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Research Article

Dentogingival Tissues Measures by Means of Cone Beam Computed Tomography of Patients with Altered Passive Eruption and their Connection with Altered Active Eruption

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Abstract

Aim: This study proposes to correlate, by means of cone beam computed tomography (CBCT), the periodontal tissues measurements, of anterosuperior teeth, with the presence/absence of altered active eruption (AAE), in patients with altered passive eruption (APE).

Methods: Eighteen CBCT scans were selected and 10 periodontal measurements were taken for each anterosuperior tooth compiling linear measurements and soft and bone tissue thicknesses.

Results: The data was organized in tables comparing the measurements for each dental group. The statistical analysis presented a relevant difference in the distance between the gingival margin and the cement-enamel junction for central and lateral incisors, indicating that these dental groups, when AAE is present, are more likely to have relatively smaller clinical crowns. The analysis also indicated that lateral incisors with AAE are more likely to have a thinner soft tissue volume.

Conclusion: It was possible to conclude that, by means of CBCT carried out in patients with APE, there is no difference in bone biotype as per the presence/lack of AAE in the teeth groups assessed. In the presence of AAE, incisors teeth have clinical crowns proportionally smaller and the lateral incisors presents a thinner gingival tissue volume.

Keywords: Tomography; Esthetics; Periodontics; Eruption; Measurements

Abbreviations

CBCT: Cone Beam Computed Tomography; AAE: Altered Active Eruption; APE: Altered Passive Eruption

Introduction

In dentistry, so that statically pleasant smile is achieved, several factors assessments shall be performed from the teeth shape and position, periodontal condition, and even skeletal discrepancies [1,2].

Periodontology is particularly concerned with cases involving the gingival smile [1]. Such situation is defined as being the gingival exposure by, at least, 3 mm (between the gingival zenith to the upper lip), during the smile, which may be clinically diagnosed with the use of a periodontal probe [3].

Gingival smile itself is a concern whose etiology varies widely. Its causes may be vertical excess of the bone tissue, general dental extrusions, hyperactivity of muscles related to the lips, short upper lip, usage of drug products that induce gingival growth and altered passive eruption (APE) [4,5]. The latter one happens when there is a coronal positioning of the gingival margin in relation to the cement-enamel junction. Besides APE, it is also proposed that the altered active eruption (AAE) is involved in the gingival smile etiology and this is due to the alveolar bone crest overlapping to the cement-enamel junction [6].

Clinically, biological distances measurements are carried out by means of a periodontal probe usage with the aid of radiographies common to the general dental practice [7-11]. Recently, however, literature has shown the increase of cone beam computed tomography (CBCT) for periodontal measurements [12-21].

As per CBCT, the field of application is wide; however, there is lack in literature of works using CBCT for periodontal measurements with patients bearing gingival smile. Due to such lack, this study proposes to assess, by means of CBCT, the periodontal tissues measurements, of anterosuperior teeth, at soft tissue and bone tissue level, in patients with gingival smile caused by APE, comparing the measurements attained with AAE involvement or not and with dental group.

Materials and Methods

This transversal observational study with a sample of convenience was approved by the ethics committee in research of Universidade Positivo, under the opinion number 2.115.663. For this study, the following inclusion criteria were adopted: patients of any gender, with gingival smile clinically diagnosed with periodontal probe [3] caused by APE according to Goldman and Cohen [23] definition, aged 15 to 33 years old, with full dentition from 13 to 23, and they shall be in completely healthy condition (without the presence of restorations, endodontic treatments, fractures and any sign of periodontal disease).

Smokers, with previous orthodontic indication, prosthetics indication in the anterosuperior set, pregnant and nursing women, systemic patients, infectious periodontal disease bearers and tooth decay bearers were excluded from the study, with the purpose of mitigating possible external interferences in the measurements result.

The sample comprised 18 patients bearing APE, clinically diagnosed, as per the inclusion criteria by an expert periodontist. Tomography exams were performed with PreXion 3D (Yoshida, Japan, 2012) device, and were compliant with the same tomographic protocol carried out by a single expert radiologist. Immediately before the images attainment, a lip retractor for whitening was positioned so that the lips and tongue interference in the images was removed, enabling a clearer and accurate visualization of the teeth whole periodontal tissues to be assessed, as described by Januário., *et al* [12].

