REVISTA FOUFBA
ISSN 2764 - 2291
ORIGINAL PAPER
ARTIGO ORIGINAL

DIAGNOSIS OF GINGIVAL BIOTYPE IN THE ANTERIOR MAXILLARY REGION USING DIFFERENT METHODS.

DIAGNÓSTICO DO BIOTIPO GENGIVAL NA REGIÃO ANTERIOR DA MAXILA UTILIZANDO DIFERENTES MÉTODOS.

Clariana Goes da Silva[1]
Anne Maria Guimarães Lessa[2]
Ana Luísa Teixeira Meira[3]
Renato Corrêa Viana Casarin[4]
Iêda Margarida Crusoé Rocha Rebello[5]
Érica Del Peloso Ribeiro[6]

Uniterms:
Gingiva;
Dental Implantation;
Diagnosis.

ABSTRACT

Objective: The purpose of this study was to evaluate and compare methods of gingival biotype diagnosis; transparency of the probe, clinical measurement and cone beam computed tomography with removal of soft tissue. **Methods:** Thirty patients had the gingival thickness assessed in the buccal region of the dental units 11 and 21. Clinical and demographic characteristics such as age, gender, probing depth, gingival marginal position, clinical attachment level and dental morphology (crown width/crown length ratio) were investigated and correlated to gingival thicknesses obtained from the three diagnosis methods: 1) transparency of the periodontal probe through the gingival sulcus; 2) clinical method of transgingival probing through tissue with an endodontic spreader; 3) Cone Beam Computed Tomography with removal of soft tissue. **Results:** The average gingival thickness of the central incisors obtained by computed tomography was 1.46 mm ± 0.32 mm while the clinical average thickness was 1.32 ± 0.22 mm. Transparency tissue obtained a median of 2 (1.3-1.8, 95% CI), which means that biotype was considered thick in both units 11 and 21. The result of probe transparency was positively and significantly correlated with the thickness determined in tomographic and clinical evaluations. At the same time, the tomography and clinical measurements also showed a significant correlation between measurements. Multiple regression analysis indicated no significant impact of age, crown width/crown length ratio and periodontal parameters on gingival biotype measured by any of the diagnosis methods. **Conclusion:** It can be concluded that the evaluated diagnosis methods are positively correlated and can be used to determine tissue thickness on central incisors.

[1] Mestrado Clínica Odontológica da Escola Bahiana de Medicna e Saúde Pública.
[2] Aluna da Universidade Federal da Bahia, Faculdade de Odontologia
[3] Professora da Escola Bahiana de Medicina e Saúde Pública.
[4] Professor da Universidade Estadual de Campinas, Faculdade de Odontologia de Piracicaba.
[5] Professora Titular da Universidade Federal da Bahia, Faculdade de Odontologia.
[6] Professora Associada da Universidade Federal da Bahia, Faculdade de Odontologia.

Unitermos:

Gengiva;
Implantação dentária;
Diagnóstico.

RESUMO

Objetivo: Avaliar e comparar métodos de diagnóstico do biotipo gengival: transparência da sonda, mensuração clínica e tomografia computadorizada de feixe cônico com afastamento de tecidos moles. **Métodos:** Trinta pacientes tiveram a espessura gengival avaliada na região vestibular das unidades dentais 11 e 21. Características clínicas e demográficas como idade, sexo, profundidade de sondagem, posição da margem gengival, nível de inserção clínica e morfologia dental (relação largura/ comprimento da coroa) foram investigadas e correlacionadas com espessuras gengivais obtidas a partir de três métodos de diagnóstico: 1) transparência da sonda periodontal através do sulco gengival; 2) método clínico de sondagem transgengival com alargador endodôntico; 3) Tomografia Computadorizada Cone Beam com afastamento de tecidos moles. **Resultados:** A espessura média da gengiva dos incisivos centrais obtida por tomografia computadorizada foi de 1,46 mm ± 0,32 mm, enquanto a média da espessura clínica foi de 1,32 ± 0,22 mm. O método da transparência tecidual obteve mediana de 2 (1,3-1,8, 95% CI), o que significa que o biótipo foi considerado espesso na unidade 11 e 21. Houve correlação positiva e significante entre os resultados da transparência da sonda e da espessura determinada nas avaliações tomográficas e clínica. Ao mesmo tempo, a tomografia e as medidas clínicas também mostraram correlação significativa entre as medidas. A análise de regressão múltipla não indicou impacto significativo da idade, razão largura/comprimento da coroa e dos parâmetros periodontais no biótipo gengival medido por qualquer um dos métodos de diagnóstico. **Conclusão:** Pôde-se concluir que os métodos diagnósticos avaliados estão positivamente correlacionados e podem ser utilizados para determinar a espessura tecidual em incisivos centrais superiores.

