Clinical and tomography evaluation of periodontal phenotypes of Brazilian dental students

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Abstract:

Background: The periodontal phenotype (PP) plays an important role in the function, esthetics, and maintenance of periodontal health and has a great influence in periodontal, restorative, and dental implant therapies. Aim: The aim of this study was to conduct a clinical evaluation of the PP and its morphometric variations through the cone-beam computed tomography (CBCT), from dentistry students with periodontal health. Materials and Methods: Sixty students were examined, and the clinical parameters of probing depth and width of keratinized tissue (WKT) in the upper anterior segment were accessed. The gingival thickness was evaluated as thick or thin, through the translucency of the periodontal probe through the marginal gingiva. By convenience sample, 13 students were selected to assess bone thickness and gingival thickness and biological width through the previous CBCT examination. Results: The most prevalent PP, according to the classification by De Rouck et al., was the thick scalloped (55%), and using the classification of Kao and Pasquinelli, the thick PP was most common (73,3%). The thick PP in both the classifications was more prevalent in both genders and the WKT was significantly higher in the thick-flat scalloped PP. The bone thickness was always greater than the gingival thickness in CBCT examinations both in the measures 1 mm and 3 mm above the bone crest. The average of the biological width measurement was 2.02 mm. Conclusions: The thick PP was most prevalent in the sample studied, and the gingival thickness was always thinner than the bone thickness in the measures evaluated.

Key words: Cone beam computed tomography, periodontium, phenotype

INTRODUCTION

The periodontal phenotype (PP) is defined by the evaluation of the bone architecture, gingival thickness, the amount of keratinized tissue, and the shape of dental crowns.1 Its variables may determine the behavior of the periodontium when subjected to physical, chemical, and bacterial injuries or during restorative procedures, periodontal surgeries, dental implant installation, and orthodontic treatments.2

The search for esthetic resolutions is increasing, mainly including restorative procedures associated with clinical crown lengthening, and the gingival morphology of the maxillary anterior area plays an important role in the final esthetic result.23

The thick PP usually shows a wide zone of keratinized tissue with a flat gingival outline that indicates an underlying and thick bone architecture and is more resistant to inflammatory processes or trauma.3 Thin PP is often characterized by bone defects and dehiscences and may exhibit gingival recession when submitted to surgical procedures or orthodontic forces.4 Several classifications have been presented to define the PP, with the assessment of the gingival thickness, the width of the keratinized tissue, and the bone thickness, which can only be measured using cone-beam computed tomography (CBCT) images. One classification suggested three types of PPs: the thick-flat scalloped, the thick-scalloped, and the thin-scalloped PPs,1 and another classification describes only the thin and thick categories.5

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Many noninvasive and invasive methods have been used to evaluate PP the direct method, the periodontal probe transparency (TRAN) method, ultrasonic devices, and CBCT images. In the direct method, the thickness of the tissue is measured using a periodontal probe and when the thickness is >1.5 mm, it is categorized as a thick PP, and if <1.5 mm, it is considered thin PP. In the TRAN method, PP is considered thin if the probe outline is shown through the gingival margin. CBCT, when previously available, may be a more objective method for determining the thickness of soft and hard tissues than direct measurements.

The thicker PP is generally more prevalent in the population, and men have thicker biotypes when compared to women. A study with 80 dental students to determine PP by the transparency of the probe reported 38 participants with thin blood pressure (47%, 20 men) and 42 thick PP individuals (53%, 22 women). Younger individuals had thicker PP and maxillary canines and mandibular first premolars usually have the thinnest PP.

The gingival thickness was evaluated and correlated with gender, presence of recession, and width of keratinized tissue (WKT) in 400 individuals. The prevalence of thin PP was 43.25% and the thick PP was 56.75% and there was no significant relationship between age, gender, and the presence of recession for PP and there was a positive correlation between WKT and gingival thickness.

The thickness of the vestibular gingiva measured by CBCT associated with the use of the lip retractor was compared to the clinical thickness in upper anterior areas. This technique is accurate to visualize the soft tissues of the cervical vestibular area of the anterior teeth to define the gingival thickness.