For all tomographies, ten measurements were carried out for each one of the six anterosuperior teeth. They were: clinical crown (CC) which represents the gingival margin measurement distance from the tooth incisal edge, parallel to the long axis (Figure 1); anatomic crown (AC) which represents the measurement distance of the cement-enamel junction to the tooth incisal edge (Figure 2); gingival

margin to the cement-enamel junction (MJ), which represents the measurement distance from the gingival margin to the cement-enamel junction (Figure 3); cement-enamel junction to the alveolar bone crest (JC) which represents the measurement distance of the cement-enamel junction to the alveolar bone crest (Figure 4). Measurements mentioned so far (CC, AC, MJ and JC) are understood as linear measurements. Periodontal soft tissues thickness measurements were: soft tissue first measurement (1S), which comprised the measurement of gingival tissue thickness located in the cement-enamel junction, perpendicularly to the dental surface (Figure 5); the soft tissue second measurement (2S), which comprised the measurement of gingival tissue thickness located 1 mm apical to the alveolar bone crest, perpendicularly to the dental surface (Figure 6); the soft tissue third measurement (3S), which comprised the measurement of gingival tissue thickness located in the most coronal proportion of the alveolar bone crest, perpendicularly to the dental surface (Figure 7). At last, bone tissues thickness measurements were: the bone tissue first measurement (1B), which measured the bone tissue thickness located 2 mm apical to the alveolar bone crest, perpendicularly to the dental surface (Figure 8); the bone tissue second measurement (2B), which measured the bone tissue thickness located 2 mm coronal to the root apex, perpendicularly to the dental surface (Figure 9); and the bone tissue third measurement (3B), which measured the bone tissue thickness located in the intermediate position between the 1B and 2B measurements, also perpendicularly to the dental surface (Figure 10). We took into account, for the study herein JC < 1.50 mm as having involvement of AAE and JC ≥ 1.50 mm as lacking involvement [6].