INTRODUCTION

The term periodontal biotype was used by Seibert & Lindhe classifying the gingiva as either thin-scalloped or thick-flat. Other classifications have been presented[1], but since then studies have shown the clinical significance of tissue morphology. The influence in treatment outcome is possibly due to the difference in response to aggressions, since gingival thickness is related to the amount of blood supply[2,3].

The gingival biotype becomes an important factor influencing restorative and regenerative therapy especially with implants. Thick biotypes are more favorable for implant rehabilitation as they seem to conceal more convincingly both titanium and zirconia[4]. They are also more resistant to mucosal recession[5], improving the esthetics prognosis of same cases. The tissue thickness is also related to the stability of periimplant bone crest[6,7]. Therefore, the tissue biotype evaluation should be done prior to the rehabilitation treatment plannig considering the stability of periimplant hard and soft tissue depends on pre-implant gingival thickness[8] and the possibility to use techniques to improve tissue quality.

The diagnosis methods of gingival and mucosa biotype most commonly used are the visual evaluation, probe transparency, direct method, ultrasonic devices and cone beam computed tomography (CBCT). The visual evaluation method has proven inefficient and not reliable[1,9]. Some other techniques can be considered invasive[10], ineffective[1,9] or can be dependent on hard-to-access equipment[11]. Hence no ideal method seems to exist. This therefore can contribute to the absence of gingival thickness evaluation in routine preoperative diagnostics.

Thus, the aim of this study was to assess and correlate three methods used to diagnose gingival biotype, namely, probe transparency, clinical measurement and cone beam computed tomography by soft tissue separation (ST-CBCT). Specific goals consist in assessing the influence of gender, age, periodontal parameters (probing depth [PD], gingival margin position [GMP], clinical attachment level [CAL]), and tooth morphology of gingival biotypes.

MATERIAL AND METHODS

The present study was designed as a observational, cross-sectional survey. Prior to commencement, the study protocol was approved by the Research Ethics Committee of the Bahiana School of Medicine and Public Health, Salvador, Bahia, Brazil (authorization number 561.359). An informed consent form was signed by each subject after a through explanation of the nature, risks and benefits of the study.

Study population

Subjects were recruited from those referred for dental treatment to the Bahiana School of Medicine and Public Health and to the Dentistry School of Federal University of Bahia, Salvador, Bahia, Brazil. Subjects were enrolled from March to May 2015.

Sample size calculation was conducted considering 80% power, 0.2 mm standard error of the mean, and alpha = 5%. Thus, the sample consisted of 30 adults (over 18 years old), 15 women and 15 men. Subjects who were invited to participate met the following inclusion criteria: periodontal healthy patients, presence of all superior central incisors and existence of a clinical reason to request a ST-CBCT of the maxilla. Exclusion criteria were as follows: prior surgery in the anterior maxilla; consumption of medications that might interfere with the visual gingival aspect (immunosuppressant, calcium channel blocker or anticonvulsant); patients with severe morphological changes, restorations and/or sub-gingival prosthesis on superior central incisors and pregnant or breastfeeding women.

Assessment of dental morphology

By using type IV plaster models (Durone IV, Dentsply, New York, USA), and with the aid of a centesimal precision digital caliper (Mytutoio®, São Paulo, SP, Brazil) the length and width of both central incisors (CIs) were measured following the method of Olsson and Lindle[12]. The crown length was measured as the distance between the incisal border of the crown and the free gingival margin or cemento enamel junction (CEJ) on the longer length of central incisors. Crown width (CW) was measured, after evenly dividing the crown length (CL) into three parts (incisal 1/3, middle 1/3, and cervical 1/3), from mesial to distal in the line dividing middle 1/3 and cervical 1/3. As a result, a CW/CL ratio of the crown was calculated. This ratio was used to classify teeth as narrow or wide.

Periodontal assessment

The following clinical periodontal parameters were measured: probing depth (PD), gingival margin position (GMP), and clinical attachment level (CAL). All measurements were recorded by a single calibrated researcher (ALTM) with the use of a North Carolina periodontal probe (Hu-Friedy®, Chicago, IL, USA) on superior central incisors at six sites per tooth.

