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GINGIVAL THICKNESS AND MORPHOMETRIC MEASUREMENTS RELATED TO MAXILLARY CENTRAL INCISORS IN A UNIVERSITY STUDENT POPULATION

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ABSTRACT:

Aim: To evaluate the distribution of gingival biotype among a young adult population and its correlation with morphometric data related to maxillary central incisors.

Methods: Only volunteers with healthy periodontium were included. Clinical parameters for maxillary central incisors were: Crown width/crown length ratio (CW/CL), gingival width (GW), probing depth (PD), and gingival thickness (GT). A periodontal probe was inserted in the midbuccal sulcus of the incisor to visually examine gingival thickness.

Results: The overall means for CW/CL, GW, and PD were 0.78 ±0.07, 5.82 ±1.25 mm, and 1.56 ±0.40 mm, respectively. Volunteers with clear thin-scalloped gingiva, the means for CW/CL, GW, and PD were 0.70 ±0.01, 4.85 ±0.84 mm, and 1.52 ±0.50 mm, respectively. Mean values for participants with clear thick-flat gingiva were 0.81 ±0.07, 6.30 ±1.10 mm, and 2.30 ±0.71 mm, respectively. All these values were statistically significant between the thin-scalloped and thick-flat biotypes (p<0.05).

Conclusions: Gingival biotype could be determined by uncomplicated clinical examination. The different biotypes are equally distributed between genders and there is an equal chance for a young adult to have a thin-scalloped (27%) or thick-flat (29%) biotype. Correlation is present between thick-flat gingiva and greater values of the clinical parameters CW/CL, GW, and PD.

Key words: Gingiva, Gingival biotype, Periodontal health, Periodontal probe.

INTRODUCTION:

In recent years, the dimensions of different parts of the masticatory mucosa, especially gingival thickness, has become a subject of considerable interest for dental researchers, both from an epidemiologic and therapeutic point of view.[1] The bulky, slightly scalloped marginal gingiva with short and wide teeth on one hand and thin, highly scalloped marginal gingiva with slender teeth on the other may serve to illustrate the existence of markedly different periodontal entities or so called "gingival biotype".[2,3]

The term gingival biotype has been used to describe the thickness of the gingiva in

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the facio-palatal dimension. The identification of the gingival biotype is an important factor in clinical practice; differences in gingival and osseous architecture may alter the outcome of surgical and restorative treatments. In a clinical study done on humans, Ponotoriero and Carnevale[4] showed more soft tissue regain following crown lengthening procedures in patients with the so-called "thick-flat biotype" than in those with a "thin-scalloped biotype". Olsson and Lindhe[3] reported higher prevalence of gingival recessions when a thin-scalloped gingiva was present. Regarding restorations on implants, the gingival biotype has been described as one of the key elements decisive for a successful outcome.[5] A trend of more gingival recession at immediate single-tooth implant restoration in patients with a thin-scalloped biotype was also reported.[6] These observations illustrate that the disparity of outcomes in surgical treatments could be a result of variability in tissue response to trauma.

A simple method has been proposed to visually discriminate thin from thick gingiva based on the transparency of the periodontal probe through the gingival margin.[7] Kan et al.[8] used a tension-free caliper placed 2 mm apical to the gingival margin immediately after extraction of the upper anterior teeth to directly measure the thickness of the gingiva. A thin gingiva was shown to have a thickness of 0.6 mm while thick gingiva can reach up to 1.5 mm; the average thickness was 1.06 mm for the 48 sites examined. When comparing the readings from the caliper with the visual transparency test performed before extraction, the authors concluded that assessment with a periodontal probe is an adequately reliable and objective method in evaluating gingival biotype.[8]

In 2009, De Rouck et al.[9] conducted a survey on 100 healthy subjects where they confirmed the existence of gingival biotypes. They also reported that a clear thin gingiva was found in about one-third of the sample, mainly in female subjects with slender teeth, narrow zone of keratinized tissue and highly scalloped gingival margin corresponding to the features of the previously introduced "thin-scalloped biotype". A clear thick gingiva was found in about two-thirds of the sample, mainly in male subjects. About half of their population showed quadratic teeth, a broad zone of keratinized tissue and a flat gingival margin, and corresponding to the features of the previously introduced "thick-flat biotype". The other half could not be classified as such, where they showed a clear thick gingiva with slender teeth, a narrow zone of keratinized tissue and a high gingival scallop.

