when comparing the two groups, concluding that both appliances have minimal and identical undesired results.

Even so, it was identified small, but statistically significant changes in the “A°TR” parameter, when compared between T1 and T0, within both groups. It was found that other studies had the same result and established as possible causes the high resistance of the circummaxillary sutures of adult and young adult patients being too hard for the screws to overcome, as well as a change of the screw’s position as a consequence of the low density of the maxilla [13]. The question is why it only occurred in the right screw for the two groups. Although there is no study that justifies this event, several hypotheses were raised: initial placement of the screws being susceptible to inclination; position of the orthodontist’s hand during emplacement; the order of placement of the screws; and the force of insertion produced by the orthodontist.

Furthermore, one patient reveled slight torsion of the two posterior screws after expansion. This result is considered statistically insignificant, however it is still undesirable. To avoid deformity of the screws, they should be bicortically anchored and the force applied should not be too far from the screw/bone interface [25].

Dental tipping produced by MARPE is a theme frequently described in other studies [31]. Although it was not included in this study, it cannot be left aside when choosing the appliance to use. As a result of expansion forces being partially transmitted to the sutures through the teeth in the Hybrid appliance[31], buccal tipping becomes almost inevitable. This effect was considered to be studied in this investigation. However, due to the artifacts in the CBCT images caused by the metal of the appliances and the metal in the first molars bands, this was not attainable, and it was decided to exclude this parameter.

Concerning the periodontal repercussions, authors [34-37] defend that tooth-borne or partial tooth-borne appliances have more undesirable results than bone-borne appliances, such as decreased buccal bone and bony dehiscence, due to osteoclastic resorption as teeth move through the buccal plate [28]. On that premise, there are more factors to consider when choosing the appropriate appliance than those described in this

study. As this is a short-term study, it was not possible to analyze the periodontal effects, as these usually only occur after a long period of time.

As a consequence of the small number of subjects submitted to this study, no conclusions could be taken regarding the correlation between age and sex and the sutural opening. It would be relevant in the future to investigate, with a more significant sample, this matter and take proper conclusions.

4.6. Limitations

This retrospective study offers various limitations. First and foremost, the scarce number of subjects submitted to this study does not allow the desired value. As for the measurements, they depended entirely on the investigator's perception as well as the quality of the CBCTs, which was not always the ideal. Furthermore, one CBCT was not completed and another was not done properly, resulting in an inclined image. At last, it was planned to analyze more parameters, in particular the "C6" landmark described by Park et al. [6]. However due to the artifacts in the images caused by the metal of the appliances, this was not attainable.

CONCLUSION

5. Conclusion

This study compared the short-term skeletal and dentoalveolar effects of two different MARPE appliances by analyzing CBCT data acquired after and before treatment.

After interpreting the results, it can be concluded:

- There were no statistically significant differences between the two groups in any of the evaluated distances, neither in T0, nor in T1, nor in the differences between T1 and T0;
- The comparison between T0 and T1 showed an increase in the average values of all distances in both groups, with significant differences or close to statistical significance in almost all distances;
- There were no statistically significant differences between the two groups in any of the evaluated angles, neither in T0, nor in T1, nor in the differences between T1 and T0;
- Comparisons between T0 and T1 show that there were only statistically significant differences in the angle A°TR, both in G1 (+10.95 ± 5.23; p = 0.025) and in G2 (+16.15 ± 5.97; p = 0.012).

In conclusion, the null hypothesis was confirmed.

