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The Gingival Biotype: Gaining New Insights into Soft and Hard Tissue Dimensions - A Radiographic Morphometric Study.

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Abstract

Introduction: Knowledge of the periodontal biotype is valuable and of key importance to the clinician. Distinct tissue biotypes respond in different manners to restorative and surgical treatment and to inflammation. Gingival biotype is one of the factors that may hinder the success in dental treatments.

AIM: The aim of this study was to evaluate the inter-relationship of alveolar bone thickness and thickness of the buccal gingiva at different apico-coronal levels.

Methods: In 30 periodontally healthy subjects, clinical and radiographic parameters were measured at the right maxillary central incisor. Clinical parameters included the gingival width (GW), gingival scallop (SC), and crown width/crown length ratio (CW/CL). Gingival and alveolar bone dimensions were assessed on parallel profile radiographs. Gingival thickness was measured at two points on the free gingiva (G1, G2), three points at the supracrestal attachment (G3, G4, G5), and at one point at the bone crest level (G6). Thickness of the buccal alveolar bone was assessed at the bone crest level (A1), between the coronal and middle third of root (A2), and between the middle and apical third (A3) of the root. The correlation between these parameters was analyzed using the Pearsons correlation coefficient test.

Results: All parameters showed weak correlation overall. However, G6 (thickness of attached gingival at bone crest) was found to be moderately associated though not approaching statistically significant. with CW/CL, A2 (alveolar bone thickness between coronal and middle third of root), and A3 (alveolar bone thickness between middle third and apical third of root). G4 (supracrestal attached gingiva) also showed moderate correlation with A3.

CONCLUSION: Our findings suggest that crown form (CW/CL) and thickness of attached gingiva at bone crest (G6) are helpful indicators of alveolar bone thickness.

Key words - Gingiva; Alveolar process; Odontometry; Dental Radiovisiography.

Introduction

Gingival biotype is described as the thickness of the gingiva in the faciopalatal/ faciolingual dimension.[1,2,3] Anatomical characteristics of the periodontium, such as gingival width and alveolar bone morphology, determine the behavior of periodontium when subjected response to procedures like periodontal surgeries[4], dental implants[5,6] and orthodontic treatment.

Ochsenbein and Ross developed the concept of "periodontal biotype" and classified gingiva into thick flat and thin scalloped biotypes based on phenotypical characteristics of gingiva.[7]

Patients with thick-flat biotypes show short papillae and thin-scalloped biotypes show long papillae. This morphometric discrepancy could lead to more papilla loss in thin biotype patients. The characteristic features of tissue with thick biotype include less pronounced or flat soft tissue and bony architecture, denser and relatively more fibrotic soft tissue, increased amount of attached masticatory mucosa , and respond to disease by formation of pocket and infra bony bone defects. Moreover, the teeth are more square in shape.[8]

Reserchers have observed an association between the gingival biotype and soft tissue destruction in periodontal disease.[9,10] Also it has been observed thin biotype patients have an increased propensity for recession,[11] and increased loss of alveolar bone post extraction[3]. A probable reason for which might be the observed correlation between gingival thickness and alveolar bone thickness.[12] The thick biotype on the other hand has been reported to have better treatment outcome in procedures such as recession coverage[13] and implant surgery.[2] Thus it can be stated that the biotype of gingiva has a direct bearing on the pathogenesis of periodontal disease and response to therapy.

A Study conducted by **Hirschfeld L.A** and **Morris ML** showed that the gingival margin and the alveolar bone surrounding a tooth with pronounced cervical convexity are located more apically than they would be in teeth with flat surfaces, suggesting that the gingival margin is also affected by the cervical convexity or morphology of the crown.[14,15]

Normally, facial gingiva is thinner in the mandible than in the maxilla. Mandibular first premolars and Maxillary canines have the thinnest gingiva (0.7-0.9 mm), with a relatively high incidence of gingival recession.[16,17]

A broad classification of techniques to assess gingival thickness and biotype can be described as direct and indirect. Direct techniques include transgingival probing [18] ultrasonic devices[19] and probe transparency[1]. These suffer from several disadvantages such as limited reproducibility, requirement of additional chair side time, and provide no information on alveolar bone morphology.

Indirect techniques either use surrogate parameter such as crown form (Slender and long) versus square and short [20] or radiographic technique. An advantage of using radiographic technique is the ability to measure alveolar bone thickness and morphology; further they can be combined with screening or diagnostic radiography thus reducing chair side time.

