Gingival Phenotypes Amongst Male Dental Students at Kulliyyah of Dentistry, IIUM, Malaysia

Wan Muhamad Hanif Wan Ghazali, Mohd Fariss Mohd Ghazali, Wisam A. Kamil, Suhaila Muhammad Ali[*], Munirah Yaacob

Periodontics Unit, Kulliyyah of Dentistry, International Islamic University Malaysia, Kuantan Campus, Jalan Sultan Ahmad Shah, Bandar Indera Mahkota Campus, 25200 Kuantan, Pahang Darul Makmur, Malaysia

ABSTRACT

The aim of the present study was to investigate the periodontal phenotypes among young Malay males with different gingival biotypes. Forty-seven systemically and periodontally healthy young Malay males participated in this study, where 25.5% were diagnosed with thin gingival biotype and 74.5% of thick biotype. The periodontal phenotypes were measured through clinical parameters presented by the gingival thickness (GT), gingival width (GW), papilla height (PH), and crown width/crown length ratio (CW/CL). Three clusters were identified through K-means cluster ing analysis based on the parameters of the periodontal phenotypes. Cluster 1 represents narrow crown form and the average CW/CL, GW, PH and PD were 0.69, 2.92, 4.55 and 2.16 mm, respectively. Cluster 2 displayed an average of 0.76, 4.29, 4.96 and 2.14 mm for CW/CL, GW, PH and PD, respectively. Cluster 3 represents wide crown form and the average displayed for CW/CL, GW, PH and PD were 0.80, 4.85, 3.73 and 2.23 mm, respectively. There were significant differences between the three clusters ($p<0.05$) with respect to the GW, PH and CW/CL. This study demonstrates the difference in gingival phenotypes between young Malay males. The GW has a significant positive linear correlation ($p<0.05$) with CW/CL and negatively correlated with PH.

[*]Corresponding Author

Name: Suhaila Muhammad Ali
Phone: +6012 9999 715
Email: drsuhaila@iium.edu.my

INTRODUCTION

Clinical features of healthy marginal periodontium vary among patients and teeth types (Schluger et al., 1990). There has been no data in this respect among the Malay male adults; thus, this research project was conducted to discover subjects with different gingiva morphological features, i.e., gingival phenotypes. A study from (Muller and Eger, 1997) identified the gingival phenotype among Young Caucasian males based on employing cluster analysis on the parameters of the gingival characteristic and tooth form. Since (Olsson and Lindhe, 1991) reported different characteristics of healthy gingival tissue among individuals, it is of significant importance to carry out these investigations among the Asian population.

According to (Esfahrood et al., 2013), gingival biotype is a crucial factor that affects the outcome of dental treatments, particularly in the treatment of periodontal therapy, root coverage procedures and implant placement. For this reason, it is crucial to examine the tissue biotype prior to these treatments

as to predict the outcome and prognosis since different tissue biotypes respond distinctively towards inflammation and surgical or restorative treatment.

Previously (Ochsenbein and Ross, 1969) proposed that gingival biotypes were either scalloped and thin or flat and thick gingiva. The level of underlying bone determined the gingiva contour. (Seibert and Lindhe, 1989) introduced the gingival biotype into "thick-flat" and "thin-scalloped" biotypes. A thick biotype is referred to as gingiva with ≥2mm thickness and a thin biotype is a gingiva with less than 1.5 mm. According to (Esfahrood et al., 2013), periodontal biotype includes the underlying alveolar bone in the distinct features ('flat-thick' or 'scalloped-thin') of the periodontium. Thick biotype is associated with a broad and flat keratinized gingiva with thick bone. Thin biotype is associated with a thin and scalloped keratinized gingiva with thin bone. On the other hand, the term phenotype is the features of the marginal periodontium, which is affected by genetic and environmental factors (Seibert and Lindhe, 1989). It refers to the physical traits or characteristics of the gingiva that includes the papilla height, the keratinized gingiva width, gingival recession and the crown morphology, i.e., crown width and length that influence the gingival morphology. The gingival morphologic characteristics depend on a few factors such as the alveolar bone dimension, events that happen throughout tooth eruption, teeth inclination, shape and position.