Studies on PP provide better prevention and control of side effects to esthetic restorative treatments, and with dental implants. Thus, the aim of this study was to conduct a clinical evaluation of the PP and its morphometric variations through CBCT examinations of Brazilian dental students with periodontal health.

**MATERIALS AND METHODS**

A cross-sectional study was carried out with 60 dentistry students, randomly selected for the evaluation of the PP. Participants were selected according to the following inclusion criteria: age over 18 years and presence of upper central and lateral incisors and canines on both sides, without clinical signs of gingivitis or periodontitis. The exclusion criteria were individuals with prostheses in these teeth, with systemic disease, and who underwent periodontal surgery in this area or previous orthodontic therapy. Participants were instructed on the purpose of the study and signed an informed consent form, previously submitted and approved by the University Federal of Juiz de Fora (UFJF) Ethics Committee with the number 2.360.113.

Considering the population of dentistry students in Brazil and a confidence level of 90%, it can be determined that the population of 60 individuals has a margin of error of 10.58%.

**Evaluation of clinical data**

Periodontal conditions were clinically assessed from November 2017 to April 2018 by a trained and calibrated examiner, using the North Carolina periodontal probe (PC PUNC 15-Hu FriedyChicago, IL, USA). The following clinical parameters were observed in the anterior superior sextant: probing depth on the buccal surface and WKT. The probing depth measure was evaluated corresponding to the distance between the gingival margin at the base of the gingival sulcus and the WKT as the distance between the free gingival margin and the mucogingival junction.

Gingival thickness was assessed as thick and thin by the translucency of the periodontal probe through the free marginal gingiva on the buccal surface of the upper incisors and canines. When the probe was visualized through the tissue, it was categorized as thin, if not, classified as thick.

The evaluation of the PP was performed by two examiners who were calibrated to classify the PP by examining five individuals on two occasions in the half-hour interval, with the kappa index = 0.821. Photographs in a frontal view were obtained for later reevaluation. The PP was determined using two classifications: (1) De Rouck et al.’s Classification (a) thin scalloped (and triangular teeth), (b) thick scalloped (thick and triangular teeth), and (c) thick-flat scalloped PP (thick and square teeth) and (2) Kao and Pashley’s Classification (a) thin (delicate aspect, translucent appearance, with minimal WKT, with contoured topography, suggesting minimal adjacent bone tissue with possible fenestrations) and (b) thick (dense aspect, with greater WKT, relatively flat topography with a suggestion of thick adjacent bone tissue).

**Evaluation of cone-beam computed tomography data**

CBCT images, obtained from the database of the Radiology Clinic of the Faculty of Dentistry of UFJF, were acquired with the i-CAT next-generation tomography (Imaging Sciences International, Hatfield, PA, USA) with the following acquisition protocol: 0.25 mm voxel, 26.9 s rotation, and a field of view varying between 7 cm × 13 cm and 10 cm × 13 cm. The examinations were performed with an acrylic lip retractor (Arcflex, FGM, Joinville, SC, Brazil), following the protocol used at the Radiology Clinic at UFJF [Figure 1]. The acrylic retractor removes soft tissues such as lips and cheeks, allowing gingival thickness measurement on CBCT images. The images of parasagittal sections were analyzed in the i-CAT Vision software (Imaging Sciences International, Hatfield, PA, USA), by a single experienced observer in CBCT images.

From the 60 students evaluated, 13 students were selected by convenience sample since they had recent CBCT examinations of the evaluated area. The tooth was used as a unit of measurement, including a total sample of 78 teeth, 26 central incisors, 26 lateral incisors, and 26 canines.

Thickness of the buccal bone and gingival tissues was obtained in the most central parasagittal section of each examined tooth. To determine the thickness of the vestibular bone, two measurements were taken perpendicularly along the long axis of the tooth, represented by the letters BT (tomographic bone thickness): BT1, 1 mm above the alveolar bone crest and BT2,
3 mm above the alveolar bone crest [Figure 2]. To measure the thickness of the buccal gingival tissue, tomographic measurements were also obtained perpendicularly along the long axis of the tooth and corresponding to the bone measurements described above. These measures, used to correlate bone thickness with gingival thickness obtained by CBCT, are represented by gingival thickness (GT) (tomographic gingival thickness): GT1, 1 mm above the alveolar bone crest and GT3, 3 mm above the alveolar bone crest [Figure 2].

