

The Difference in the Morphometric Assessment of Gingival Biotype by Using Periodontal Probe Transparency Method and Photogrammetry

Nida Ayub, Yousaf Athar, Ramsha Jalal, Fatima Saleem, Shafiq-ur-Rahman, Mashal Amir

ABSTRACT

Objective: To evaluate the photogrammetric assessment of gingival biotype against the clinical gold standard method of probe transparency in terms of their consistency in assessment

Study Design and Setting: Cross-sectional comparative; Periodontology Department, Institute of Dentistry, CMH Medical and Dental College, Lahore

Methodology: The study targeted 149 adult subjects aged 18-30 years reporting to dental out patient department for routine dental treatment. A periodontal probe was inserted into the marginal gingiva of maxillary right central incisor and probe visibility through the gingival soft-tissues was judged. A probe visible through the tissues yielded thin gingiva and vice versa. For morphometric analysis, standardized clinical photographs were captured using digital DSLR camera. A photoshop software was used to measure crown width, crown height and papillary height for maxillary central incisor on all photographs. A crown width-to-height ratio >0.75 and a papillary height <4.5 mm indicated thick gingiva and vice versa. Data was analyzed via Statistical Package for Social Sciences version 24. Descriptive statistics were calculated. An inter-method reliability analysis using Cohen's Kappa was performed to determine the consistency among the two methods in diagnosing gingival biotype. $p=0.05$ was taken as significant.

Results: About 54.4% subjects were identified having a thin gingival biotype. A significant difference was observed between males and females as well as between age groups for gingival biotypes ($p<0.001$). Using Cohen's Kappa, a "perfect agreement" between probe transparency and photogrammetric methods was observed ($\hat{\kappa} = 1$, $p<0.001$)

Conclusion: Photogrammetry offers a reliable and noninvasive method for evaluation of gingival thickness

Keywords: Crown length, Crown width, Gingival thickness, Papillary height, Periodontium

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INTRODUCTION:

Gingival biotype (GBT) refers to the labiolingual thickness of the gingiva which can either be thin i.e., $=1.5$ mm in dimension or thick with a thickness $=2$ mm.¹ GBT is influenced by an individual's genetic makeup and it plays a significant role in determining the outcome of dental treatments, especially affecting results of procedures such as periodontal therapy and dental implants. Thick GBT manifests increased density with optimal zone of keratinization, whereas thin GBT is delicate, with minimal keratinization and more translucency.²

The two GBTs respond in a differing manner to any insinuated insult. While the thick GBT easily withstands trauma and manipulation, with less inflammation and recession, a higher incidence of gingival recession has been reported in subjects with a thin biotype following invasive dental procedures.^{3,4} Hence, evaluation of GBT is an important parameter while planning dental procedures to ensure a predictable outcome.⁵

Numerous methods have been employed for an objective evaluation of GBT. These include both invasive and non-invasive methods including visual inspection, needle/probe transparency method, ultrasonography, radiographic

measurements and CBCT.^{6,7} Of these, the probe transparency method is the most widely used. It is considered the “clinical gold standard” for GBT assessment,⁸ and involves transgingival probing through the gingival sulcus, observing the visibility of the probe through the gingiva. A probe visible through a “transparent” gingiva indicates a thin biotype and vice versa.⁹ This method is relatively easy to apply in clinical practice and yields reliable results. However, it is still invasive and somewhat cumbersome for the patient.

Studies suggest that GBT also relates to the dental and periodontal morphology including crown width to height ratio (CR) and height of inter-dental papilla. Olson and Lindhe¹⁰ were the first to correlate gingival morphology with tooth dimensions. They reported thin GBT in long and narrow central incisors while thick GBT in wide squarish teeth. It is suggested that a crown width to height ratio of <0.75 and an interdental papillary height >4.5 mm is consistent with thin GBT and vice versa.^{1,11} These features can be regarded as a simple and non-invasive alternative to assess GBT. Although clinical assessment of these parameters is possible, photogrammetry involving standardized photographs coupled with an analytical software offer an easier and reproducible method of assessment, without keeping the patient engaged.¹

This research study was undertaken with an aim to evaluate the photogrammetric assessment of GBT against the clinical gold standard method of probe transparency in terms of their consistency in assessment of GBT in the local population. No such work has previously been reported in this regard.