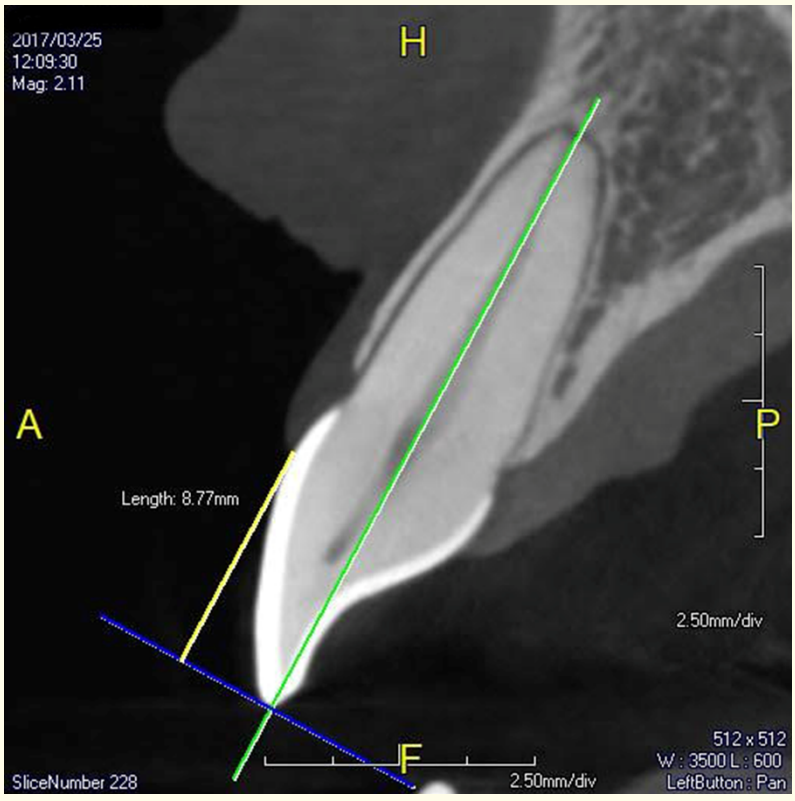

Figure 1: *Clinical crown measurement (CC).*

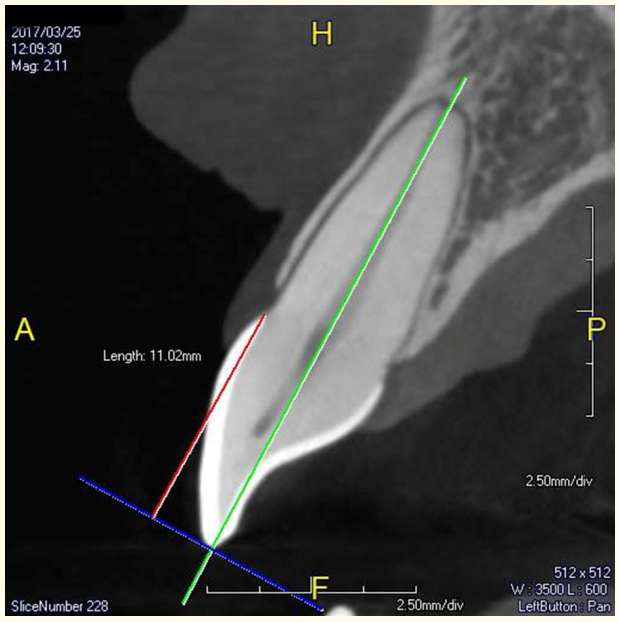

Figure 2: *Anatomic crown measurement (AC).*

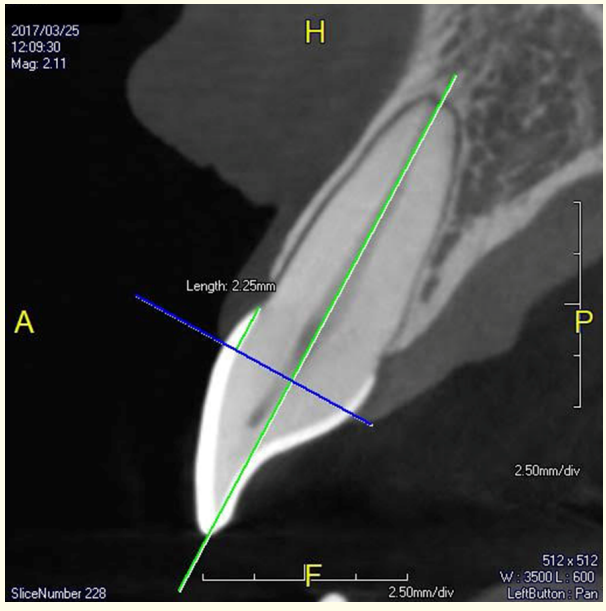

Figure 3: *Distance between the gingival margin and the cement-enamel junction (MJ).*

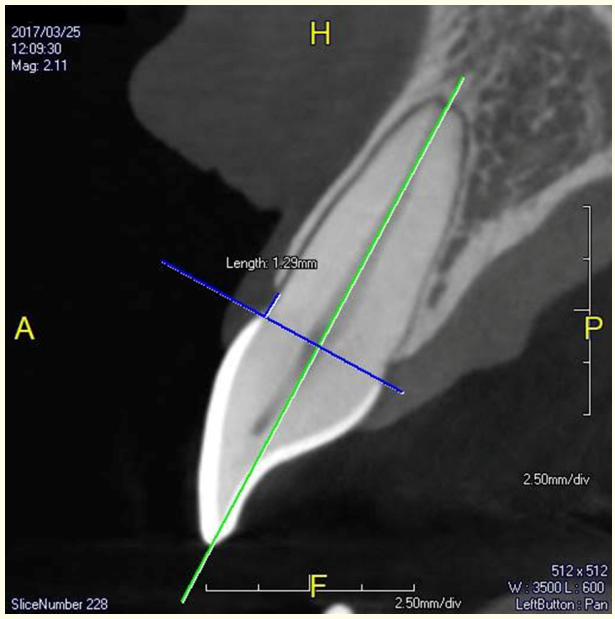

Figure 4: *Distance between the cement-enamel junction and the alveolar bone crest (JC).*