Gingival biotype influences the restorative and regenerative treatment results. The variation of the tissue response towards trauma leads to the difference in the treatment result. Variation in tissue biotypes influences the response to inflammation, restorative, trauma and parafunctional habits. Thick gingival biotype is more withstanding to inflammation than the thin biotype. Inflammation of the periodontium develops periodontal pockets and gingival recession in both tissue biotypes. Therefore clinically, periodontal biotype recognition is critical to determine the treatment result (Esfahrood et al., 2013).

The objective of the present investigation was to study the periodontal phenotypes among young Malay males with different gingival biotypes. This research also intended to investigate the correlation between each gingival phenotype.

MATERIALS AND METHODS

Study Design and Sampling Procedure

This research adopted a cross-sectional study design that included Malay male dental students between 20 to 30 years old attending the Kulliyyah of Dentistry, International Islamic University Malaysia (IIUM). This research used simple random sampling to recruit the respondents. Periodontally healthy subjects with intact attachment, patients having all anterior teeth in the maxillary and mandibular arch, and those who do not require special health care for daily activities were included in this study. The exclusion criteria were subjects with fillings or fixed prosthodontic restorations involving the incisal edge on anterior maxillary teeth, taking any drugs which impact on the periodontium, subjects with clinical signs of periodontal diseases defined as moderate to severe gingivitis/pocket exceeding 3 mm, and subjects with orthodontic appliances. A total of 47 systemically and periodontally healthy Malay young male adults, 20-30 years of age, were voluntarily recruited in this study.

Ethical Consideration

This study was conducted after approval by Kulliyyah of Dentistry Research Committee and IIUM Research Ethical Committee (IREC) (ID No. IREC 315). This study depended on clinical examinations under supervision without invasive procedures. A signed consent form was obtained from all participants where they were first informed verbally regarding the study purpose and assigned a written consent after explaining the details of clinical procedures prior to participation.

All information collected is highly confidential and are used for research purpose only. In terms of location and safety, examination and data collection were done in the dental polyclinic of Kulliyyah of Dentistry, IIUM, in which all procedures performed followed standardized infection control measures. A periodontal examination was conducted using instruments provided by the polyclinic.

Examination and Data Collection

Detailed medical and dental histories were obtained from each participant. The clinical periodontal parameters involved in the research were recorded from the sample following intra-oral and extra-oral examinations.

The reproducibility of the measurement was evaluated in 4 study samples. For the inter-examiner repeatability, 4 samples were examined twice with a close time span within 24 hours; no instructions were given to the patients in this period.

Clinical Parameters

The clinical parameters included in this study are probing depth (PD), crown width/crown length ratio (CW/CL), papilla height (PH), gingival thickness (GT) and gingival width (GW). William's peri-

odontal probe was used as the main instrument for the measurement of all these parameters. PD was determined at the distal, mid-facial, and mesial aspects of each central incisor. Scores obtained from both central incisors are averaged. CW/CL of the central incisor was determined, according to Olsson and Lindhe (1991). The CL was determined between the incisal edge of the crown and the free gingival margin. Crown width was recorded at the middle third of the tooth. PH was assessed using the same periodontal probe at the mesial and distal aspects of both central incisors. This parameter is defined as the distance from the tip of the papilla to the imaginary line connecting to the mid-facial margin of two adjacent teeth (Olssoin et al., 1993). GT was evaluated and categorized into thick or thin on a site level (Kan et al., 2003) depending on the transparency of the periodontal probe. The gingival biotype is considered thin if the outline of the probe is shown through the gingival margin from the sulcus. According to (Abraham et al., 2014), this method was found to be highly reproducible. GW was measured mid-facially with a periodontal probe to the nearest 0.5 mm. GW is defined as the distance from the free gingival margin to the mucogingival junction. Scores obtained from both central incisors were averaged (Rouck et al., 2009).