There exists a paucity of research on gingival biotype in the Indian population. Therefore, an accurate determination of gingival biotype and the factors affecting it are of importance for designing appropriate treatment plan and achieving a predictable esthetic outcome.

Thus, the aim of the present study was to evaluate the interrelationship of alveolar bone thickness and other parameters {gingival width (GW), gingival scallop (SC), and crown width/crown length ratio (CW/CL)} with the thickness of the buccal gingiva at different apico-coronal levels..

Material and Methods

Study population consisted of 40 volunteers of 21 to 25 year of age group (23 male and 17 female) who were enrolled in the study from the students and administrative and services personnel of the Faculty of the Department of Periodontology and Implantology, in the College of Dental Sciences and Research Center, Ahmedabad, between April to June 2016. The study was designed as cross-sectional study.

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The purpose of the study was explained to all volunteers, and written informed consent was obtained in all cases. The study was approved by ethical committee of College of Dental Sciences and Research Centre, Ahmedabad. Inclusion criteria were defined for the study: (1) periodontally healthy patient. (2) no missing teeth in maxillary anterior segment. (3) no history of orthodontic or restorative procedure in maxillary anterior region and (4) systemically healthy individuals. Seven exclusion criteria were defined for study: (1) any medication intake known to cause gingival overgrowth, (2) pregnancy, (3) systemic diseases having gingival manifestations and with influence on bone metabolism, (4) patient with periodontal probing depths more than or equal to 4mm, (5) patient having periodontal recessions, (6) teeth with incisal attrition, (7) crown restorations or fillings in the maxillary central incisor area.

The participants meeting the inclusion criteria underwent a clinical oral and radiographic examination (parallel profile radiograph) as described below.

After undergoing the clinical and radiographic examination, quality control of the radiographs was assessed leading to a second exclusion of subjects not meeting the following quality criteria.

Firstly, The following anatomic landmarks had to be clearly identified on the radiographs without superimpositions: lead plate, cemento-enamel junction (CEJ), bone crest, buccal surface of the bone plate, buccal root surface. Second, The lead plate had to be detectable on all radiographs defining the gingival profile in each subject and only the profile of the plate was to be visible with a minimal thickness over the entire length thus ensuring the correct tangential position of the tooth. Following radiograph quality assessment, the final study consisted of 30 participants

Calculation of sample size was made on the basis of method as described by **Hulley SB et al. (2013)**[21]. Which utilized the following assumptions: 1) α (two tailed)= 0.05,which is the threshold probability for rejecting the null hypothesis also called as type I error. 2) β =0.200, which is the probability of accepting the null hypothesis when it is false, also called type II error. B value was chosen as desired study power was 80%. r value was taken as 0.500, which is the hypothesized excepted correlation coefficient. The following formulas were used - Standard normal deviation for $\alpha=Z_\alpha=1.96$ and $\beta=Z_\beta=0.842$. $C=0.5*\ln[(1+r)/(1-r)]=0.549$. Total sample size= $N= [(Z_\alpha+Z_\beta)/C]^2+3 = 29$. On the basis of this if r = 0.5 then sample size=29. So we took 30 sample size.

Clinical examination

All clinical oral examinations (direct measurements) and radiographic analysis were performed on the maxillary right central incisor (index tooth).

The clinical assessments were directly measured using a periodontal probe (CP 15 UNC; Hu-Friedy) and were as follows: 1) Width of the keratinized gingiva (GW) measured from the midbuccal position of the marginal gingiva to the mucogingival junction. 2) Height of the gingival scallop (SC) measured as the widest distance between the line formed by the connection of the highest point of the two adjacent inter-dental papillae and the most apical position of the buccal marginal gingiva [22]. 3) Crown width/crown length ratio: (CW/CL): Crown width/crown length ratio (CW/CL) of the right and the left central incisor were measured. The assessment was recorded with the help of vernier calipers. Wherein, the crown length was measured as the distance from the incisal edge of the crown to the free gingival margin, while the crown width was recorded as the border between the middle and the cervical portion.[22] [**Fig- 1a and 1b**].