There is no data on the distribution of gingival dimensions in Palestine, neither their relation to morphometric measurements of the maxillary incisor teeth. Hence, this study was conducted to identify the gingival biotype expression in a sample of periodontally healthy young Palestinians using the visual transparency method for gingival thickness assessment.

MATERIAL AND METHODS:

Subjects and Examiners:

Clinical data was collected from 83 senior dental students of Al-Quds University; only ten other students from this class of 2010 refused or where unavailable to volunteer in this study. The exclusion criteria of subjects were as follow: (i) Missing of any of the maxillary incisors (ii) dental restorations in any maxillary incisor (iii) Clinical signs of periodontal disease (iv) Pregnant or lactating females (v) Taking medication with known effect on the periodontal soft tissue (vi) Systemic disease that may affect periodontal tissue (vii) History of previous periodontal surgery in upper anterior region (viii) Previous or current orthodontic treatment (ix) Attrition of the incisal edges of maxillary incisors. All candidates included in this study had either clinically healthy gingiva or mild gingival inflammation, and they all received a session of oral hygiene instructions with scaling and polishing on the same day.

The examinations were carried out by five examiners including four senior dental students and a staff periodontist from the faculty of dentistry at Al-Quds University.

Clinical parameters:

Clinical parameters were recorded one week after the oral hygiene session. At this stage, participants were examined for any signs of gingival inflammation or presence of plaque or calculus; if present, they would either be excluded from study or received a scaling and polishing session to be examined one week later. For assessment of gingival morphology the following parameters were recorded:

1) Crown width/crown length ratio (CW/CL) of both central incisors was determined according to Olsson & Lindhe (3). Assessments of width and length were recorded to the nearest 0.5 mm using a caliper. The crown length was measured between the incisal edge of the crown and the free gingival margin, or if discernible, the cemento-enamel junction. The length of the crown was divided into three equal portions of equal height. Crown width defined as the distance between the approximal tooth surfaces, was recorded at the border between the middle and the cervical thirds.

2) Probing depth (PD) was measured to the nearest 0.5 mm at the midfacial aspect of each maxillary central incisor.

3) The width of the gingiva was measured midbuccally at maxillary central teeth, with a standard periodontal probe (CP 15 UNC; Hu-Friedy Instrument Co., Chicago, IL, USA) to the nearest millimeter. The mucogingival border was identified by inspecting mucosal surface characteristics as color and stippling and this was also aided by painting the mucosa with Schiller's potassium iodide. If still in doubt, the zone of attached gingiva was functionally demarcated by applying the periodontal probe to the alveolar mucosa parallel to the mucogingival border.[10,11]

4) Gingival thickness (GT) was evaluated and categorized into thick or thin on site with the presence of all five examiners. This evaluation was based on the transparency of the periodontal probe through the gingival margin while probing the sulcus at the midfacial aspect of both central maxillary incisors to the full

depth.[7,9] If the outline of the underlying periodontal probe could be seen at the whole subgingival part, it was categorized as thin (score: 1); if not, it was categorized as thick (score: 2). This resulted in three possible scores on a patient level: 2 (both central incisors with score 1), 3 (one central incisor with score 1 and the other with score 2), or 4 (both central incisors with score 2).

5) Architecture/contour of the gingiva was determined visually on site where the examiners had to choose either "scalloped gingiva" or "flat gingiva" after considering the morphology of the gingiva of the whole anterior teeth. Similar to all other records, all of the five examiners had to agree on the observation before it was recorded.

Data analysis:

Each individual was assigned to a cluster according to the GT and contour of the gingival margin. Individuals with thin gingiva (score=2) and scalloped contour were assigned to cluster A. Those who showed thin gingiva (score=2) with flat contour or those with a thick gingiva (score= 3 or 4) and a scalloped contour were assigned to cluster B. Any individual showing a thick gingiva (score= 3 or 4) and flat contour was assigned to cluster C.