The investigator was calibrated for intraexaminer repeatability prior to the start of the trial. Three patients were enrolled for this purpose. Duplicate measurements for PD and CAL were collected with an interval of 24 hours. The intraclass correlation coefficients as a measure of intraexaminer reproducibility were 0.83 and 0.87 for mean PD and CAL, respectively.

Gingival biotype assessment

Each individual's gingival thickness was assessed by three different methods. In evaluating the transparency of the probe, a single researcher used a North Carolina periodontal probe (Hu-Friedy®, Chicago, IL, USA) to probe the buccal gingival sulcus in the mid-buccal region of central incisors. If the outline of the underlying periodontal probe could be seen through the gingiva, it was categorized as thin and if not, it was categorized as thick. This resulted in three possible scores on a patient level: 0 (thin biotype on both central incisors), 1 (biotype divergence between incisors), or 2 (thick biotype on both central incisors)[13].

To do the clinical measurement, marks were made 2 mm apical to the gingival margin on the mid-buccal region of the teeth, employing a North Carolina periodontal probe (Hu-Friedy®, Chicago, IL, USA). After local topic anesthetic (Benzocaína 200mg/g, DFL **®),** gingival thickness was measured by transfixion with an endodontic reamer coupled to a rubber stopper. The spacer region that corresponded to the gingival thickness was converted to numbers using a centesimal precision digital caliper (Mytutoyo®, São Paulo, SP, Brazil). Thereafter, the biotype was classified as thin (<1.0 mm), or thick (≥1.0 mm)[10].

To use ST-CBCT to measure gingival thickness, a plastic lip and cheek retractor (Expandex®, Indusbello, Londrina, PR, Brazil) was placed in each patient. Subsequently, their maxillas were scanned by cone beam computed tomography using an EAGLE 3D scanner (Dhabi Atlante®, Ribeirão Preto, SP, Brazil), at a 1:1 ratio. Scanning time was 20 sec, 85 kVp, 63 mA high and voxel size 0.2 mm.

In the sagittal section, measurements were made of gingival thickness (GT) and bone thickness (BT) of CIs by the same examiner (CG). Measurements were made using OsX software (OsiriX, Lite, image software, Apple, CA). A line was drawn parallel to the long axis of the tooth. Perpendicular measurements were performed, 2 mm and 5 mm apical to the gingival margin to assess gingival and bone thickness, respectively. The gingival biotype was classified as either thin (<1.0 mm), or thick (≥1.0 mm).

Statistical Analysis

The analyses were performed with SAS 9.03 release and Bioestat 5.0 software, with 5% significance level. Demographic data were grouped and presented as means and standard deviations. To evaluate the methods used to determine gingival thickness, correlation models were built. The measurement techniques were considered as dependent variables (clinical thickness, tomographic or gingival transparency, separately), whereas the independent variables were age, gender, tomographic bone thickness, CW/CL, GMP, PD and CAL. Normality was initially confirmed by the Shapiro-Wilk test, while chi-square tests were used for qualitative variables, and Pearson's correlation test and Student's t-test for the quantitative variables. In order to model multiple regression models, only variables whose $p<0.10$ were included, and in the final multiple regression model, those with $p\leq0.05$ were considered significant variables. In addition, to determine concordance between the techniques, Pearson's correlation test (for clinical and tomographic gingival thickness techniques), and Spearman test (for clinical gingival thickness and tissue transparency techniques, as well as for tomographic gingival thickness and tissue transparency) were applied.

RESULTS

Thirty patients with a mean age of 42.43 (±10.89) years, and 60 maxillary CIs were included in the study. The clinical reason for ST-CBCT of the maxilla was planning for implants or gingivectomy. Power level was set at 0.81. Probe transparency obtained a median value of 2 (1.27 to 1.70, 95% CI). Mean gingival thickness by ST-CBCT was 1.46 ± 0.32 mm. Clinically, the mean gingival thickness was 1.32 ± 0.22 mm. A significant positive correlation was found between the diagnosis methods ($p<0.05$) (Table 1). Thus, a linear correlation could be established between tomographic and clinical measurements (Figure 1).