Statistical Analysis

Data analysis was performed using the computer software Statistical Package for the Social Sciences IBM$^®$ SPSS$^®$ Statistics version 24. Data were expressed as mean and standard deviation (SD). A chi-square test was used to test for significant differences (observed frequencies) between groups with respect to gingival biotype. The independent t-test was used to test the differences between different gingival biotype groups' measurements (means). K means clustering was used to identify groups with different characteristics. One-way ANOVA was used to test the differences (means) among the three clusters. Pearson's correlation coefficient was used to measure the linear correlation (dependence) between the variables. P values of less than 0.05 were considered statistically significant.

RESULTS AND DISCUSSION

Table 1 presents the association between the gingival tissue biotype and the number of subjects in 47 young Malay male adults. Following data analysis, the majority of the respondents have thick gingival biotype constituting 74% of the whole sample size. It revealed a statistically significant association between the number of subjects with the thick gingival biotype (p=0.001).

Table 2 presents the clinical characteristics of gingiva with respect to different gingival biotypes in subjects. The independent t-test revealed a significant difference (p<0.05) in keratinized gingiva between samples with thin and thick gingival biotype. The mean of keratinized gingiva (GW) at the anterior teeth of the sample having thin gingival biotype range from 3.71±0.96 mm, whereas samples with thick gingival biotype range from 4.53±0.77 mm. This indicated that there is an increase in GW among thick gingival biotype group. The result also shows no significant relationship between both gingival biotypes in other clinical parameters such as PD, CW/CL and PH.

Table 3 presents the periodontal phenotype according to K means clustering analysis displayed three types of gingival phenotype and tooth form with respect to the thickness of the gingiva. The majority of our study sample (51%) was within CII with average features in between CI (13%) of the narrow teeth and short PH with narrow GW, and CIII (36%) with wide teeth and wider GW and significant PH. The p-value of the ANOVA test shows the significant difference (p<0.05) between these three clusters in the aspects of CW/CL, papilla height and gingival width of keratinized gingiva but not in probing depth. This means that half of the respondents are categorized in CII, which displayed an average CW/CL, GW, PH and PD of 0.76, 4.29, 4.96 and 2.14 mm, respectively.

Table 4 presents the frequency distribution for gingival biotype per cluster. In regards to gingival thickness, CII and CIII consist primarily of samples with thick gingival biotype with 79% and 88% in each cluster II and III respectively, while all of the samples in CI have thin gingival biotype.

Table 5 presents the Pearson correlation among the gingival characteristics. The analysis was done to see any correlation between each clinical parameter; a significant positive correlation (p<0.05) was seen between keratinized gingiva and CW/CL, while it negatively correlates with the papilla height.

Gingiva is part of the soft tissue lining of the mouth that surrounds the teeth and provide a seal around them. It tightly bounds to the underlying bone and has a smooth scalloped appearance around each tooth. Clinical features of healthy gingiva reflect the underlying structure of the periodontium (Muller and Eger, 1997). The particular clinical features and characteristics of the gingiva seem to be related to its surrounding structure, including the tooth itself. (Abraham et al., 2014) suggested that the success rate of immediate implants in anterior teeth is higher in individuals with thick biotypes.

Table 1: The association between the gingival tissue biotype and the number of subjects

Total N(%)	GI n (%)	GII n (%)	P-value Chi-square test
47 (100)	12 (26)	35 (74)	0.001*

GI: Group I (thin gingival biotype); GII, Group II(thick gingival biotype); n: number; %: percentage; *significant at p-value ≤ 0.05.

Table 2: The periodontal phenotype with respect to different gingival biotypes

Variables	Total Mean (SD)	G1 Mean (SD)	GII Mean (SD)	P-value independent t-test
PD	2.17 (0.41)	2.07 (0.38)	2.21 (0.48)	0.303
CW/CL	0.77 (0.09)	0.74 (0.11)	0.78 (0.09)	0.174
GW	4.32 (0.89)	3.71 (0.96)	4.53 (0.77)	0.004*
PH	4.46 (0.76)	4.50 (0.48)	4.45 (0.84)	0.844

GI: Group I(thin gingival biotype); GII, Group II (thick gingival biotype); PD: probingdepth; CW/CL: crown width/crown length ratio; GW: gingival width of keratinized gingiva; PH: papilla height; *significant at p-value ≤ 0.05.