The distance from the enamel cementum junction to the starting point of the alveolar cementum enamel junction and bone crest (CEJ-BC) was also measured [Figure 2], which represents the periodontal biological width.\[1\]

**Statistical analysis**

For data analysis, absolute and percentage distributions were obtained (descriptive statistics) and the Chi-square test was used to assess the association between the classification of PPs and gender, and for the evaluation between WKT and phenotypes, it was used the Krushall–Wallis test. To verify the relationship between bone and gingival thickness measurements, Pearson’s correlation coefficient was applied. For the statistical treatment, the BioEstat software, version 5.3 for Windows, was used and the statistical differences were considered significant with P ≤ 0.05.

**RESULTS**

The sample evaluated consisted of 60 individuals who had a mean age of 22.9 (±3.03) years with 40 female individuals (66.7%) and 20 male individuals (33.3%). None of the individuals showed probing depth >3 mm in the evaluated sites and bleeding on probing, which characterizes the sample with periodontal health.

In the PP evaluation, according to the first classification used,\[1\] the sample showed a larger number of thick scalloped PP (55%), followed by thin scalloped (26.7%) and thick-flat scalloped (18.3%) and the thick scalloped PP was the most found both genders, without statistical difference. The distribution of PP\[5\] in relation to gender is described in Table 1. All individuals described with a thick-flat scalloped PP showed “square” teeth.

In the PP assessment, according to the second classification used,\[5\] they were classified as thin (16, 26.66%) and thick (44, 73.33%). Thick PP was most frequent in both women and men, with no statistical difference. The distribution of PP\[5\] by gender is described in Table 2.

The WKT obtained an overall average of 5.28 mm, with males being 5.39 mm and females 5.19 mm. The thick-flat scalloped PP showed the highest WKT with an average of 6.04 mm, significantly greater than the thick scalloped with 5.27 mm (P = 0.0007) and that the thin scalloped with an average of 4.70 mm (P = 0.003). Using the other classification,\[5\] the WKT for the thin PP had an average of 4.90 mm and the thick had an average of 5.46 mm. The analysis of the WKT for each tooth, and its distribution by gender is described in Table 3. The lateral incisors showed a greater WKT than the other teeth, however, without statistical difference.

Of the total of thirteen individuals selected at random to perform the CBCT scans, 3 (23.07%) were classified with the thin scalloped PP, 8 (61.53%) with thick scalloped, and 2 (15.38%) with thick-flat scalloped.

Bone and gingival thickness had their averages always below 1 mm, and canines showed gingival thicknesses (GT1 and GT3) and bone thickness (BT1) thinner than in the other evaluated teeth. The measurements presented the following averages:

**Table 1: Periodontal phenotype classification\[1\] according to gender**

| Periodontal phenotype | Men, n (%) | Women, n (%) | Total, n (%) |
|-----------------------|------------|--------------|--------------|
| Thin scalloped        | 3 (5.0)    | 13 (21.7)    | 16 (26.7)    |
| Thick scalloped       | 14 (23.3)  | 19 (31.7)    | 33 (55.0)    |
| Thick flat scalloped  | 3 (5.0)    | 8 (13.3)     | 11 (18.3)    |
| Total                 | 20 (33.3)  | 40 (66.7)    | 60 (100.0)   |

n – number of individuals

**Table 2: Periodontal phenotype classification\[5\] according to gender**

| Periodontal phenotype | Men, n (%) | Women, n (%) | Total, n (%) |
|-----------------------|------------|--------------|--------------|
| Thin                  | 3 (5.0)    | 13 (21.7)    | 16 (26.7)    |
| Thick                 | 17 (28.3)  | 27 (45.0)    | 44 (73.3)    |
| Total                 | 20 (33.3)  | 40 (66.7)    | 60 (100.0)   |