Table 1. Correlation (r, p) between the measuring techniques of gingival thickness

	Mean / Median (mm)	SD/95% CI	r	p
Clinical measurement	1.32	0.22	0.62	**0.0003**
ST-CBCT	1.46	0.32		
Clinical measurement	1.32	0.22	0.46	**0.01**
Transparency of the probe*	2	1.27-1.70		
ST-CBCT	1.46	0.32	0.43	**0.02**
Transparency of the probe*	2	1.27-1.70		

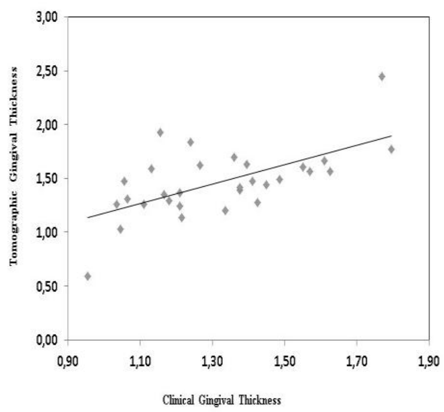

Figure 1. Linear correlation between clinical gingival thickness (mm) and tomographic gingival thickness (mm).

Multiple regression analysis indicated no significant impact of age, CW/CL, PD, GMP and CAL on gingival biotype for any of the test methods (p>0.05). However, the clinical measurement technique was influenced by gender (p=0.02) (Table 2). The gingival thickness measured by the tomographic method was associated with bone thickness (r=0.46; p=0.01), establishing a linear correlation between them (Figure 2). The sample population was mainly classified as having a thick gingival biotype (Table 3).

Table 2. Association between demographic, clinical and measurement methods of the gingival thickness. Student's t-test and chi-square test (p < 0.05). (BT = bone thickness, CW/CL = crown width/crown height ratio, PD = probing depth , GR = gingival recession, CAL = clinical attachment level, r = correlation, p = statistical significance, SD = standard deviation)

			Clinical measurement		ST-CBCT		Transparency of the probe	
	Mean	SD	r	p	r	p	r	p
Age	42.43	10.89	-0.14	0.45	-0.02	0.91	0.29	0.12
BT	0.85	0.29	0.07	0.70	**0.46**	**0.01**	0.00	0.99
CW/CL	0.89	0.16	-0.10	0.61	0.24	0.20	0.18	0.34
PD	2.18	0.26	0.14	0.46	0.12	0.52	0.03	0.88
GR	0.23	0.63	-0.18	0.35	-0.10	0.60	0.13	0.51
CAL	2.42	0.76	-0.10	0.61	-0.04	0.83	0.00	0.98

		Clinical measurement			ST-CBCT			Transparency of the probe			
		Mean	SD	p	Mean	SD	p	0	1	2	p
Gender	Female	1.23	0.18		1.41	0.38		20.0%	26.7%	53.3%	
	Male	1.41	0.22	**0.02**	1.52	0.39	0.38	6.7%	13.3%	80.0%	0.19

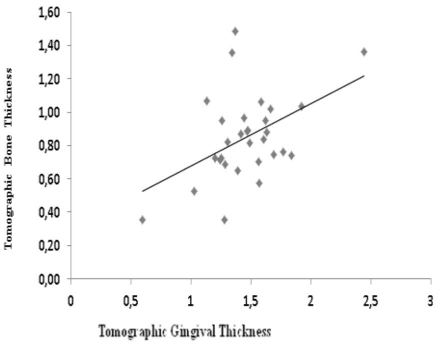

Figure 2. Linear correlation between tomographic gingival thickness (mm) and tomographic bone thickness (mm).

Table 3. Distribution of thin and thick biotypes on the right and left central incisor. ST-CBCT = soft tissue cone beam computed tomography.

Teeth	Gingival Biotype	Transparency of the probe	Clinical measurement	ST-CBCT
Right central incisor	Thin	23,3%	3,33%	13,33%
	Thick	76,7%	96,67%	86,67%
Left Central incisor	Thin	23,3%	6,66%	6,66%
	Thick	76,7%	93,34%	93,34%

DISCUSSION

The thin gingival biotype has been associated with buccal recession[14-16], translucent prosthetic material[4], higher cervical bone loss rates[7], and is more prone to periimplant disease in implant-supported rehabilitation[17]. Thus, tissue biotype is a significant factor that influences treatment outcomes and for these reason it is necessary to accurately diagnose it so that reverse planning can prevent or minimize possible complications. The most common classification is the thin vs. thick tissue biotype dichotomy.

Since the simple visual evaluation of gingival biotype is unreliable even for seasoned professionals[1,9], methods of diagnosis have been proposed and studied. The present study aimed to evaluate and compare the diagnosis methods of transparency of the periodontal probe, clinical and tomography measurements. Correlation models were constructed for each pair of techniques. A statistically significant positive correlation was found between the three pairs.