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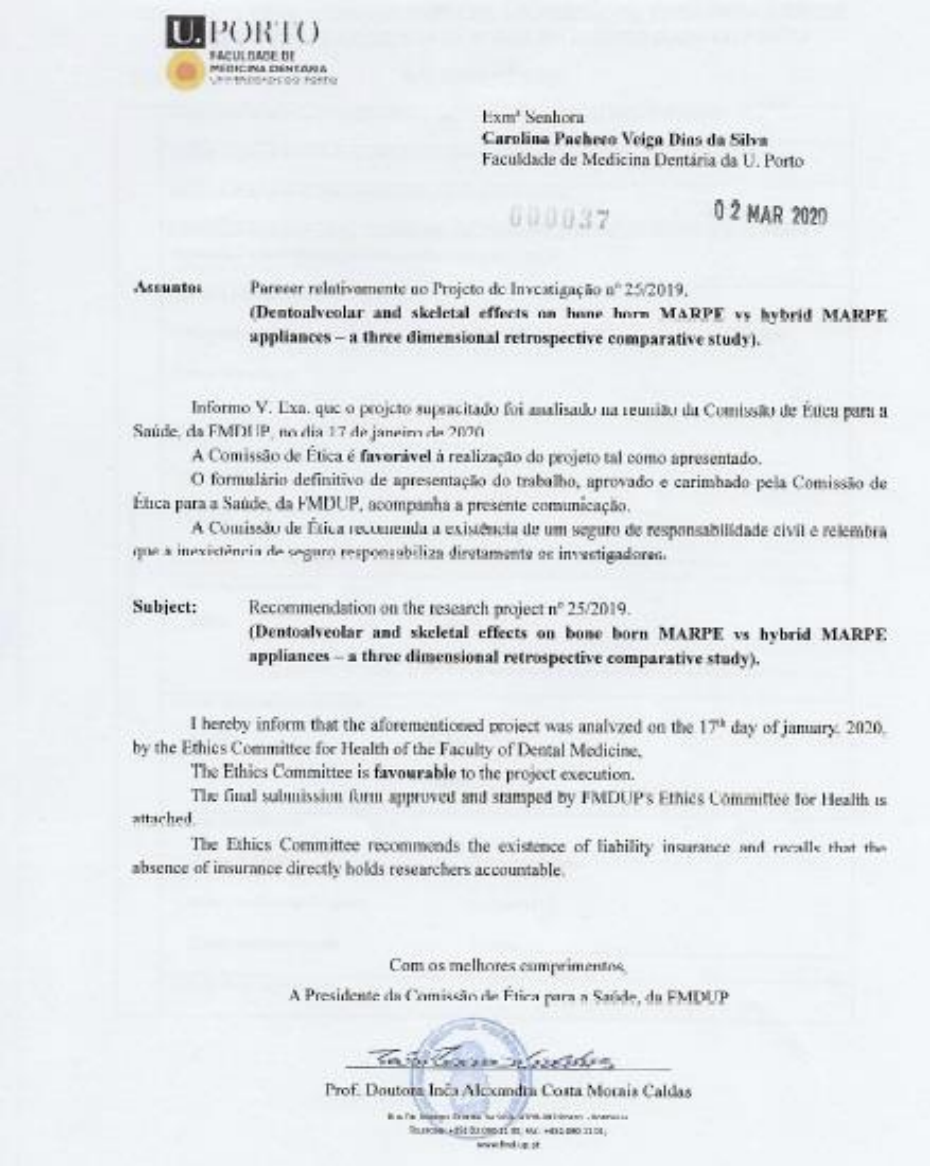
ATTACHMENTS

7. Attachments

7.1. Ethics Committee Statement



U.PORTO
FACULDADE DE MEDICINA DENTÁRIA
UNIVERSIDADE DO PORTO

Exmª Senhora
Carolina Pacheco Veiga Dias da Silva
Faculdade de Medicina Dentária da U. Porto

000037 02 MAR 2020

Assunto: Parecer relativamente ao Projeto de Investigação nº 25/2019.
(Dentoalveolar and skeletal effects on bone born MARPE vs hybrid MARPE appliances – a three dimensional retrospective comparative study).

Informo V. Exa. que o projeto supracitado foi analisado na reunião da Comissão de Ética para a Saúde, da FMDUP, no dia 17 de janeiro de 2020.
A Comissão de Ética é **favorável** à realização do projeto tal como apresentado.
O formulário definitivo de apresentação do trabalho, aprovado e carimbado pela Comissão de Ética para a Saúde, da FMDUP, acompanha a presente comunicação.
A Comissão de Ética recomenda a existência de um seguro de responsabilidade civil e relembra que a inexistência de seguro responsabiliza diretamente os investigadores.

Subject: Recommendation on the research project nº 25/2019.
(Dentoalveolar and skeletal effects on bone born MARPE vs hybrid MARPE appliances – a three dimensional retrospective comparative study).

I hereby inform that the aforementioned project was analyzed on the 17th day of january. 2020, by the Ethics Committee for Health of the Faculty of Dental Medicine.
The Ethics Committee is **favourable** to the project execution.
The final submission form approved and stamped by FMDUP's Ethics Committee for Health is attached.
The Ethics Committee recommends the existence of liability insurance and recalls that the absence of insurance directly holds researchers accountable.