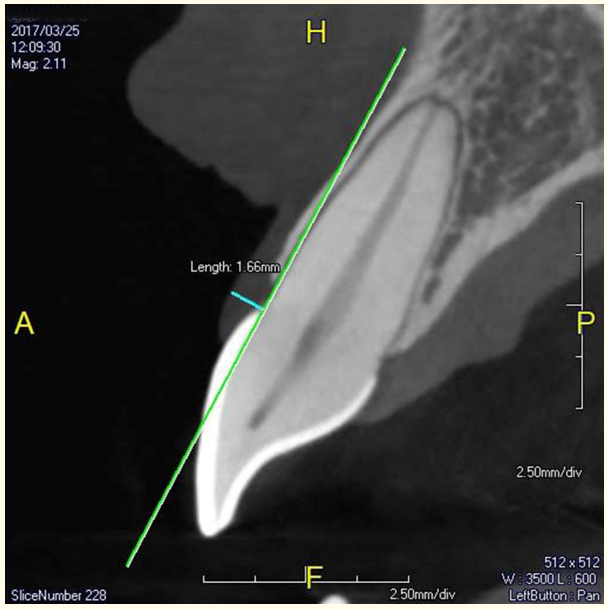

Figure 5: *Soft tissue thickness at the cement-enamel junction (1S).*

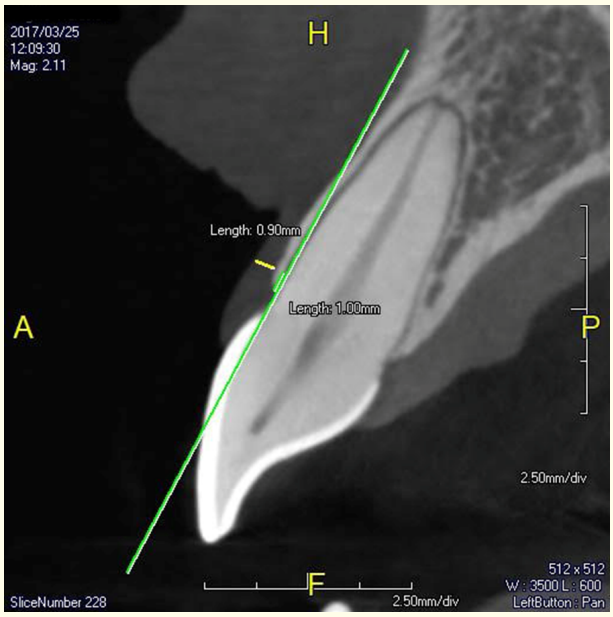

Figure 6: *Soft tissue thickness 1 mm apical to the alveolar bone crest (2S).*

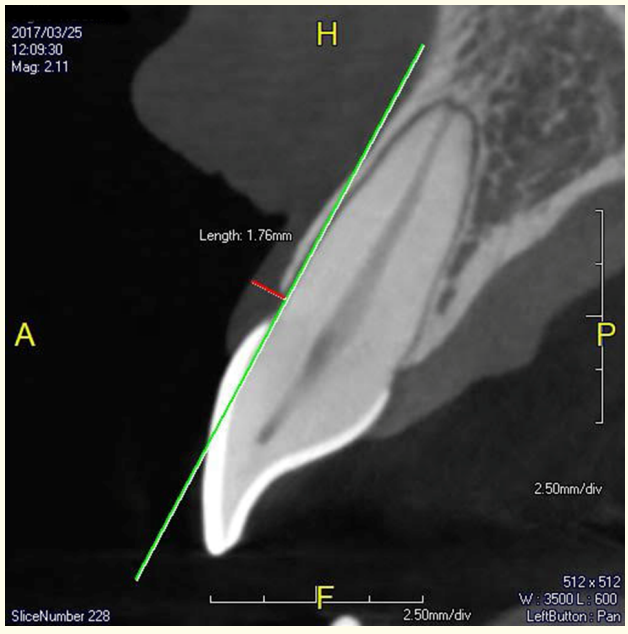

Figure 7: *Soft tissue thickness at the alveolar bone crest limit (3S).*

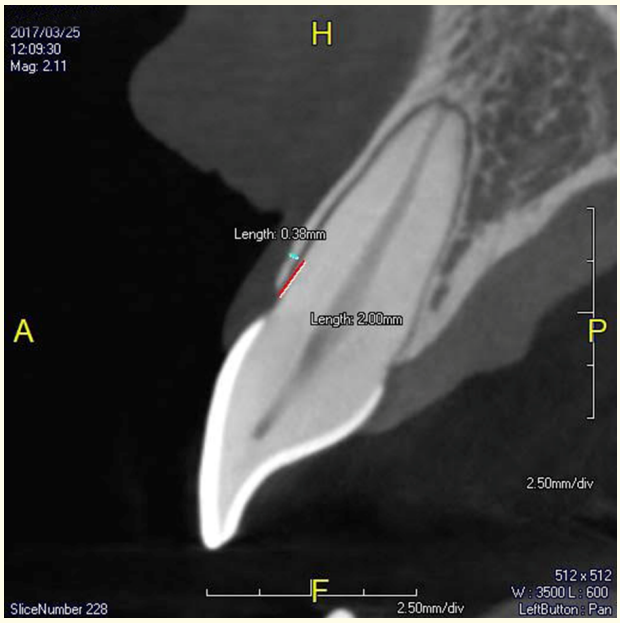

Figure 8: *Bone tissue thickness 2 mm apical to the alveolar bone crest (1B).*

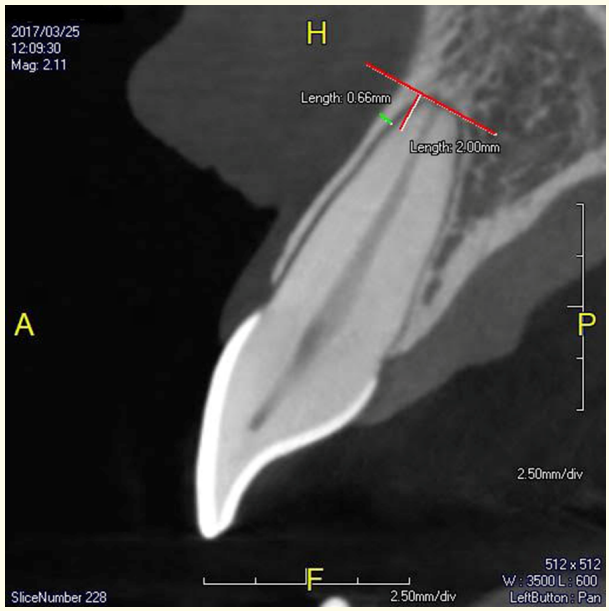

Figure 9: *Bone tissue thickness 2 mm coronal to the root apex (2B).*

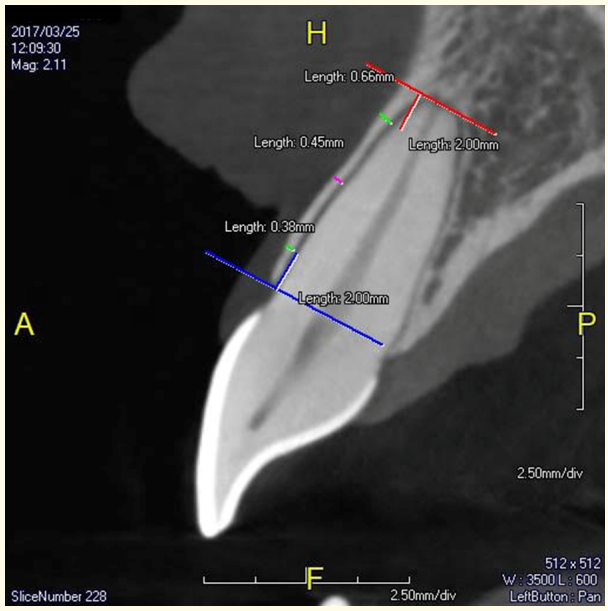

Figure 10: *Bone tissue thickness at the exact intermediate point between 1B and 2B (3B).*

All measurements have been performed with millimeter hundredths precision in an image with the tooth at a sagittal cut, carried out exactly on its long axis in its greatest diameter. As per the clinical crown and anatomical crown measurements (Figure 1 and 2), a tooth long-axis line was initially drawn. Perpendicularly to it, another line tangential to the tooth at the incisal edge has been outlined. At last, perpendicularly to it, and parallel to the long-axis that the clinical and anatomical crown measurements attained in an accurate way.

All 10 measurements for each of the 6 anterosuperior 6 teeth of 18 patients (total of 1080 measurements) were then carried out and all the values attained, were organized in an individual board. This framework also contained, individually, for each dental element, whether there was or not involvement of AAE, i.e. less than 1.5 mm between the alveolar bone crest and the cement-enamel junction [6].