METHODOLOGY:

A cross-sectional comparative study was designed and undertaken at Periodontology Department, Institute of Dentistry, CMH Medical and Dental College, Lahore from October 2023 – March 2024. Ethical approval for the study was sought from the Institute’s Ethical Review Committee ((Letter no. 647/ERC/CMH/LMC). Sample size has been calculated with the help of WHO calculator.¹² With confidence level (1- α) as 95%, margin of error (d) as 0.071, anticipated population proportion (P) as 0.733¹³, a total sample size of 149 has been calculated. The study targeted subjects reporting to dental out patient department of CMH Lahore Institute of Dentistry for routine dental treatment. Non-probability consecutive sampling was done. Adult subjects aged 18-30 years, with well-aligned natural maxillary and mandibular anterior teeth and healthy periodontal tissues were included. However, subjects with missing or malaligned anterior teeth, restorations in anterior teeth, h/o orthodontic treatment esp. involving anterior teeth, h/o medications that affect gingival health, h/o systemic disease with oral or gingival manifestations, active periodontal disease, gingival recession and/or probing pocket depths >4mm, h/o parafunctional habits and signs of tooth wear, chain smokers as well as pregnant or lactating females were excluded from the study

cohort. Informed consent was obtained from selected individuals and their demographic details were noted in a proforma.

Using the probe transparency method, a periodontal probe (Michigan O’ probe with William’s markings) was inserted into the marginal gingiva of maxillary right central incisor and probe visibility through the gingival soft-tissues was judged. A probe visible through the tissues yielded thin GBT while when the probe remained invisible through the tissues, GBT was marked as thick.

Standardized clinical photographs were captured using digital DSLR camera (Canon EOS 2000D, 24.1MP) by the principal investigator (NAK). Camera calibration was checked to ensure photographs were well-focused. The camera was mounted on a tripod stand and at a 12 o’clock position almost 30 cm away from the subject.¹⁴ Subjects were seated in an upright position with the head conforming to its natural posture. A photoshop software (Adobe photoshop CS7) was used to measure crown width, crown height and papillary height for maxillary right central incisor on all photographs. Crown height was measured from the incisal edge to the free gingival margin at the mid-facial point. Crown width was measured at the widest point in the middle 1/3rd of the crown. Papillary height was measured at the midfacial point, from the tip of the papilla to the free gingival margin. A CR >0.75 and a papillary height <4.5 mm indicated a thick GBT and vice versa.¹ All measurements were recorded by the principal investigator (NAK). To minimize intra-operator errors, each measurement was performed thrice and a mean value for each variable was noted in the proforma. Twenty-five percent of the photographs were re-assessed by the same clinician two weeks later and intra-rater reliability was assessed using intra-class coefficient (ICC) test (owing to continuous data).¹⁵ A strong correlation value of 0.87 was found, depicting good reliability.

Data was analyzed via Statistical Package for Social Sciences (SPSS) version 24. Descriptive statistics were calculated. Mean \pm standard deviation values of quantitative variables such as age and morphometric parameters (papillary height, crown width, crown height) were calculated while frequency and percentage for categorical variables like gingival biotype were determined. Stratification was done to control effect-modifying variables e.g., age and gender and post-stratification chi-squared test of independence was used. An inter-method reliability analysis using Cohen’s Kappa statistic was performed to determine the consistency among the two methods in diagnosing GBT. $p=0.05$ was taken as significant.

RESULTS:

Of the 149 subjects comprising the study sample, 45% (n=67) were male and 55% (n=82) were females. Mean age of the study subjects was 24.77 ± 3.67 years (range: 18 – 30 years). Mean CR of the study subjects was 0.78 ± 0.09 . Table

I highlights the mean values of all morphometric parameters assessed.

Using the probe transparency method, 54.4% (n=81) subjects had thin gingival biotype i.e., the probe could be easily seen through the gingival soft tissues. Likewise, gingival biotype measured via morphometric analysis using photogrammetry also yielded 54.4% (n=81) subjects with thin biotype. Cohen's kappa was used to calculate the level of agreement between the two methods in assessing the GBT of patients. Using the Landis and Koch¹⁶ interpretation, a "perfect agreement" between the two methods was observed, $\hat{\epsilon} = 1$, $p < 0.001$ (Table II).

A statistically significant difference was observed between males and females for GBT assessed via both methods ($p < 0.001$). A thin GBT was more prevalent in females than in males. Similarly, a significant difference in GBT was also seen in subjects from different age groups i.e., 18-24 years old and 25-30 years old ($p < 0.001$). Younger subjects aged 18-24 years old were more prone to harbor thin GBT than older subjects (Table III).

DISCUSSION:

A thorough patient evaluation and treatment planning can help achieve predictable dental surgical outcomes. While dental hard tissues are essential for the success of a treatment, dental soft tissue parameters cannot be overlooked. Gingival biotype or the "thickness" of gingival tissues is one such critical parameter that, if overlooked, can jeopardize the treatment outcomes. An otherwise predictable tissue healing may turn into unaesthetic gingival recession if gingival biotype is not taken into account.