Table 3: The periodontal phenotype according to K means clustering

Variables	CI (%) Mean (SD)	CII (%) Mean (SD)	CIII (%) Mean (SD)	P-value Anova test
n (%)	6 (13)	24 (51)	17 (36)	-
PD	2.16 (0.45)	2.14 (0.43)	2.22 (0.38)	0.843
CW/CL	0.69 (0.09)	0.76 (0.09)	0.80 (0.09)	0.028*
GW	2.92 (0.49)	4.29 (0.67)	4.85 (0.70)	<0.001*
PH	4.55 (0.61)	4.96 (0.45)	3.73 (0.54)	<0.001*

CI: Cluster I(Narrow); CII: Cluster II (Mixed); CIII: Cluster III (Wide); PD: probing depth;CW/CL: crown width/crown length ratio; GW: gingival width of keratinized gingiva; PH: papilla height;*significant at p-value ≤ 0.05.

Table 4: Frequency distribution for gingival biotype percluster

Biotype	CI	CII	CIII
Score 0 (%)	100	21	12
Score 1 (%)	0	79	88

C I: Cluster I (Narrow); C II: Cluster II (Mixed); C III:Cluster III (Wide); Score 0: thin gingival biotype; Score1: thick gingival biotype.

Table 5: The Pearson correlation among the gingival characteristics

Variables	Pearson Correlation Value			
	PD	CW/CL	GW	PH
PD		-0.009	0.076	0.051
CW/CL			-0.037*	-0.107
GW				-0.344*

PD: probing depth; CW/CL: crown width/crown length ratio; GW: gingivalwidth or keratinized gingiva; PH:papilla height; *correlation is significant at p-value ≤ 0.05.

However, in patients with thin biotypes, the frequency of gingival recession is high following implant restoration. This coincides with our study result in which thick gingival biotype has wider keratinized gingiva that indicates a lower influence on the gingival recession. Thick gingival tissues are more withstanding to mucosal recession or mechanical irritation and are able to create a barricade to conceal restorative margins. Gingival thickness can be assessed by various methods. The methods include direct measurement, probe transparency method, ultrasonic devices, and cone-beam computed tomography scan. Periodontal probe insertion in the gingival sulcus and observing the transparency is a simple and easier method to determine tissue thickness in which we have chosen as the method for assessing the gingival biotype. For our study, central maxillary incisors were examined for the data collection since differences in gingival biotypes are most explicit for these teeth (Olssoin et al., 1993).

From this study, a significant three-quarter of the respondents showed gingiva that was thick enough to conceal the periodontal probe. These findings were expected since a previous report by Rouck et al. (2009) had already demonstrated that a high percentage of male subjects displayed thick gingival biotype in both central incisors. In the cluster analysis, cluster I categorized samples with slender tooth form (CW/CL=0.69), papilla height of 4.55 mm and narrow zone of keratinized gingiva. This result was not surprising since the cluster consists of 100% samples with thin gingival biotype. Interestingly, this is consistent with the previous research by Rouck et al. (2009) in which the vast majority of the thin biotype individuals displayed slender teeth with a relatively narrow zone of keratinized gingiva and a highly scalloped gingival margin. Our result also seems to be tallied with the term "thin scalloped biotype," which was introduced by Seibert and Lindhe (1989). However, from our analysis, only a minority of the young Malay male adults sampled in this study are in this cluster.

In contrast to that, cluster III consists primarily of a thick gingival biotype with broader and shorter crown form, short papilla height and a wider zone of keratinized gingiva. Research by Muller and Eger (1997) also have shown that subjects with thicker gingival biotype displayed a more apparent quadratic tooth shape and wider gingiva, which was observed in one of the clusters. Moreover, the Pearson correlation between each gingival phenotype showed a significant positive linear dependence between keratinized gingiva (GW) and CW/CL, while there is a significant negative correlation between GW and PH. (Stein et al., 2013) also reported a similar correlation, respectively.