Com os melhores cumprimentos,
A Presidente da Comissão de Ética para a Saúde, da FMDUP

Prof. Doutora Inês Alexandra Costa Morais Caldas

7.2. Oporto University Statement

U.PORTO	Unidade de Proteção de Dados	DATA 10/12/2019

PARECER A-15/2019

Nome	Carolina Pacheco Veiga Dias da Silva
N.º Mecanográfico	201602921
Unidade Orgânica	Faculdade de Medicina Dentária da Universidade do Porto (FMDUP)
Título	Efeitos esqueléticos e dentários no tratamento de MARPE com bandas vs MARPE sem bandas – um estudo retrospetivo e comparativo
Ticket N.º	2019120315003406

Sumário do Pedido

No âmbito da unidade curricular de "Monografia de investigação ou Relatório de Atividade Clínica", integrada no plano de estudos do Mestrado Integrado em Medicina Dentária da FMDUP, pretende a requerente levar a cabo um estudo clínico sem intervenção, destinado a avaliar um método de correção do défice transversal da maxila, o MARPE (Miniscrew Assisted Rapid Palatal Expansion). Em particular, o estudo tem como objetivo verificar se existe uma diferença estatisticamente significativa entre a aplicação do MARPE dento-osteo-suportado ("com bandas") ou osteo-suportado ("sem bandas"), através da comparação de pontos radiográficos medidos em CBCT (Tomografia Computorizada de Feixe Cónico).

A amostra será constituída por pacientes da Clínica Dias da Silva, que foram submetidos ao tratamento com MARPE. Todos os dados necessários ao estudo (data de nascimento dos pacientes, informação acerca do tipo de MARPE que utilizaram e imagens de CBCT antes e depois do tratamento, com as respetivas datas em que foram realizados), serão fornecidos à investigadora pela Clínica, já expurgados de outros dados que possam levar à identificação dos pacientes.

Conclusões

Considerando que,

(1) a Clínica Dias da Silva se configura como Responsável pelo Tratamento dos dados acima referidos, nos termos do art.º 4.º/7 do Regulamento Geral sobre a Proteção de Dados;

(2) foi autorizada pelo Diretor Clínico da Clínica Dias da Silva, a cedência desses dados;

(3) as operações de tratamento de dados a desenvolver pela requerente apenas incidirão sobre dados consideráveis anónimos, tendo em conta os meios atualmente colocados à disposição do Homem-médio para direta ou indiretamente identificar uma pessoa singular,

somos do parecer que o tratamento de dados acima referenciado não carece de autorização prévia do Senhor Reitor, pelo que poderá a requerente avançar com a sua realização, sem necessidade de mais formalismos.

Anexos

Anexo 1	Autorização_Diretor_Clínico

a Encarregada da Proteção de Dados da Universidade do Porto

Susana Rodrigues Pereira

Doutora Susana Rodrigues Pereira

7.3. Compliance of the UP directives Statement

U.PORTO
FACULDADE DE MEDICINA DENTÁRIA
UNIVERSIDADE DO PORTO

INFORMAÇÃO

(Entrega do trabalho final de Monografia após cumprimento das diretivas emanadas pelo Serviço de Proteção de Dados da U.Porto)

Informo que, relativamente ao Trabalho de Monografia com o título: Dentoalveolar and skeletal effects on Bone Borne MARPE vs Hybrid MARPE appliances – a three dimensional retrospective comparative study, **foram cumpridas todas as diretivas emanadas pelo Serviço de Proteção de Dados da U.Porto, encontrando-se em condições de ser apresentado em provas públicas.**

20/05/2020

O(A) Estudante

(Nome em maiúsculas): CAROLINA PACHECO VEIGA DIAS DA SILVA

(Assinatura): Carolina Dias da Silva

7.4. Author's Statement

U.PORTO
FACULDADE DE MEDICINA DENTÁRIA
UNIVERSIDADE DO PORTO

PARECER

Monografia de Investigação/Relatório de Atividade Clínica

Declaro que o presente trabalho, no âmbito da Monografia de Investigação/Relatório de Atividade Clínica, integrado no MIMD, da FMDUP, é da minha autoria e todas as fontes foram devidamente referenciadas.