Measures taken, values were organized in three great groups, separated according to the type of tooth: canine (CN) (n = 36), lateral incisors (LI) (n = 36) and central incisors (CI) (n = 36).

After the division in three groups per type of teeth, a single board for all the teeth assessed in the research was created, in order to enable the data comparison in the statistical analysis.

Data were initially submitted to the Kolmogorov-Smirnov and Shapiro-Wilk tests in order to check the variances homogeneity. As the homogeneity has not been ascertained for the measurements majority, data were submitted to the Mann-Whitney test, comparing each measure average in each teeth group with the presence of AAE in an overall level of 5% significance. Statistic tests were performed using the SPSS software version 17.0.

Results and Discussion

Out of 18 patients selected to the study, all with APE, 89% were female while 11% male, aged 24.4 years in average. AAE was present in 58% of the central incisors, 33% of the lateral incisors and 47% of the canine. When the teeth groups were assessed together, 54% thereof lacked AAE and 46% had it.

Average values for each measure attained within each tooth type, are submitted in table 1, with the purpose of enabling comparison. In this table, it is noted that central incisors have clinical and anatomical crown greater regarding other groups. It is also noted that the bone and gingival biotype of central incisors are thicker than the other groups in the six average values of the tissue thickness.

	CC	AC	MJ	JC	1S	2S	3S	1B	2B	3B
CN	7,75	9,45	1,70	1,79	1,16	0,47	0,94	0,83	0,48	0,50
LI	6,60	9,06	2,32	1,87	1,26	0,61	0,97	0,80	0,51	0,44
CI	8,64	10,71	2,13	1,43	1,54	0,71	1,17	0,86	0,71	0,65

Table 1: *Average values for each measurement taken for each dental group (in millimeters).*

For the three groups of teeth (Table 2-4), the statistical analysis has ascertained a statistically significant difference in JC ($p < 0.05$) measure. And the teeth that lacked AAE had values greater than 1.50 mm.

Unlike canine, lateral and central incisors groups (Table 3 and 4) showed averages with statistically significant differences in MJ measurement (from gingival margin to cement-enamel junction), showing that the incisor teeth (being them central or lateral) with AAE involvement have greater coverage in their anatomic crowns than the incisors without AAE.

	Presence of AAE				Absence of AAE			
	Average	Minimum	Maximum	Interquartile interval	Average	Minimum	Maximum	Interquartile interval
CC	7,51[a]	5,97	8,17	0,75	8,29[a]	6,61	9,26	1,09
AC	9,38[a]	8,00	9,93	0,54	9,50[a]	8,30	10,97	1,42
MJ	1,78[a]	1,02	3,36	0,60	1,59[a]	0,77	2,92	1,08
JC	1,27[a]	0,96	1,47	0,34	1,89[b]	1,51	6,06	0,55
1S	1,16[a]	0,76	1,73	0,31	1,12[a]	0,58	1,56	0,20
2S	0,44[a]	0,25	0,71	0,27	0,44[a]	0,17	1,44	0,16
3S	0,93[a]	0,68	1,35	0,28	0,88[a]	0,72	1,33	0,27
1B	0,87[a]	0,47	1,36	0,45	0,78[a]	0,28	1,53	0,44
2B	0,36[a]	0,00	2,28	0,44	0,32[a]	0,00	1,29	0,23
3B	0,42[a]	0,20	1,04	0,21	0,48[a]	0,00	1,18	0,38

Table 2: *Comparison of values in millimeters of linear measurements, soft tissue thicknesses and bone tissue thicknesses between canine teeth with or without AAE.*

Different letters on the same line represent a statistically significant difference ($p < 0.05$).

	Presence of AAE				Absence of AAE			
	Average	Minimum	Maximum	Interquartile interval	Average	Minimum	Maximum	Interquartile interval
CC	6,46[a]	5,07	7,43	1,13	6,72[a]	4,85	8,59	0,61
AC	9,16[a]	7,83	10,30	1,13	8,88[a]	7,70	10,66	1,08
MJ	2,44[a]	1,92	4,62	1,16	2,09[b]	1,28	3,56	0,79
JC	1,22[a]	0,62	1,49	0,31	2,01[b]	1,62	3,02	1,05
1S	1,24[a]	0,96	1,41	0,19	1,30[a]	0,89	1,55	0,32
2S	0,52[a]	0,21	0,77	0,11	0,62[b]	0,42	0,87	0,23
3S	0,91[a]	0,58	1,19	0,31	1,00[a]	0,60	1,37	0,33
1B	0,79[a]	0,41	1,09	0,68	0,69[a]	0,36	1,56	0,63
2B	0,44[a]	0,13	0,85	0,33	0,37[a]	0,15	1,82	0,35
3B	0,39[A]	0,21	1,36	0,39	0,35[a]	0,00	1,22	0,25