The direct clinical measurement of buccal gingival thickness started being reported using perforating instruments[10]. Changes in the direct measurement technique include the use of adapted blunt-ended thickness gauges used after extraction[18], or with the aid of digital calipers to determine buccal thickness. Although today clinical measurement is considered the gold standard of gingival thickness evaluation techniques, measurement errors are likely to occur due to the angulations of perforating instruments[10], or resulting from changes in tissue volume after anesthetic infiltration. Measurements during the operative period should be avoided since an early diagnosis helps in developing an ideal surgical-prosthetic planning[10]. With that in mind, the clinical measurement realized in the present study is a method used for diagnosis prior to surgery that has a documented precision with minor discomfort for the patient[19].

The computed tomography (CT) has been described as a possible noninvasive method to measure the thickness of the masticatory mucosa[12,20,21]. Nevertheless, the radiographic protocol necessary to ensure accuracy when using this technique has not yet been well established[13,21,22]. There may be variations between CT types (CBCT/Computed Tomography; Spiral CT), the various CT equipment manufacturers, slice thickness, and the software used to perform the post-scan measurements. Although CBCT exhibits a low contrast power, making it difficult to distinguish between the different soft tissues, the use of lip and cheek retractors[20,23], or simply stretching the cheeks[13,24] makes up for these disadvantages, thus enabling oral soft tissues to be measured. CBCT requires low exposure time, which results in low doses, particularly when compared to spiral CT. The downside involves the fact that besides being a quantitative method it does not allow for a distinction between connective tissue and epithelial tissue, and healthy conditions vs. periodontal disease[20]. Furthermore, values are likely to be overestimated in CBCT, according to studies that assessed palatal tissue thickness[25].

The present study found a positive correlation between clinical measurements buccally to the CIs, and tomographic gingival thickness using a 0.2 mm voxel size. This confirms the hypothesis that ST-CBCT can be used as a diagnostic tool for gingival thickness along with the methods already established in the clinical literature as the clinical measurements and the probe transparency technique. However, further investigation is warranted to confirm the ideal CT slice thickness and to ascertain the accuracy of a variety of software currently used in evaluating post-scan soft tissue.

The tissue transparency method proposed by Kan et al.[26] distinguishes between thin and thick biotype by examining the transparency – or non-transparency – of a periodontal probe through the buccal gingival sulcus. Duplicate assessments by the same examiner found that the method has a high reproducibility, around 85 to 90%[2,27,28]. The main disadvantage is not to be able to quantify the gingival thickness. Although, in the present study, this method was confirmed to be useful in the diagnosis of gingival biotype since it was correlated with the other two quantifying method. This is also confirmed in a study comparing the correlation between tissue transparency and clinical measurement where no statistical difference was found between the two methods. Moreover, when clinical thickness decreased below 0.6 mm or increased above 1.2 mm there was a 100% match between the two techniques[18].

No positive correlation was found in the three techniques between buccal gingival biotype and age. It should be indicated that the mean age was 42.43 (ranging from 19 to 65 years). Thus, the sample was considered young, which may have exerted some impact on the result. Studies relating age to buccal gingival thickness are scarce in the literature or with relatively younger age sample[15], with mostly contradictory results[29,30].

To assess the gender variable, this study used a paired sample (15 men and 15 women). The clinical measurement technique was the only method showing to be statistically impacted by gender. It is important to remind that this result was achieved in a sample characterized by a low percentage of CIs with a thin biotype. As regards tissue transparency, 80% of the men and 53.3% of the women exhibited a thick biotype for both CIs. The mean buccal gingival thickness was thick (> 1 mm) for both men and women when using the clinical and tomographic diagnosis techniques. Further research with samples paired by tissue thickness might help to assess the impact of gender on buccal gingival thickness. Other studies, using tissue transparency[30], direct measurement of the maxilla[29,31], and CBCT of the palatal mucosa[21] also failed to establish a relationship between gingival biotype and gender. Paradoxically, some studies using tissue transparency reported an association between gender and gingival thickness[2,27,32].