A Investigadora

Carolina Dias da Silva

(Carolina Pacheco Veiga Dias da Silva)

Porto, 20 de Maio de 2020

7.5. Advisor's Statement

U.PORTO
FACULDADE DE MEDICINA DENTÁRIA
UNIVERSIDADE DO PORTO

PARECER

(Entrega do Trabalho final da Monografia de Investigação)

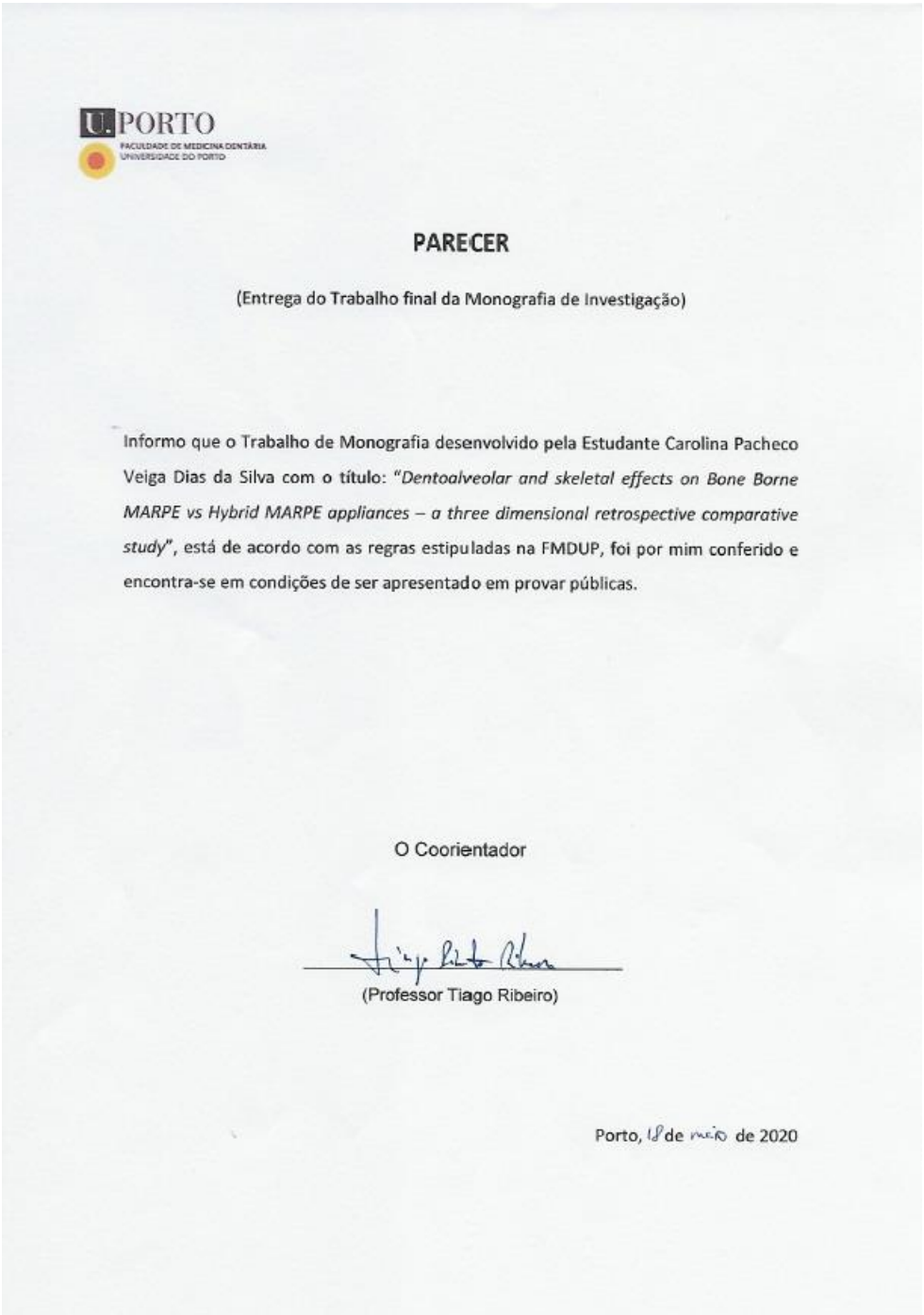
Informo que o Trabalho de Monografia desenvolvido pela Estudante Carolina Pacheco Veiga Dias da Silva com o título: "*Dentoalveolar and skeletal effects on Bone Borne MARPE vs Hybrid MARPE appliances – a three dimensional retrospective comparative study*", está de acordo com as regras estipuladas na FMDUP, foi por mim conferido e encontra-se em condições de ser apresentado em provar públicas.