Statistical analysis was performed using SPSS computer program (Stastical Package of Social Sciences 10.0). The mean value and standard deviation were calculated for each clinical parameter CW/CL, GW, PD. Significant differences between males and females and between clusters were assessed using the independent sample *t*-test. Statistical significance was recognized at p-value < 0.05.

RESULTS:

The study population consisted out of eighty-three senior dental students. After examination and taking dental and medical history, forty-four participants were included; 32 (72.72%) females and 12 (27.27%) males all of whom ages were within the range of 22-24 years. None of the females were smokers, while three of the included males were smokers. The most frequent cause for exclusion was dental restoration involving the maxillary incisors in 24 students.

Clinical parameters:

Table 1 presents descriptive statistics of three clinical parameters. CW/CL was a reference for the crown form of the central incisor. Its mean was 0.78 ±0.07 for the whole population; this ratio tended to be smaller in females (0.76 ±0.06) compared to the males (0.80 ±0.09). For GW, its overall mean was 5.82 ±1.25 mm; it was also slightly smaller in females (5.75 ±1.35 mm) than males (5.90 ±1.15 mm). The mean PD was 1.56 ±0.40 mm for the whole population; a statistically significant variation was observed when comparing the PD in females (mean 1.47 ±0.43 mm) to males (mean 1.64 ±0.38mm) (p=0.048). There were no statistical significant differences between males and females for CW/CL and GW (p=0.214 and p=0.667, respectively).

The frequency distribution for GT is depicted in Table 2. In twenty-five participants (57%) the gingiva was thick enough to conceal the periodontal probe at both incisors (score 4).

Cluster analysis:

The morphometric data obtained from the 44 participants was used to distribute the participants into three clusters. The specific features of each cluster are presented in Tables 3 and 4. Cluster A (clear thin-scalloped gingiva) contained twelve participants; 4 males and 8 females, cluster B (thin-flat or thick-scalloped gingiva) had 4 males and 15 females, and cluster C (clear thick-flat) contained thirteen participants; 9 females and 4 males.

Cluster A displayed a slender tooth form; CW/CL average was 0.70, GW of 4.85 mm, and a thin gingiva (probe visible on one or both incisors) which was characterized in 12 of the subjects.

Cluster B presented similar features (CW/CL 0.78, and GW 5.50 mm) with no significant differences for these parameters from those of cluster A (p=0.240, and p=0.115, respectively).

Cluster C consisted of thirteen participants who displayed a clear thick flat gingiva where the probe was concealed on both incisors of each participant. They showed more quadratic tooth form (CW/CL = 0.81 ±0.07) when compared to both cluster A (0.70 ±0.01, p=0.046) and cluster B (0.78 ±0.06, p=0.036). The mean GW of in cluster C (6.30 ±1.10 mm) was also statistically significantly higher from that of cluster A (4.85 ±0.84 mm; p=0.024) and cluster B (5.50 ±1.40; p=0.014). The mean PD was the greatest for cluster C (2.30 ±0.71 mm), and was statistically significantly higher when compared to that of cluster A (1.52 ±0.50 mm; p=0.0313) and cluster B (1.40 ±0.34 mm; p=0.022).

DISCUSSION:

The total of 93 dental students was offered to volunteer in this study; ten of them refused to participate. Evaluation of 83 subjects resulted in the inclusion of 44 volunteers after the exclusion of 39 subjects as follows: 24 (61.5%) of them had restorations involving at least one maxillary incisor, thirteen (33.3%) were subjected to orthodontic treatment, one student had a periodontal surgery in upper anterior segment, and one student was pregnant at the time of evaluation. This high exclusion rate was due to the strictly applied criteria which insured that all examinees had intact teeth and healthy periodontium. Restorations in maxillary incisors could change the dimensions of these teeth which might affect the CW/CL ratio and its correlation with gingival biotype; for this reason any restorative treatment in these teeth was considered an absolute cause of exclusion as well as signs of attrition of the incisal edges for the same reason.[12] Orthodontic treatment was also considered as an exclusion factor due to the possible changes in crown length due to intrusive and extrusive movements and the

concomitant changes in gingival width and sulcus probing depth.[13-16]