In the present study, a higher percentage of males (64%) exhibited thick GBT whereas majority of females (69.5%) showed thin GBT. These findings compare favorably with those of Moorpani et al.¹⁷ who found a higher percentage (65%) of males with thick GBT and 66.7% females with thin GBT. Similar results have been reported by Haritha et

al.⁵ in Indian population with 76% males showing thick GBT and 74% females showing thin GBT and by Zhao et al.¹⁸ in Chinese population with thin GBT prevalent in females. An even higher percentage of thick GBT in males (92.7%) and thin GBT in females (93%) has been reported in the Syrian population by Barakat and Dayoub.¹⁹

With the probe transparency method as the gold standard for assessing gingival biotype, morphometric analysis using photogrammetry accurately diagnosed all cases of thick and thin GBT. There was complete agreement between the two methods in assessment of GBT of the study subjects as evident by Kappa coefficient. This makes morphometric analysis using photogrammetry a non-invasive reliable method for assessing GBT. Joshi et al.¹ also reported morphometric parameters especially crown width to height ratio and papillary height as useful predictors of gingival thickness. Shao et al.²⁰ also reported a high correlation of gingival thickness with tooth's morphometric parameters including crown width to height ratio, width of attached gingiva and papillary volume. Likewise, Tom K²¹ reported a significant correlation between GBT and crown length and papilla height.

A significant difference in GBT was seen between genders. This is in accordance with results reported by Yin et al.¹¹ and Joshi et al.¹ Similar results have also been reported in Chinese population by Shao et al.²⁰ who found lower gingival thickness values in females than in males. Agarwal et al.,²² however, reported increased gingival thickness in female subjects whereas Alhajj WA²³ reported no difference in gingival thickness between the two genders. These differences may be attributed to the difference in study samples as well as ethnic and racial differences.

The present study also found significant difference in GBT based on age with thin GBT present in younger individuals. Similar results have been reported by Tom K. in Malaysian

Table 3: Frequency of gingival biotype according to gender and age

Parameter	Gingival Biotype* (n)		p value
	Thin	Thick	
Gender	Male	24	43
	Female	57	25
Age	18-24 years	56	14
	25-30 years	25	54

* measured via probe transparency and morphometric analysis

Table 2: Inter-method consistency analysis using Cohen's Kappa

Gingival Biotype	Morphometric Analysis	Probe Transparency Method		Inter-method consistency Cohen's Kappa	p value
		Thin Gingival Biotype	Thick Gingival Biotype		
Thin Gingival Biotype		81	0	1	<0.001
		0	68		

population where a higher frequency of thin GBT was seen in younger age group.²¹ Alhajj WA²³ reported no significant difference in GBT between different age groups. Agarwal et al.²² reported a decrease in gingival thickness with age although the difference between groups was not statistically significant. These differences may be explained by differences in study populations as well as by the fact that the age range for the present study was quite narrow.

While literature favors the probe transparency method in terms of reliability and reproducibility, reports regarding “poor inter-examiner agreement” and “limited diagnostic value” also exist.²⁴ However, it is important to note here that all clinical methods and procedures are highly dependent on the clinician’s experience. Eghbali et al.²⁵ reported accurate assessment of thick GBT using visual inspection by experienced clinicians in more than 70% of the cases as compared to inexperienced clinicians, although the method itself was deemed unreliable. Likewise, the method suggested in the present study i.e., photogrammetric assessment and analysis is technique-sensitive. It requires familiarity with the involved equipment especially the camera, knowledge regarding the implications of correct patient positioning as well as the digital competency to accurately use and interpret the photo-analysis software. Since the newer generations are more tech-savvy, this method may appeal more to the young clinicians than to the experienced or old-school generation.

The present study had a few short comings. The study sample was relatively small and not very diverse. Also, the age range of subjects was very limited. The study also did not take into account confounding factors such as pigmentation, history of smoking and related habits as well as existing malocclusion which can affect gingival thickness.^{4,26}

Moreover, GBT may vary from tooth to tooth even in the same individual.^{18,20} The present study only considered the right central incisor for all subjects, hence analysis based on different tooth types could not be done. Further studies evaluating all these factors affecting GBT are suggested. Another scope of research can be to compare results of photogrammetric analysis using different camera models and different analysis softwares to assess their inter-class agreement. Advances in biomedical technology may also provide “gingival scanning devices” for diagnostic purposes.

CONCLUSION:

The present study found a perfect consistency between probe transparency method and morphometric analysis via photogrammetry in assessing gingival biotype. A statistically significant difference was observed between males and females for gingival biotype assessed via both methods. Morphometric analysis via photogrammetry offers a reliable and noninvasive method for evaluation of gingival thickness.

Authors Contribution:

- | **Nida Ayub:** Conception, design analysis, interpretation of data
- | **Yousaf Athar:** Conception, design, analysis
- | **Ramsha Jalal:** Design, analysis
- | **Fatima Saleem:** Design, analysis
- | **Shafiq-ur-Rahman:** interpretation of data
- | **Mashal Amir:** interpretation of data

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