Table 3: *Comparison of values in millimeters of linear measurements, soft tissue thicknesses and bone tissue thicknesses between lateral incisor teeth with or without AAE.*

Different letters on the same line represent a statistically significant difference ($p < 0.05$).

	Presence of AAE				Absence of AAE			
	Average	Minimum	Maximum	Interquartile interval	Average	Minimum	Maximum	Interquartile interval
CC	8,72[a]	6,14	10,29	1,88	8,83[a]	5,98	10,21	1,12
AC	10,74[a]	9,12	12,36	1,30	10,60[a]	9,28	11,52	0,97
MJ	2,21[a]	1,40	4,54	0,71	1,71[b]	1,14	4,75	0,59
JC	1,11[a]	0,43	1,45	0,55	1,74[b]	1,50	2,82	0,61
1S	1,57[a]	1,22	2,30	0,36	1,43[a]	1,12	1,79	0,39
2S	0,67[a]	0,49	0,97	0,33	0,72[a]	0,48	1,01	0,32
3S	1,16[a]	0,81	1,84	0,36	1,07[a]	0,70	1,67	0,28
1B	0,81[a]	0,38	1,63	0,38	0,92[a]	0,42	1,67	0,45
2B	0,54[a]	0,15	2,04	0,44	0,61[a]	0,14	1,80	0,58
3B	0,50[a]	0,30	2,06	0,33	0,59[a]	0,31	1,32	0,50

Table 4: *Comparison of values in millimeters of linear measurements, soft tissue thicknesses and bone tissue thicknesses between central incisor teeth with or without AAE.*

Different letters on the same line represent a statistically significant difference ($p < 0.05$).

Three tables (Table 2-4) were prepared, each one representing a group of teeth (canine, lateral incisor and central incisor), in which the average, minimum and maximum values and interquartile interval were organized, with columns identifying the presence or lack of AAE as proposed by [6].

As per the lateral incisors (Table 3), there is also a statistically significant difference for 2S measurement (gingival thickness at 1 mm apical point to alveolar bone crest). In this comparison, it is noted that the lateral incisors with AAE tend to have a less thick soft tissue biotype.

As per the measurements in bone tissue, the research has not shown statistically significant differences in any of the measurements in any of the groups. Therefore, in patients bearing APE, trend is not having a connection between AAE with the patient´s bone biotype. As per the clinical and anatomical crown size values, no difference was noted as per the presence or lack of AAE.

This study proposed to assess, by means of CBCT, the periodontal tissues measurements, of anterosuperior teeth, at soft tissue and bone tissue level, in patients with gingival smile caused by APE, relating the measurements attained with AAE involvement or not and with dental group.

CBCT importance for odontology has already been known for a long time, especially in dental implant [24] but also in several other areas as orthodontics or maxilo-facial surgery [12-22].

CBCT relevance as periodontal assessment tool, as shown in other researches [8,13,14] has also been taken as important in the present study. The possibility of an extremely accurate measurement by CBCT of the patient´s periodontal biotype helped greatly in classifying APE and in associating it or not with AAE.

CBCT accuracy issue in periodontal measurements in this study is in compliance with what Batista Jr., *et al*. [7] also show. In it, measurements of the most coronal third of the periodontium were taken so that an accurate surgical planning could be performed.

Within the publications, the study by Batista Jr., *et al*. [7] is the only one showing a methodology closer to this study proposal. Due to the lack of periodontal tissues well-defined measurements in tomography in literature, the methodology proposed was seeking for aggregation of periodontium up to the apical third, with the purpose of assessing more completely the involvement of periodontal biotype in APE and in AAE.