This research involved the study population among the dental students considering their availability, different backgrounds, uncompromised oral hygiene, and suitable age range. 47 subjects were enrolled in this study, while some others had to be excluded due to orthodontic treatment, whether on an active appliance or on the first-6-months passive retainer, which limits our research population. The differences in the architecture of the gingiva and bone play a major role in the outcome of treatments. In many cases, aesthetics plays a crucial part in the success of the restoration. Therefore, in certain treatment that demands aesthetic outcome such as in full-coverage crown restoration, the gingival biotype should be identified and evaluated at the beginning of the treatment plan since the long term success of aesthetic restorations depends on several factors like gingival biotype, the architecture of the gingival tissue and shape of the anterior teeth. The gingival morphology is crucial, as it will later influence the final aesthetic outcome of the treatment. Therefore during treatment planning, in order to achieve the optimal aesthetic result, the soft tissue biotype should be taken into consideration as it affects the final treatment outcome.

CONCLUSION

The present study investigated the phenotypic features of the gingiva with two different biotypes in 47 study samples using a simple and reproducible method for the gingival thickness assessment, which is the probe transparency method. This study indicated different gingival phenotypes and crown form in young Malay male adults, with an increase in the keratinized gingiva in thick gingival biotype individuals. A transparent thin gingival biotype was found in about one-fourth of the respondents with narrower keratinized gingiva compared to the thick biotype with a wider zone of keratinized gingiva. A minor 13% of the samples showed narrow keratinized gingiva with low CW/CL (Cluster I), while 36% of them displayed broad keratinized gingiva with a high CW/CL ratio (Cluster III). The other half of the study samples that cannot be classified as such (Cluster II) has a mixed crown width with a significant increase in PH. Since different tissue biotypes have different morphological features and exhibit different pathological responses towards inflammation and certain dental treatments (which dictates different treatment modalities), the identification and evaluation of the tissue biotype during treatment planning is paramount to achieve a better

treatment outcome.

REFERENCES

Abraham, S., Deepak, K. T., Ambili, R., Preeja, C., and Archana, V. (2014). Gingival biotype and its clinical significance - A review. *The Saudi Journal for Dental Research*, 5(1):3–7.

Esfahrood, Z. R., Kadkhodazadeh, M., and Ardakani, M. R. T. (2013). Gingival biotype: A review. *General Dentistry*.

Kan, J. Y. K., Rungcharassaeng, K., Umezu, K., and Kois, J. C. (2003). Dimensions of Peri-Implant Mucosa: An Evaluation of Maxillary Anterior Single Implants in Humans. *Journal of Periodontology*, 74(4):557–562.

Muller, H. P. and Eger, T. (1997). Gingival phenotypes in young male adults. *Journal of Clinical Periodontology*, 24(1):65–71.

Ochsenbein, C. and Ross, S. (1969). A reevaluation of osseous surgery. *Dental Clinics of North America*, 13(1):87–102.

Olssoin, M., Lindhe, J., and Marinello, C. P. (1993). On the relationship between crown form and clinical features of the gingiva in adolescents. *Journal of Clinical Periodontology*, 20(8):570–577.

Olsson, M. and Lindhe, J. (1991). Periodontal characteristics in individuals with a varying form of the upper central incisors. *Journal of Clinical Periodontology*, 18(1):78–82.

Rouck, T. D., Eghbali, R., Collys, K., Bruyn, H. D., and Cosyn, J. (2009). The gingival biotype revisited: transparency of the periodontal probe through the gingival margin as a method to discriminate thin from thick gingiva. *Journal of Clinical Periodontology*, 36(5):428–433.

Schluger, S., Yuodelis, R., Page, R. C., and Johnson, R. H. (1990). Periodontal Diseases, 2nd edition. pages 541–545, Philadelphia: Lea & Febiger.

Seibert, J. and Lindhe, J. (1989). Esthetics and periodontal therapy. Textbook of Clinical Periodontology, 2nd edition. pages 477–514, Copenhangen, Denmark. Munksgaard.

Stein, J. M., Lintel-Höping, N., Hammächer, C., Kasaj, A., Tamm, M., and Hanisch, O. (2013). The gingival biotype: measurement of soft and hard tissue dimensions - a radiographic morphometric study. *Journal of Clinical Periodontology*, 40(12):1132–1139.