The mean bone thickness obtained was 0.85 mm (± 0.29 mm), which is consistent with the mean found in the literature[19]. Furthermore, a positive statistically significant correlation was found between bone and gingival thickness measured with ST-CBCT. Also with this method, the mean buccal bone thicknesses were 0.63 mm and 0.87 mm for the thin and thick biotypes, respectively. It is suggested that when measuring two variables (bone thickness-BT and gingival thickness-GT) with the same technique, using the same scanning protocol (voxel size, volume and definition) and the same sagittal section, less minor dimensional changes occur[33]. The ST-CBCT was used in 144 patients to assess the relationship between facial bone thickness (BT) and gingival thickness (GT) in maxillary anterior teeth. To determine the gingival biotype, GT was measured 2 mm apical to the gingival margin. The mean of bone thickness and gingival thickness in the two biotypes was 0.35 mm and 0.99 ± mm at thin biotype and 0.52 mm and 1.24 mm for thick biotype. The bone thickness at all levels was greater in patients with thick biotype compared to those with thin biotype[33]. Another *in vivo* study evaluating the buccal BT determined in the ST-CBCT in different biotypes diagnosed by the transparency of the probe, observed that the thin biotype had the buccal bone plate less thick when compared to the thick gingival biotype[30]. Systematic review confirmed that gingival biotype may be a reliable indicator for estimating the thickness of buccal bone in maxillary anterior region[34].

This study found no relationship between CW/CL ratio and gingival thickness in any of the three methods evaluated. The hypothetical relationship between dental morphology and gingival thickness was not confirmed in studies evaluating gingival thickness with the probe transparency method [27,30,32]. Neither was such correlation found with the aid of an ultrasonic device[19]. Mean CW/CL for the CIs was 0.89, very close to the mean found in other published studies, namely, 0.80[27], 0.81[2], 0.88[12]. These results suggest that population in general might have wide teeth, although this not a good indicator of a thick gingival biotype.

Some periodontal parameters (PD, CAL and GMP) were collected in order to evaluated a possible correlation between them and the gingival thickness. The sample yielded means indicate periodontal health (PD: 2.18 ± 0.26 mm/ CAL: 2.42 ± 0.76 mm), and a low prevalence of gingival recession (0.23 ± 0.63 mm). No correlation was found between these parameters and periodontal gingival thickness in any of the techniques under evaluation. These results are in accordance with other studies that did not found association between PD and GMP and the gingival biotype[30,32]. However, another study[12] observed that the means of PD, CAL and GMP were different in thin and thick biotype. This should be interpreted with caution, since the sample had patients with untreated periodontal disease and the biotype classification was made by the CW/CL ratio. In this study, few teeth exhibited recession. This may be due to the patients low mean ages and their good periodontal condition.

The future prospects of gingival thickness measurement methods include three-dimensional techniques. Clinical images, obtained through CAD-CAM technologies, oral scanners and virtual models can be superimposed on maxillo-mandibular bone reconstructions obtained in CBCT. Thus, the gingival thickness could be measured after the images overlap. However, these methods still present great distortions and need for research to verify clinical correspondence[21,35].

CONCLUSIONS

Within the study population, with thick gingival biotype, the three methods evaluated, transparency of the probe, clinical measurement and ST-CBCT were equivalent and can therefore be used reliably in diagnosing the gingival biotype of maxillary central incisors (CIs). The gingival biotype did not correlate with age, dental morphology and periodontal clinical parameters in any of the techniques evaluated, but the clinical measurement technique was influenced by gender. Bone thickness and gingival thickness measured with ST-CBCT are positively correlated.

REFERENCES

1. Eghbali A, De Rouck T, De Bruyn H, Cosyn J. The gengival biotype assessed by experienced and inexperienced clinicians. J Clin Periodontol. 2009 Nov; 36 (11): 958-63. https://doi.org/10.1111/j.1600-051X.2009.01479.x.
2. De Rouck T, Eghbali R, Collys K, De Bruyn H, Cosyn J. The gingival biotype revisited: transparency of the periodontal probe through the gingival margin as a method to discriminate thin from thick gingiva. J Clin Periodontal. 2009 May; 36 (5):428-33. https://doi.org/10.1111/j.1600-051X.2009.01398.x.
3. Kao RT, Fagan MC, Conte GJ. Thick vs. thin gingival biotypes: A key determinant in treatment planning for dental implants. J Calif Dent Assoc. 2008 Mar; 36 (3):193-8.
4. Jung RE, Hammerle CHF, Attin T, Schmidlin P. In vitro color changes of soft tissues caused by restorative materials. Int J Periodontics Restorative Dent. 2007 Jun; 27 (3): 251-7.
5. Sorní-Broker M, Peñarrocha-Diago M, Peñarrocha-Diago M. Factors that influence the position of the peri-implant soft tissues: A review. Med Oral Patol Oral Cir Bucal. 2009 Sep 1; 14 (9): 475-9.
6. Linkevicius T, Apse P, Grybauskas S, Puisys A. The influence of soft tissue thickness on crestal boné changes around implants: A 1-year prospective controlled clinical trial. Int J Oral Maxillofac Implants. 2009 Jul-aug;24 (4):712-9
7. Suárez-López Del Amo F, Lin GH, Monje A, Galindo-Moreno P, Wang HL. Influence of Soft Tissue Thickness on Peri-Implant Marginal Bone Loss: A Systematic Review and Meta-Analysis. J Periodontol. 2016 Jun;87(6):690-9. https://doi.org/10.1902/jop.2016.150571.
8. Fu JH, Lee A, Wang HL. Influence of tissue biotype on implant esthetics. Int J Oral Maxillofac Implants. 2011 May-Jun; 26 (3): 499-508.
9. Cuny-Houchmand M, Renaudin S, Leroul M, Planche L, Le Guchennec L, Soucidan A. Gingival biotype assessement: visual inspection relevance and maxillary versus mandibular comparison. Open Dent J. 2013; 7: 1-6. https://doi.org/10.2174/1874210601307010001.
10. Goaslind GD, Robertson PB, Mahan CJ, Morrison WW, Olson JV. Thickness of facial gingiva. J Periodontol. 1977 Dec; 48 (12): 768-71. https://doi.org/10.1902/jop.1977.48.12.768.