Measurements taken of clinical crown and anatomic crown (CC and AC) are the obvious starting point when dealing with patients with APE where there is partial coating of anatomic crown. Measurements of gingival margin to cement-enamel junction (MJ) and the cement-enamel junction to alveolar bone crest (JC) are also extremely important in periodontal biotype assessment, as it is the zone comprised by biological distances. In JC specific distance case, as proposed by Zangrando., *et al*. [6], we have accurate indication of the AAE involvement or not in gingival smile. In the present study, all the teeth groups have shown differences in JC measure between teeth with or without AAE. Such observation is obvious as we take into consideration, for the present study, JC < 1.50 mm as having the involvement of AAE and JC ≥ 1.50 mm as not having it. Therefore, the statistical difference noted in JC measures for all the groups was already expected.

All the tissues thickness measures defined for this study (1S, 2S, 3S, 1B, 2B and 3B) are not found in other works with CBCT of periodontal tissues. These positions choice for the thickness measures was defined that way, because there are few works that address the periodontal assessment via CBCT of gingival smile bearers due to APE, except the study by Batista Jr., *et al*. [7], and there are not, therefore, the presence of protocol defined on which measures to take. Also, current literature does not take into account the periodontium vestibular volume as a whole [7]. Given that the incomplete active eruption is associated with APE, as proposed by Zangrando., *et al*. [6], the periodontium up to the apical third shall be taken into consideration.

For tomographic performance, patients were submitted to the tomographic protocol proposed by Januário., *et al*. [12] for periodontal structures highlighting. It has been clear in the present study, that these structures highlighting is extremely important in accurate

measurement of any part of the periodontium. Januário., *et al*. [12] in his work, use a lip retractor "expandex" type. However, so that the tongue interference in palatal region tissues is efficiently removed, even a little bit regardless the patient (without him having to keep it retracted), we notice that the use of whitening retractor, due to its surface targeted to retract the tongue, is more effective and mitigates the chance of errors in radiographic performance, even reducing the possible unnecessary exposures of radiation in case a new examination is necessary.

Patients engaged in the present study were women in their majority. Disregarding the fact that women possibly worry more about aesthetics than men, such observation is in compliance with the work by Silberbert., *et al*. [25] which shows a greater female tendency to APE.

As for the patients, we have received young patients predominance, seeking for a solution to gingival smile, as the age average in this study was 24.4 years old. In a similar study, Batista Jr., *et al*. [7] had a 29-year average.

Within the passive eruption stages proposed by Gottlieb and Orban [26] obviously it is noted that all teeth involved in the study are stagnated in stages I or II, which Goldman and Cohen [23] later would define as altered passive eruption.

In the present research results description, a much greater presence of AAE is noted in central incisors compared to the lateral incisors. However, when we assess all the teeth involved in the study, in a single list, we notice that 54% of them did not have AAE and 46% had it, i.e. a very homogeneous sample regarding the presence of AAE. As the AAE presence/lack is a determining factor whether surgical treatment will involve or not marginal osteotomy, and as a single patient may or not have the presence of AAE in different teeth, once more it is ascertained the importance of CBCT and the protocol by Januário., *et al*. [12] in APE cases surgical planning.

Yet, it is also important that distances greater than 1.5 mm between cement-enamel junction and alveolar bone crest, which may be understood as the lack of AAE according to Zangrando., *et al*. [6], are differentiated from pre-existent periodontal bone losses.

In inferential analysis, the lateral incisors group has shown more interesting. In that, statistically significant difference ($p < 0.05$) was noted in measure 2S. We note that the teeth, besides having a clinical crown proportionally smaller than the anatomic crown compared to the other teeth groups, tend to have a gingival biotype less thick when there is the presence of AAE. As per the bone biotype, no statistically significant differences were found for any of the teeth group.

In incisors groups (both lateral and central), gingival margin measures to cement-enamel junction (MJ) have shown statistically significant ($p < 0.05$) suggesting greater values when there is the presence of AAE. The presumption is that the difference is related to some kind of organism mechanism that search for compensating the bone proximity to the cement-enamel junction, which shall yet be better explained in literature, based on the lack of works similar to this one.

Conclusion

Within the present study limitations, it was possible to conclude that, by means of CBCT carried out in patients with APE, there is no difference in bone biotype as per the presence/lack of AAE in the teeth groups assessed. In the presence of AAE, incisors teeth have clinical crowns proportionally smaller and the lateral incisors presents gingival tissue less thick next to the cement-enamel junction.

Conflict of Interest

Declare if any conflict of interest exists.

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