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A lead plate (5.0 × 1.0 × 0.1 mm) placed on the gingiva as described below was used as a reference point for all measurements in the radiograph (**Fig.2).**

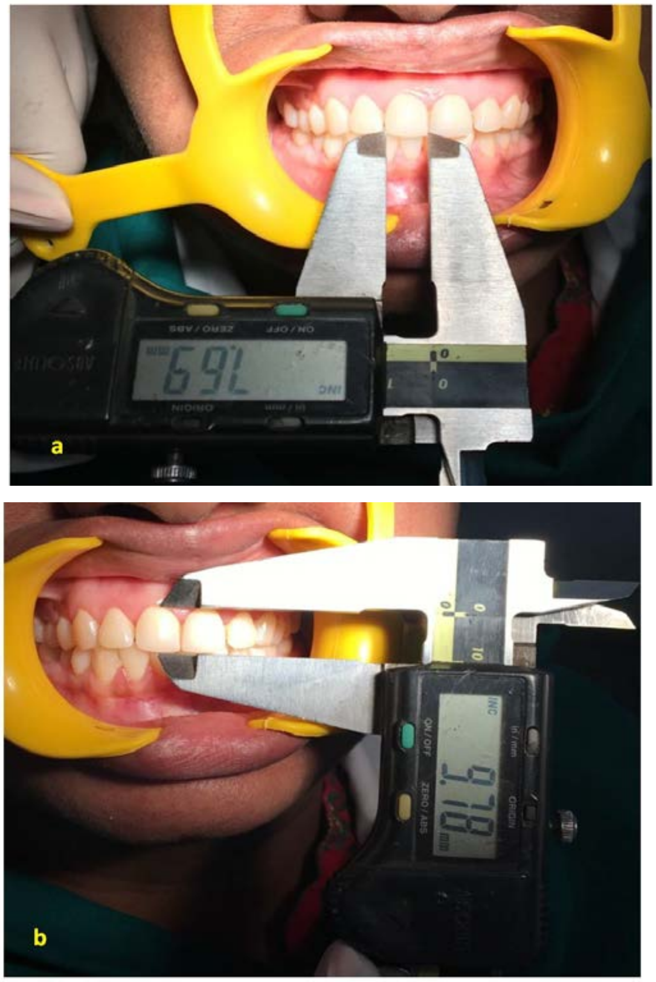

Fig- 1a and 1b: 1(a) Measurment of crown length. **1(b)** Measurment of crown width..

Figure 2: Right central incisior (index tooth) with lead plate, positioned over the midbuccal area of the tooth.

Parallel profile radiographs:

According to the method introduced by Alpiste-Illueca F [23], parallel profile radiographs (PPRx) using long cone projection or paralleling technique were obtained from a lateral position with the use of the lead plate, to analyse the dimensions of the soft and hard tissue structures in the coronal aspect of the periodontium around the index tooth.[23]

The self-sticking lead plate of above dimensions was positioned on the gingival surface, with its most coronal margin aligned with the edge of the gingival margin, aligned with the long axis of the tooth , thus defining the profile of the gingiva from a lateral perspective.

The paralleling system XCP Paralleling System (Rinn) was used for radiography. The film was positioned on the lateral vestibule and the bite block was fixed with the anterior teeth. The film was placed in an orientation parallel to the long axis of the tooth. This was achieved by viewing the lead plate through the aiming ring and only the profile of the lead plate had to be seen. From each patient, a digital radiograph using an intra-oral sensor was obtained (Radionuclide Ventriculo Gram-RVG).(**fig-3a**).

Analyses of the radiographs:

All images of the digital radiographs were analyzed using a photo editing software (Adobe Photoshop CS3®, Adobe Systems). The length of the lead plate in the radiograph was used as a reference for the calculation of all measurements.

The following eight measurements were made on the radiographs:

Thickness of the free gingiva were measured as the distance between the enamel surface to the palatal side of the lead plate measured at the coronal margin (G1) and distance at the base of the free gingiva(G2).

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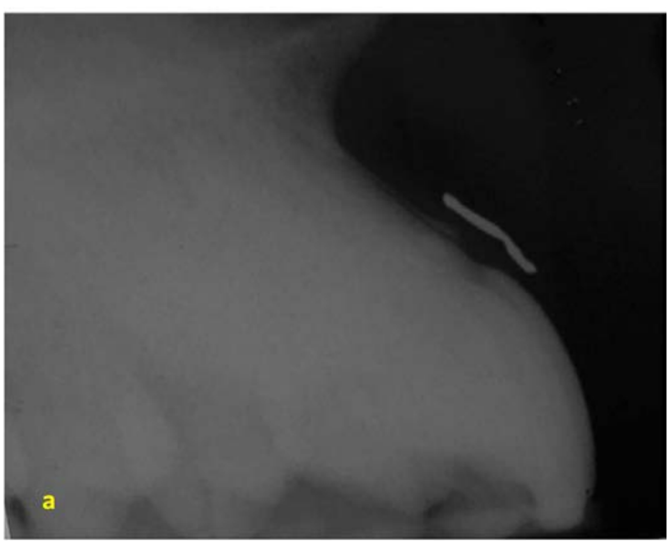
Dimension of the gingiva at the supracrestal attachment were calculated as the distance between the root surface and the palatal side of the lead plate calculated at the cementoenamel junction (CEJ) (G3), the distance at the middle third (midpoint between the distance CEJ - bone crest) (G4) and the distance at directly above the bone crest level (G5) Dimension of the attached gingiva were calculated as distance between the buccal margin of the bone crest and the palatal side of the lead plate (G6).