11. Muller HP, Heinecke A, Schaller N, Eger T. Masticatory mucosa in subjects with different periodontal phenotypes. J Clin Periodontal. 2000 Sep; 27 (9): 621-6. https://doi.org/ 10.1034/j.1600-051x.2000.027009621.x.

12. Olsson M, Lindhe J. Periodontal characteristics in individuals with varying form of the upper central incisors. J Clin Periodontal. 1991 Jan; 18 (1): 78-82. https://doi.org/ 10.1111/j.1600-051x.1991.tb01124.x.

13. Dvorak G, Arnhart C, Schon P, Heuberer S, Watzek G, Gahleitner A. The "puffed cheek method" to evaluate mucosal thickness: case series. Clin Oral Impl Res. 2013 Jul; 24 (7): 719-2. https://doi.org/10.1111/j.1600-0501.2012.02469.x.

14. Zigdon H, Machtei EE. The dimensions of keratinized mucosa around implants affect clinical and immunological parameters. Clin Oral Impl Res. 2008 Apr; 19 (4): 387-92. https://doi.org/10.1111/j.1600-0501.2007.01492.x.

15. Shah DS, Duseja S, Vaishnav K, Shah RP. Adaptation of gingival biotype in response to prosthetic rehabilitation. Adv Hum Biol. 2017 May-Aug; 7 (2): 85-8. https://doi.org/10.4103/AIHB.AIHB_30_16.

16. Kinaia BM, Ambrosio F, Lamble M, Hope K, Shah M, Neely AL. Soft tissue changes around immediately placed implants: a systematic review and meta-analyses with at least 12 months of follow-up after functional loading. J Periodontal. 2017 Sep; 8 (9): 876-886. https://doi.org/10.1902/jop.2017.160698.

17. Casado PL, Bonato LL, Granjeiro JM. Relação entre fenótipo periodontal fino e desenvolvimento de doença peri-implantar: avaliação clínico-radiográfica. Braz J Periodontol. 2013; 23 (1): 68-75.

18. Kan JYK, Morimoto T, Rungcharassaeng K, Roe P, Smith DH. Gingival Biotype assessment in the Esthetic Zone: Visual Versus Direct Measurement. Int J Periodontics Restorative Dent. 2010 Jun; 30 (3): 237-43.

19. Claffey N, Shanley D. Relationship of gingival thickness and bleeding to loss of probing attachment in shallow sites following nonsurgical periodontal therapy. J Clin Periodontal. 1986 Aug; 13 (7): 654-7. https://doi.org/10.1111/j.1600-051x.1986.tb00861.x.

20. Barriviera M, Duarte WR, Januário AL, Faber J, Bezerra ACB. A new method to assess and measure palatal masticatory mucosa by cone beam computerized tomography. J Clin Periodontal. 2009 Jul; 36 (7): 564-8. https://doi.org/10.1111/j.1600-051X.2009.01422.x.

21. Yan S, Shi SG, Niu ZY, Pei ZH, Shi SM, Mu C. Soft tissue image reconstruction using cone-beam computed tomography combined with laser scanning: a novel method to evaluate the masticatory mucosa. Oral Surg Oral Med Oral Pathol Oral Radiol. 2014 Dec; 118 (6): 725-731. https://doi.org/10.1016/j.oooo.2014.08.012.