O Orientador

(Professor Doutor Eugénio Martins)

Porto, 8 de Maio de 2020

7.6. Co-Advisor's Statement



U.PORTO
FACULDADE DE MEDICINA DENTÁRIA
UNIVERSIDADE DO PORTO

PARECER

(Entrega do Trabalho final da Monografia de Investigação)

Informo que o Trabalho de Monografia desenvolvido pela Estudante Carolina Pacheco Veiga Dias da Silva com o título: "*Dentoalveolar and skeletal effects on Bone Borne MARPE vs Hybrid MARPE appliances – a three dimensional retrospective comparative study*", está de acordo com as regras estipuladas na FMDUP, foi por mim conferido e encontra-se em condições de ser apresentado em provar públicas.

O Coorientador

(Professor Tiago Ribeiro)

Porto, 18 de maio de 2020

7.7. Authorization of the Responsible for Access to the Information

Clínica Médico Dentária
Dias da Silva

Porto, 1 de dezembro de 2019

José Pedro Dias da Silva, diretor clínico da Clínica Dias da Silva – Consultórios Médicos, LDA, situada na Praça Francisco Sá Carneiro nº 103 - Galeria, 4200-312 Porto, NIF 503 111 953, venho por este meio autorizar a cedência à estudante Carolina Pacheco Veiga Dias da Silva dos dados clínicos necessários, conforme as considerações éticas que me são exigidas, para a realização do projeto intitulado "*Dentoalveolar and skeletal effects on bone born MARPE vs hybrid MARPE appliances – a three dimensional retrospective comparative study*" a realizar no âmbito da Unidade Curricular "Monografia de Investigação ou Relatório de Atividade Clínica" no Mestrado Integrado em Medicina Dentária da Universidade do Porto.

DIAS DA SILVA
Consultórios Médicos, Lda.

O Diretor Clínico

(José Pedro Dias da Silva)

7.8. Data Measurement Tables

			T0																
Numeração	DN	Género	"N"	"J"	"WANS"	"WPNS"	"IM"	"IPM"	"IA"	"A°R"	"A°L"	"A°TR"	"A°TL"	"A°T1"	"A°T2"	"A°T3"	"A°T4"	"P12"	"P34"	"II"
1	18/07/2002	F	21,4	84,3	0	0	47,5	37,7	48,7	84,5	92,7	84,9	95	0	0	0	0	5,4	5,4	1,8
2	01/04/1990	M	22	78,8	0	0	44,5	34,9	46,6	84,5	89,3	79,9	87,6	0	0	0	0	12,4	13,4	2,2
3	29/11/2001	M	23	85,9	0	0	44,6	32,1	46,5	97	96	79,4	77,5	0	0	0	0	11,7	14,7	3
4	22/05/2001	M			0	0	49,8	39,5	48,3	89	87	79,9	91,2	0	0	0	0	10,2	11,1	2,7
5	21/03/1995	F	20	75,2	0	0	47,2	36	42,1	82,3	88,9	87,6	92,4	0	0	0	0	6	6,5	1,8
6	01/07/1997	F	20,1	75,8	0	0	53	43	46,8	78,4	82,5	90	93,1	0	0	0	0	7,3	11,1	2,2
7	01/06/1999	M	22,9	77	0	0	46,9	38,2	46,9	94,5	89,6	84,9	70,9	0	0	0	0	8,6	6,7	2,2
8	04/03/1981	F	24,6	84,4	0	0	50	39,1	47,4	85,9	82	80,2	83,6	0	0	0	0	10,2	10,9	2