Dimension of the buccal alveolar bone plate were calculated as distance between the buccal surface and the palatal side (Lamina dura) of the buccal bone plate calculated at the bone crest level (A1), distance at the border between the coronal and middle third (A2) and the distance between the middle and apical third (A3) of the root length (**fig-3b**).

In order to minimize the effect of any potential error resulting from non-tangential positioning of the lead plate, the minimum and maximum deviation of the plate in the radiograph from the actual thickness (0.10mm) was calculated. The mean deviation was 0.10 ± 0.04 mm, whereas maximal and minimal deviation was 0.13 ± 0.04 and 0.07 ± 0.05 mm respectively.



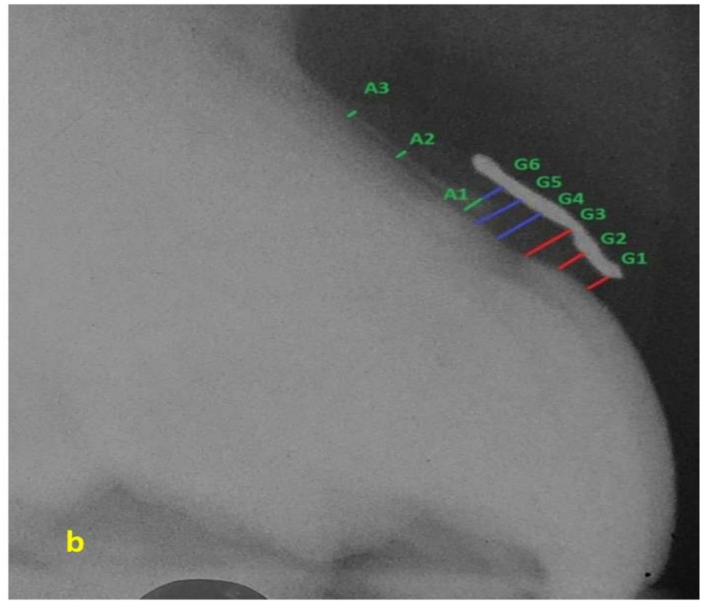


Fig-3a and 3b: **3(a)** radiographic view of index tooth with lead plate. **3(b)** radiographic measurement points for assessment of gingival thickness and alveolar bone thickness's value.

Statistical analysis

The values of all parameters were given as mean and standard deviation (SD). Using the Pearsons correlation coefficient with the corresponding 95% confidence interval, correlations of CW/CL, SC and GW with the thickness of the gingiva at different apico-coronal levels (G1–G6) as well as thickness of the buccal alveolar bone plate at different apico-coronal levels (A1,A2, A3) were calculated. The p-values <0.05 were considered statistically significant. The statistical analysis were carried out with graph pad prism® 5 (graph pad software Inc)

Results

The study population consisted of 30 subjects (13 men, 17 women) with a mean age of 20-25 years. **Table-1** shows the descriptive data of all clinical and radiographic measurements. The subjects comprised crown forms that ranged from a tapered long form with a very low CW/CL of 0.54 mm to a squared short shape with a maximum CW/CL of 0.92 mm and an average of 0.73. The mean

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values for SC and GW were 4.56 and 5.27 mm respectively. The mean thickness of the free gingiva was 0.29 mm at the coronal margin (G1) and increased to 0.39 mm at its base (G2). For the gingival thickness at the supracrestal attachment, the mean values in the middle third (G4; 0.55 mm) and directly coronal to the bone crest (G5; 0.55 mm) were minimally higher than at the CEJ (G3; 0.51 mm). The thickness of the attached gingiva over the bone crest (G6; 0.57 mm) was higher than the gingival thickness at the supracrestal attachment (G3–G5). The mean thickness of the alveolar bone plate decreased from 0.24 mm at the crest to 0.19 mm at the apical third of the root length.