22. Ueno D, Sato J, Igarashi C, Ikeda S, Morita M, Shimoda S. Accuracy of oral mucosal thickness measurements using spiral computed tomografy. J Periodontol. 2011 Jun; 82 (6): 829-36. https://doi.org/10.1902/jop.2010.100160.

23. Januário AL, Barriviera M, Duarte WR. Soft tissue cone-beam computed tomography: a novel method for the measurement of gingival tissue and the dimensions of the dentogingival unit. J Esthet Restor Dent. 2008; 20 (6): 366-73; discussion 374. https://doi.org/10.1111/j.1708-8240.2008.00210.x.

24. Bredesen K, Aalokken TM, Kolbenstvedt A. Ct of the oral vestibule with distended cheeks. Acta radiol. 2001 Jan; 42 (1): 84-87.

25. Ueno D, Sekiguchi R, Morita M, Jayawardena A, Shinpo S, Sato J, et al. Palatal mucosal measurements in a japonese population using cone-beam computed tomography. J Esthet Restor Dent. 2014 Jan-Fev; 26 (1): 48-60. https://doi.org/10.1111/jerd.12053.

26. Kan JYK, Rungcharassaeng K, Umezu K, Kois JC. Dimensions of peri-implant mucosa: An evaluation of maxillary anterior single implants in humans. J Periodontol. 2003 Apr, 74 (4): 557-62. https://doi.org/10.1902/jop.2003.74.4.557.

27. Anand V, Govila V, Gulati M. Correlation of gingival tissue biotypes with gender and tooth morphology: A randomized clinical study. Indian J Dent. 2012; 3 (4):190-5. https://doi.org/10.1016/j.ijd.2012.05.006

28. Lee SP, Kim TI, Kim HK, Shon WJ, Park YS. Discriminant analysis for the thin periodontal biotype based on the data acquired from three-dimensional virtual models of korean young adults. J Periodontol. 2013 Nov; 84 (11): 1638-45. https://doi.org/10.1902/jop.2013.120594.

29. Vandana KL, Savitha B. Thickness of gingiva in association with age, gender and dental arch location. J Clin Periodontol. 2005 Jul; 32 (7): 828-30. https://doi.org/10.1111/j.1600-051X.2005.00757.x.

30. Cook DR, Mealey BL, Verrett RG, Mills MP, Noujeim ME, Lasho, DJ, et al. Relationship between clinical periodontal biotype and labial plate thickness: an in vivo study. Int J Periodontics Restorative Dent. 2011 Jul-Aug; 31 (4):345-54.

31. Shah R, Sowmya NK, Mehta DS. Prevalence of gingival biotype and its relationship to clinical parameters. Contemp Clin Dent. 2015 Sep; 6(1): S167-71. https://doi.org/10.4103/0976-237X.166824.

32. Fischer KR, Grill E, Jockel-Schneider Y, Bechtold M, Schlagenhauf U, Fickl S. On the relationship between gingival biotypes and supracrestal gingival height, crown form and papilla height. Clin Oral Impl Res. 2014 Aug; 25 (8): 894-8. https://doi.org/10.1111/clr.12196.

33. Amid R, Mirakhori M,Safi Y, Kadkhodazadeh M, Namdari M. Assesment of gingival biotype and facial hard/soft tissue dimensions in the maxillary anterior teeth region using cone beam Computed tomography. Arch Oral Biol. 2017; 79: 1-6. https://doi.org/10.1016/j.archoralbio.2017.02.021.

34. Anegundi RV, Shenoy SB, Punj A. Gingival biotype as an indicator for the buccal bone thickness - a systematic review of the literature. Evid Based Dent. 2021 Nov 23. https://doi.org/10.1038/s41432-021-0206-y.

35. Ronay V, Sahrmann P, Bindl A, Attin T, Schmidlin PR. Current status and perspectives of mucogingival soft tissue measurement methods. J Esthet Restor Dent. 2011 Jun; 23 (3): 146-57. https://doi.org/10.1111/j.1708-8240.2011.00424.x.

Recebido em 27 de novembro de 2023

Aceito em 07 de abril de 2025

Endereço para correspondência
Clariana Goes da Silva
E-mail: goesclariana@gmail.com
Escola Bahiana de Medicina e Saúde Pública
Endereço: Rua Silveira Martins,100, Cabula, 41150-100, Salvador, Bahia.