T1																
"N"	"J"	"WANS"	"WPNS"	"IM"	"IPM"	"IA"	"A°R"	"A°L"	"A°TR"	"A°TL"	"A°T1"	"A°T2"	"A°T3"	"A°T4"	"P12"	"P34"	"II"
23,5	86,8	2,2	1,5	52,1	40,2	52,2	82,8	97,5	93,2	94,2	0	0	0	0	8,4	8,9	5,9
23,7	82,5	2,2	1,2	48,9	37,2	47,8	84,1	79,7	92,9	84,6	0	0	14,9	16,8	17,3	21,4	2
22,8	86,1	0	0	44,1	32,6	46	94,8	96,5	87,8	84,4	0	0	0	0	13,6	16,3	3,1
23,6	85,1	3,3	3	58	43,7	52,2	73,8	76,7	94,4	110,3	0	0	0	0	13,7	18,9	6
21,6	77,9	2,9	1,5	52	42,5	46,3	84	82,2	92,9	100,4	0	0	0	0	12,1	12	6,5
22,3	80,3	4,6	1,8	58	45,6	52,4	77	80,8	111	89	0	0	0	0	16,4	21,6	6,9
24,6	79,9	1,6	2	50,2	40,5	49,7	91,8	85,3	102,1	90,8	0	0	0	0	13	13,6	4,4
24,1	85,2	4,6	2,3	53,8	42,6	52	82,2	88,5	100,9	90	0	0	0	0	16	18,2	4,8

			T0																
Numeração	DN	Género	"N"	"J"	"WANS"	"WPNS"	"IM"	"IPM"	"IA"	"A°R"	"A°L"	"A°TR"	"A°TL"	"A°T1"	"A°T2"	"A°T3"	"A°T4"	"P12"	"P34"	"II"
1	18/07/2002	F	21,9	82,1	0	0	46,4	36,8	48,1	85,7	102,5	84,5	95,5	0	0	0	0	5,3	5,3	1,7
2	01/04/1990	M	22,5	78,7	0	0	44,8	35,3	43,8	88,9	87,4	78,2	90	0	0	0	0	12,4	13,1	1,7
3	29/11/2001	M	23,7	84,8	0	0	44,4	32,8	44,1	93,3	93,3	80,8	78,8	0	0	0	0	12,1	15,5	4,4
4	22/05/2001	M			0	0	50	40,1	49	91,8	85,6	87,8	90,4	0	0	0	0	10,4	11,1	3,2
5	21/03/1995	F	22,1	76	0	0	45,8	36	42,2	82,6	80	85,2	90	0	0	0	0	5,9	6,3	2,2
6	01/07/1997	F	19,2	76,8	0	0	52,7	40,9	46,8	80,5	80,5	90,6	95,2	0	0	0	0	7,1	11,1	2,2
7	01/06/1999	M	24	77,5	0	0	46,5	37,9	48,4	94	86,9	85,5	66,6	0	0	0	0	7,9	6,4	2,9
8	04/03/1981	F	24,5	82,5	0	0	48,9	37,8	46,6	88	83,7	80,3	83,7	0	0	0	0	10	10,9	2,9

T1																	
"N"	"J"	"WANS"	"WPNS"	"IM"	"IPM"	"IA"	"A°R"	"A°L"	"A°TR"	"A°TL"	"A°T1"	"A°T2"	"A°T3"	"A°T4"	"P12"	"P34"	"II"
23,2	85,9	2,7	2,6	51	39,6	49,1	84,7	82,7	94,4	96,3	0	0	0	0	8,6	9	4,8
22,2	80,3	1,9	1,2	48,9	36,9	48,1	83,5	81	96,1	82,4	0	0	11,07	15,11	19,7	20	2,6
22,4	86	0	0	44	32,5	45,9	95,1	94,8	89,1	84,8	0	0	0	0	13,4	16,7	4,3
23,7	81,3	2,9	2,5	57,5	43,7	51,9	72	92,7	99,6	113,7	0	0	0	0	14	18,9	5,4
22,4	75,6	4,8	2,2	51,1	42,2	47,7	78,2	81,5	98,3	98,4	0	0	0	0	12,1	12,2	6,8
22,5	80,8	5,3	2,3	57,2	45,5	51,7	79,7	80,3	110,4	92,2	0	0	0	0	15,3	21,3	7,6
24	80,8	2,2	2	50,5	40,2	50,1	86,8	83	102,5	91,5	0	0	0	0	13,4	13,9	4,2
23,9	85,1	2,8	2,2	53,4	42,7	52,2	85,8	84	101,1	90,9	0	0	0	0	15,4	18,3	4,6