Table-1: Clinical and radiographic measurements.

	Mean	Std. Deviation	Std. Error
CW/CL Ratio	0.733	0.115	0.021
SC	4.567	0.858	0.157
GW	5.267	1.172	0.214
G1	0.294	0.090	0.016
G2	0.393	0.095	0.017
G3	0.512	0.121	0.022
G4	0.555	0.158	0.029
G5	0.558	0.151	0.028
G6	0.576	0.174	0.032
A1	0.246	0.050	0.009
A2	0.225	0.044	0.008
A3	0.195	0.051	0.009

Correlation analysis revealed: All parameters show weak correlation overall. However,G6 (thickness of attached gingival at bone crest) was found to be moderately associated though not approaching statistically significant with CW/CL. G6 (thickness of attached gingival at bone crest) showed moderate correlation with A2 (alveolar bone thickness between coronal and middle third of root), and A3 (alveolar bone thickness between middle third and apical third of root). G5 (directly above the bone crest level) also showed moderate correlation with A3. G4 (supracrestal attached gingiva) also showed moderate correlation with A3. These observed correlations were also statistically significant. (**Table-2**), (**Table-3**).

Table-2:correlation between CWCL,gingival scallop,width of keratinized gingiva ,gingival thickness ad alveolar bone thickness.

	CW/CL Ratio		height of gingival scalloping (SC)		gingival width (GW)	
	Pearson Correlation	P Value	Pearson Correlation	P Value	Pearson Correlation	P Value
CW/CL Ratio	1		-0.061	0.747	0.240	0.201
height of gingival scalloping(SC)	-0.061	0.747	1		0.016	0.933
gingival width(GW)	0.240	0.201	0.016	0.933	1	
G1	0.014	0.942	-0.030	0.874	-0.121	0.524
G2	0.002	0.991	0.093	0.626	-0.200	0.290
G3	-0.010	0.959	0.090	0.636	-0.229	0.223
G4	0.059	0.757	0.197	0.297	-0.262	0.161
G5	0.086	0.653	0.153	0.420	-0.155	0.414
G6	0.352	0.056	0.053	0.782	-0.197	0.296
A1	0.140	0.460	-0.013	0.945	0.067	0.724
A2	0.149	0.433	-0.164	0.387	-0.015	0.937
A3	0.088	0.643	0.067	0.726	-0.138	0.467

Table-3:correlation between thickness of gingival and alveolar bone plate thickness.

		G1	G2	G3	G4	G5	G6
A1	**Pearson Correlation**	0.274	0.321	0.084	0.151	0.207	0.334
	P Value	0.143	0.084	0.658	0.426	0.272	0.071
A2	**Pearson Correlation**	0.295	0.180	0.046	0.280	0.334	0.473**
	P Value	0.113	0.342	0.810	0.134	0.072	0.008
A3	**Pearson Correlation**	-0.034	-0.039	-0.159	0.364*	0.378*	0.367*
	P Value	0.860	0.836	0.400	0.048	0.039	0.046

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed)

For all parameters pearson correlation coefficients given with 95% confidence interval.

Discussion

Tissue biotype is one of the important factors that determine the result of dental treatment. Over the past several decades, the measurements of different parts of the masticatory mucosa, specially gingival thickness, has

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become the subject of interest in periodontics from an epidemiologic and a therapeutic point of view.[24,25] Especially in the aesthetic area, knowledge about these factors can help to better assess the need for soft or hard tissue augmentations and avoid consequent failures or complications.

Therefore, it would be useful to have reliable guidelines for the identification of cases with thin gingiva and/or alveolar bone thickness, which can negatively affect the success of the treatment.

Several authors have developed varying classification systems for periodontal biotypes. These and their qualifying criteria have ben summarized in **Table-4.**[7, 12, 26-28]

Table-4: Classification of periodontal biotype.