n – number of individuals

**Figure 2:** Parasagittal sections of cone-beam computed tomography for measurements of bone and gingival thickness and the distance from the cementoenamel junction to the bone crest. (a) Measures for bone thickness, BT1, 1 mm above the bone crest and BT3, 3 mm above the bone crest; (b) Measurements for gingival thickness, GT1, 1 mm above the bone crest and GT3, 3 mm above the bone crest; (c) Measurement of the cementoenamel junction to the crest to the cementoenamel junction–bone crest.
BT1 = 0.80 mm, BT3 = 0.83 mm, GT1 = 0.51 mm, and GT3 = 0.49 mm.

The bone thickness was always greater than the gingival thickness both in the measures 1 mm above the bone crest (GT1 and OT1) and in the measures 3 mm above the bone crest (GT3 and OT3). In the measurements obtained 1 mm above the bone crest, a significant and negative correlation was observed for teeth 12, 13, and 21. In the measurements obtained 3 mm above the bone crest, no significant correlations were observed. The averages of tomographic measurements performed for each tooth are described in Table 4 and their correlations in Table 5.

The average of the CEJ-BC distance in the individuals evaluated was 2.02 mm (±0.13) and the measurements per tooth are described in Table 4.

**DISCUSSION**

The characterization of PP and also the thickness of the gingival and bone tissues is of paramount importance, due to its influence on several dental procedures, mainly in the anterior region of the maxilla, an aesthetic area that can compromise the success of rehabilitation. The esthetic results of periodontal plastic surgeries and treatments with implants in the esthetic zone can be affected by different PPs.

Several classifications have been proposed for PPs, some dichotomous that divide the PPs in thin and thick. A more detailed classification showed a more specific division: thin scalloped, thick scalloped, and thick-flat scalloped PPs. In this study, thick-scalloped PP was most prevalent with 55%, followed by thin scalloped with 26.6%, and thick-flat scalloped with 18.33%, which is in agreement with the study that described the occurrence of thick PPs in two-third of the sample. Two studies showed thick-flat scalloped and thick scalloped PPs as the most prevalent, with no difference between men and women as found in this study as well.

Several factors must be considered when carrying out studies on PP, such as healthy periodontal tissue, probing depth <4 mm, healthy mucosa, absence of harmful habits, and conditions observed in the clinical evaluation of this study.

Clinical methods are used to measure gingival thickness, and consequently, to classify PPs, using the transparency of the periodontal probe through the gingival margin and through direct thickness measurements, requiring local anesthesia. These visual assessment methods may be inaccurate and vary according to the examiner’s experience, although they are the most used in clinical routine.

In recent years, CBCT has been used routinely in the investigation and planning of dental implants. It is used to assess bone quality and possible bone defects, in cases where there is the possibility of treatment with immediate implantation. In an attempt to decrease the discomfort in determining the thickness of soft tissues and eliminate limitations of preexisting methods, the authors suggest the use of CBCT images, when these examinations are available, to determine the thickness of the mucosa and gingiva. The use of the lip retractor while obtaining the image of the CBCT allows the subsequent measurement of gingival thickness without any interference. In our study, the lip retractor was used, following the methodology of Silva et al., seeking this precision in the evaluation of gingival thickness, although the CBCT method can be beneficial only to classify the thick PP.

In this study, the average CEJ-BC measurement was 2.02 mm, which is in agreement with the two studies that defined the biological width, represented by this measure, around 2 mm and corroborated by another study that also reported the average CEJ-BC value at 2 mm. The mean values of this study were also close to those described by Ghassemian et al.