Author	Classification
Ochsenbein and Ross (1969) [7]	1) Flat [flat gingiva was related to a square tooth form] 2) Highly scalloped [scalloped gingiva was related to a tapered tooth form].
Seibert & Lindhe (1989) [12]	1) Thin scalloped [thin ≤1.5mm] 2) Thick-flat [thick ≥2mm]
Becker et.al (1997) [26] Measured gingival dimensions from the height of the bone interproximally to the height at the exact midfacial of gingival zenith.	1) Flat 2) Scalloped and 3) Pronounced scalloped gingival
Kois JC (1996)).[27] Based on the relationship between the cementoenamel junction (CEJ) and the crest of the bone.	1) Normal crest: Alveolar crest is 3 mm apical to the CEJ (85% of the population) 2) High crest: alveolar crest is < 3 mm apical to the CEJ (2% of the population) 3) Low crest: Alveolar crest is > 3 mm apical to the CEJ (13% of the population.
Kois JC. (1994) [28] (Scalloped gingival)	1)High 2)Normal, and 3)Flat.
De Rouck et al. (2009)[6]	1) Thin gingival biotype: slender tooth form, narrow zone of keratinized tissue, and a high gingival scallop, most prominent among females. 2) Thick gingival biotype: quadratic tooth form, broad zone of keratinized tissue, and a flat gingival margin, occurred in mainly among males.

The gingival thickness or gingival biotype can predict the outcome of root coverage procedures [29,30]. It has also been documented that thin gingival biotype was more likely to cause gingival recession following nonsurgical periodontal therapy. Orthodontic movement of teeth away from the alveolar process, particularly in patients with thin biotype may cause mucogingival problems. In implant therapy, thicker biotype prevents gingival recession, covers the restorative margins and camouflages the titanium implant shadow. It also enhances biological seal around implants, hence reducing the crestal bone resorption. The gingival thickness level, before regenerative surgery was found to be a predicting factor for further recession. However, in thin biotype, the periodontal surgical procedures can enhance the quality of tissue resulting in a more favorable treatment outcome.[31]

Many parameters have been used to assess the gingival thickness. However, the results are controversial and none of the described parameters can be considered as most reliable. Up to now, no precise definition exits for how a thick biotype should be compared to a thin one in terms of dimensions. One of the reasons may be seen in the fact that thickness of the gingiva has been assessed at different vertical levels[1,22,32]. Various methodologies, invasive and non invasive, have been proposed for measurement of the gingival tissue form. These include visual inspection, ultrasonic devices, transgingival probing [1], and manual assessment using a caliper after tooth extraction[1,32], a syringe with endodontic depth marker [22] or cone beam radiographs[32].

In this study, to overcome the above all other method's limitation, a modified radiographic technique described by **Alpiste-Illueca** [23] was used.

To obtain precise measurements, quality control was established via: (a) parallel orientation of the film along the long axis of the tooth which should be exact, (b) exclusion of cases with poor contrast of anatomic landmarks, (c) reproducibility of the real tissue dimensions using a standardized lead plate allowing the calculation of the magnification effect and (d) there should be recordings of the thickness values to 0.1 mm precision using Photoshop software. However, there are two possible limitations. (a)Measurements done at the base of the free gingiva (G2) comprise the sulcus width, which could be considered as bias. Though, as all

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participants did not have any signs of gingival inflammation and no attachment loss that could be associated with remarkably increased gingival sulcus, this bias can be minimized by strict inclusion criteria. (b)A strictly tangential projection over the entire length of the plate is difficult. Regardless, the possible error due to the difference of the projected thickness from the real thickness of the lead plate was not more than 0.1 mm in average. This amount of bias can be considered as minimal and supposed to be minimal than errors occurring in previously reported techniques such as direct measurements with invasive techniques.[1,22]

The present data clearly show that gingival thicknesses measured at different levels (G1–G6) differ from each other and notably increase from the level of the margin (G1) towards the level directly coronal to the bone crest (G6).

One of the primary results of this study was the weak correlation of gingival thickness at all levels with the thickness of the buccal alveolar bone, and G6 showing moderate correlation with A2 and A3. G5 also showed moderate correlation with A3. G4 (supracrestal attached gingiva) also showed moderate correlation with A3 (**Table: 3**). This confirms the results of the study by **Zweers et al.** [33] who concluded that the dental, gingival and osseous dimensions have a weak to moderate association and showed disagreement to the study conducted by Fu et al.[32] who recognized a moderate correlation between gingiva and bone thickness on cadaver teeth.

Mallikarjun S et al.[34] compared gingival thickness data obtained using identical methodology, and compared it to measurements obtained via cone beam computed tomography (CBCT). It was found both techniques demonstrated similar accuracy with no additional benefit of CBCT. They reported weak correlation between alveolar bone thickness and gingival thickness which is in keeping with the results obtained by the authors.[34]

Though crown morphology and tooth form was not determined, analysis of data by correlation analysis revealed a negative correlation between CW/CL and SC & GW and moderate correlation with G6 ($r>0.35$)(**Table:2**).This confirm the results of the study done by **Olson et al.**[22] who did not find a significant association between CW/CL and gingival thickness.

The results are, however, contrary to the findings of **Ranjan Malhotra et al.** [35], Who postulated that there exists highly significant correlation between crown length and gingival biotype and area of papilla.[35]

A possible explanation for the varied results observed in this study could be the fact that there is limited data on biotype dimensions in Indian populations and possible phenotype differences could have influenced the results which vary from than observed by **Jamal M. Stein et al.** [36].

The advantages of the described technique are it enables precise measurement of gingival thickness at multiple apico coronal levels which is not possible by use of transgingival probing as it is a blind procedure. Secondly, it can be incorporated as part of routine screening or diagnostic procedures to shorten treatment planning time and chair side time. Further the technique allows for reliable measurement of facial and palatal alveolar plate thickness which hitherto depended on use of computed tomography (CT)/ CBCT. This is of benefit in Implantology and guided bone regeneration.

Limitations of the study include a certain degree of technique sensitivity wherein precise positioning of lead plate and radiographic apparatus is necessary to eliminate errors and obtain reliable results. Also the described method cannot be used in the posterior jaw regions, Owing to a strictly tangential projection over the entire

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length of the plate is difficult, as film should be positioned on the lateral vestibule and in the posterior region it is inconvenient and it will be blind procedure.

Future directions worth considering include research with larger sample sizes, differing age groups, correlation with anthropometric data and effect of iatrogenic and therapeutic procedures on gingival thickness.

Conclusion

The data of the present study show that a clear distinction between a “thin” and a “thick” gingival biotype is difficult. According to our study CW/CL represents a predictor albeit weak for the thickness of the buccal alveolar crest. All thickness parameters of the gingiva (G1–G6) were show weak correlation related to alveolar crest thickness. However, some parameters showed moderate correlation between G6 with A2 and A3, G5 with A3, G4 with A3. Finally, the data indicated that the height of the gingival scallop can be recommended as an indicator for tissue thickness. However, due to the limited sample size the results should not be generalized.

References

1. Kan JY, Morimoto T, Rungcharassaeng K, Roe P, Smith DH. Gingival biotype assessment in the aesthetic zone: Visual versus direct measurement. Int J Periodontics Restorative Dent. 2010; 30: 237-43.
2. Kois JC. Predictable single-tooth peri-implant aesthetics: Five diagnostic keys. Compend Contin Educ Dent. 2004; 25:895-6.
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; 36:193-8.
4. Claffey N, Shanley D. Relationship of gingival thickness and bleeding to loss of probing attachment in shallow sites following nonsurgical periodontal therapy. J Clin Periodontol 1986;13:654-7
5. Zigdon H, Machtei EE. The dimensions of keratinized mucosa around implants affect clinical and immunological parameters.Clin Oral Implants Res 2008; 19:387-92.
6. 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 Periodontol 2009;36: 428-33.
7. Ochsenbein C, Ross S. A re-evaluation of osseous surgery. Dent Clin North Am. 1969;13(1):87-102.
8. Richard T, Kao, Mark C, Fagan, Gregory J. Thick vs. thin gingival biotypes: A key determinant in treatment planning for dental implants. CDA J 2008; 36:193–8.
9. Ericsson, I. & Lindhe, J. Recession in sites with inadequate width of the keratinized gingiva. An experimental study in the dog. Journal of Clinical Periodontology 1984;11, 95–103.
10. Wennstr€om, J. L., Lindhe, J., Sinclair, F. & Thilander, B. Some periodontal tissue reactions to orthodontic tooth movement in monkeys. Journal of Clinical Periodontology 1987; 14, 121–9.
11. Larato, D. C. Alveolar plate fenestrations and dehiscences of the human skull. Oral Surgery, Oral Medicine and Oral Pathology 1970; 29, 816–9.
12. Seibert, J. L. & Lindhe, J. Esthetics and periodontal therapy, Chapter 19. In: Lindhe, J. (ed). Textbook of Clinical Periodontology, 2nd edition, 1989 ; 477–514, Copenhagen: Munksgaard.
13. Hwang, D. & Wang, H. L. Flap thickness as a predictor of root coverage: A systematic review. Journal of Periodontology 2006;77, 1625–34.
14. Hirschfeld L.A study of skulls in the American Museum of Natural History in relation to periodontal disease. J Dent Res. 1923;5: 241-65.