Table 3: Width of keratinized tissue (mm) for each tooth according to gender

| Teeth | Mean |
|-------|------|
| 13    | 5.05 |
| 12    | 5.5  |
| 11    | 5.275|
| 21    | 5.25 |
| 22    | 5.175|
| 23    | 5.025|
| Female| 5.19 |
| Male  | 5.39 |
| Total | 5.28 |

Table 4: Mean (standard deviation) of measurements (mm) of bone thickness (BT1 and BT3) and gingival thickness (GT1 and GT3) and the distance between the enamel cementum junction and the bone crest (cementoenamel junction-bone crest) obtained in cone-beam computed tomography images

| Teeth | BT1 (0.16) | BT3 (0.13) | GT1 (0.15) | GT3 (0.20) | CEJ-BC (0.45) |
|-------|------------|------------|------------|------------|---------------|
| 11    | 0.88       | 0.85       | 0.65       | 0.57       | 1.87          |
| 12    | 0.77       | 0.85       | 0.52       | 0.53       | 2.12          |
| 13    | 0.71       | 0.84       | 0.43       | 0.35       | 1.87          |
| 21    | 0.87       | 0.85       | 0.56       | 0.54       | 1.99          |
| 22    | 0.84       | 0.80       | 0.48       | 0.54       | 2.19          |
| 23    | 0.75       | 0.79       | 0.43       | 0.42       | 2.07          |

BT = Bone thickness; GT = Gingival thickness; CEJ-BC = Cementoenamel junction-bone crest

Table 5: Correlation between bone and gingival thickness measurements

| r (P) | 11    | 12    | 13    | 21    | 22    | 23    |
|-------|-------|-------|-------|-------|-------|-------|
| BT1 x GT1 | 0.30 ** (−0.31) | 0.03 ** (−0.59) | 0.01 ** (−0.66) | 0.01 ** (−0.73) | 0.99 (−0.01) | 0.93 (−0.02) |
| BT3 x GT3 | 0.75 (−0.09) | 0.17 (−0.40) | 0.08 (−0.49) | 0.64 (−0.14) | 0.65 (−0.13) | 0.40 (−0.25) |

r = de Pearson; **P≤0.05 statistically significant. BT = Bone thickness; GT = Gingival thickness; r = Pearson’s coefficient; P = Significance level
who showed mean values for this measure of 2.28 mm in individuals under 30 years old. The respect for biological width is a fundamental requirement for the success of prosthesis, and its violation can generate gingival inflammation and gingival recession in buccal and lingual surfaces.

CBCT images have shown that the maxillary anterior teeth have thin bone thickness.[24,30] An average thickness of 0.9 mm was related[25] very similar to that found in this study where an average thickness of 0.80 mm was reported in BT1 and 0.83 mm in BT3. Another evaluation also reported that all bone thicknesses of the evaluated upper anterior teeth were <1 mm.[29] This fact reinforces the importance of special attention for periodontal and dental implant surgeries in the anterior maxillary region.

Bone thickness was lower in canines in both measures, according to the other studies that also showed thinner bone thickness in the canines when compared to maxillary incisors.[24,30] This fact associated with the dental anatomy of the canines, with a larger diameter in the cervical area and its position in the arch, may be factors that support gingival recessions in this area.

Measurements of gingival and bone thickness, with CBCT, were obtained 1 mm and 3 mm below the bone crest and gingival thickness which was always lower at these levels, in accordance with another CBCT evaluations.[8,24] There was a statistically negative correlation for teeth 12, 13, and 21, not clinically important, due to the small sample.

Bone and gingival thicknesses were variable from tooth to tooth in this evaluation, a fact that was related before.[24] The gingival and bone thicknesses were considered thin in our results, although 10 of the 13 individuals submitted to the CBCT examination were clinically classified as having a thick biotype, which may represent that the imaging examinations are different from the clinical analysis, which is routinely used. Different PPs can occur in different teeth, in the same patient.[30]

Thus, individualized clinical and tomographic evaluations can be fundamental requirements for the classification of PP and for a good oral rehabilitation or surgical planning, which determines satisfactory esthetic and functional results.

**CONCLUSIONS**

The thick PP was the most prevalent in the sample studied, both in males and females using the two classifications, and the WKT was significantly higher in the thick-flat scalloped PP when compared to the thick scalloped and the thin scalloped. The gingival thickness was always thinner than the bone thickness in the measures evaluated, and the average measure of biological width in the evaluated teeth was 2.02 mm.

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**Conflicts of interest**
There are no conflicts of interest.
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