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15. Morris ML.The position of the margin of the gingiva. Oral Surg Oral Med Oral Pathol. 1958;11(9):969-84.
16. Eger T, Muller HP, Heinecke A. Ultrasonic determination of gingival thickness. Subject variation and influence of tooth type and clinical features. J Clin Periodontol.1996;23(9):839-45.
17. Serino G, Wennstrom JL, Lindhe J, Eneroth L. The revalence and distribution of gingival recession in subjects with a high standard of oral hygiene. J Clin Periodontol. 1994; 21(1):57-63.
18. Greenberg, J., Laster, L. & Listgarten, M. A. Transgingival probing as a potential estimator of alveolar bone level. Journal of Periodontology 1976; 47, 514–7.
19. M€uller, H. P., Schaller, N., Eger, T. & Heinecke, A. Thickness of masticatory mucosa. Journal of Clinical Periodontology 2000:27, 431–6.
20. Olsson, M. & Lindhe, J. Periodontal characteristics in individuals with varying form of the upper central incisors. Journal of Clinical Periodontology 1991:18, 78–82.
21. Hulley SB, Cummings SR, Browner WS, Grady D, Newman TB. Designing clinical research : an epidemiologic approach. 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2013. Appendix 6C, page 79.
22. Olsson M, Lindhe J, Marinello CP. On relationship between crown form and clinical features of the gingival in adolescents. J Clin Periodontol 1993; 20: 570-7
23. lpiste-Illueca, F. Dimensions of the dentogingival unit in maxillary anterior teeth: anew exploration technique (parallel profile radiograph). Int J PeriodonticsRestorative Dent.2004:24, 386-96.
24. Vandana KL, Savitha B. Thickness of gingiva in association with age, gender and dental arch location. J Clin Periodontol 2005; 32: 828-30.
25. Müller HP, Heinecke A, Schaller N, Eger T. Masticatory mucosa in subjects with different periodontal phenotypes. J Clin Periodontol 2000;27:621-6.
26. Becker W, Ochsenbien C , Tibbetts L , Becker BE.Alveolar bone anatomic profiles as measured from dry skulls clinical ramifications J Clin Periodontol, 1997; 24: 727-31.
27. Kois JC, The restorative – periodontal interface: biological parameters .periodontal 2000 1996;11:29-38.
28. Kois JC. Altering gingival levels: The restorative connection. Part 1: biologic variables. J Esthet Dent. 1994; 6(1):3-7
29. Baldi C, Pini-Prato G, Pagliaro U, Nieri M, Saletta D, Muzzi L, et al. Coronally advanced flap procedure for root coverage Is flap thickness a relevant predictor to achieve root coverage? A 19- case series. J Periodontol.1999; 70: 1077-84.
30. Hwang D, Wang HL. Flap thickness as a predictor of root coverage: A systematic review. J Periodontol. 2006; 77: 1625-34.
31. Anderegg CR, Metzler DG, Nicoll BK. Gingival thickness in guided tissue regeneration and associated recession at furcation defects. J Periodontol. 1995; 66: 197-402.
32. Fu, J. H., Yeh, C. Y., Chan, H. L., Tatarakis, N., Leong, D. J. & Wang, H. L. Tissue biotype and its relation to the underlying bone morphology. J Periodontol.2010; 81, 569-74.
33. Zweers J, Thomas RZ, Slot DE, Weisgold AS, Van der Weijden GA. Characteristics of periodontal biotype, its

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dimensions, associations and prevalence: a systematic review. J Clin Periodontol 2014; 41: 958-71.

34. Mallikarjun S, Babu HM, Das S, Neelakanti A, Dawra C, Shinde SV. Comparative evaluation of soft and hard tissue dimensions in the anterior maxilla using radiovisiography and cone beam computed tomography: A pilot study. J Indian Soc Periodontol. 2016;20(2):174-7.
35. Ranjan Malhotra, Vishakha Grover, Arvind Bhardwaj, Kanika Mohindra: Analysis of the gingival biotype based on the measurement of the dentopapillary complex. J Indian Soc Periodontol - 2014;18: 43.
36. Stein JM, Lintel-Ho¨ping N, Hamma¨cher C, Kasaj A, Tamm M, Hanisch O. The gingival biotype: measurement of soft and hard tissue dimensions - a radiographic morphometric study. J Clin Periodontol 2013; 40: 1132-9.

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