Megne et al.[12] measured the width and length of maxillary anterior teeth using standard digital images of extracted upper central incisors, lateral incisors, and canines. The teeth were designated into two groups: "worn" and "unworn" according to the presence of wear facets. Using a computer software analysis, the width was the widest mesio-distal portion and the length was the longest inciso-cervical distance. The length difference was 1-2 mm between "worn" and "unworn" central incisors. The range of CW/CL of "unworn" central incisors was 0.71-0.84 with a mean of 0.78. This was in accordance to our results where the mean ratio was 0.78 and the range was 0.75 – 0.83. In this study, an insignificant slight increased ratio of CW/CL was found in males in comparison to females (Table 1). However, significant differences were present between cluster A and Cluster C in terms of CW/CL ratio (Table 3).

In 1963, Bowers[17] has conducted a survey to evaluate the buccal width of attached gingiva in upper and lower teeth; this width was determined by subtracting the depth of the gingival sulcus from the distance between the margin of the free gingiva and mucogingival junction. The study examined 160 subjects with healthy gingiva and showed that the width of the calculated attached gingiva ranged from 1 to 9 mm. Individual variations were observed, some had a broad zone of attached gingiva in both maxilla and mandible; others had a narrow zone in both. Width of attached gingiva showed no difference between adult age groups and there was no difference between males and females at any of the various age groups. In general, it was wider on upper teeth than in lower teeth. The author reported that the factors that affected width of attached gingiva of periodontally healthy teeth where associated with malposed teeth and high frenum attachment. In the maxilla, it was reported that the greatest width of attached gingiva was related to central and lateral incisors, particularly lateral incisors. On upper central incisors, the width ranged from 3-7 mm and the mean values were 4.5 - 4.7 mm.[17] These observations were not much different from the results obtained in this study. The width of buccal keratinized gingiva including the free gingival margin for upper central incisors ranged between 3.75 – 8.50 mm with mean of 5.82 ±1.25 mm. Males showed a minimal increased width which was not statistically significant (Table 1).

In this study, the thickness of facial attached gingiva was measured in only one tooth type, the upper central incisors, and in subjects from both sexes but similar age, ranging between 22-24 years. All participants were from one class and most of them (89%) accepted to volunteer which gives a randomized population and reduction of any possible bias. Maxillary central incisor teeth were chosen for this study due to their convenience and accessibility for measurement; especially that some parameters were evaluated by all the five examiners at the same time.

Also, biotype characteristics are most explicit in maxillary incisors, and their specific features usually represent the other parts of the dentition.[3,18,19]

Patients with a thick gingiva have been shown to be relatively resistant to gingival recession following surgical and/or restorative therapy.[4,6,20,21] In this study the gingival biotype was evaluated clinically by sulcus probing; this assessment provides some objectivity where it tests the visibility of the metallic color of underlying periodontal probe during evaluation. The ability of the gingival tissue to conceal any underlying material is important in achieving esthetic results, especially in restorative and implant dentistry, where subgingival alloys are present extensively. Therefore, Kan et al.[8] stated that using the metal periodontal probe to evaluate gingival tissue thickness is a logical, minimally invasive method, adequately reliable and objective method in evaluating gingival biotype.

Gingival thickness was present in more than half of the examined population in this study; 50% of males and 59% of females had the gingiva to conceal the underlying probe on both incisors (Table 2).

In this study, a simple classification was used to group the patients into three clusters. Cluster A with both thin gingiva and scalloped contour; Cluster C with a thick gingiva and flat contour; and Cluster B for the uncertain cases with either a thin and flat gingiva or thick and scalloped gingiva. Clusters A and C were the clear cases which could be classified into thin and thick biotypes according to periodontal literature[2,3,9] ; these two clusters consisted of a similar proportions of the examined population (27 % and 29 %, respectively). Cluster B consisted of 43 % of the population from which only 21% where considered thin gingiva using the periodontal probe test. The presence of such a group (cluster B in this study) which could not be classified in a uniform way has also been described in previous studies which compromised about one-third of their population.[9,19,22]

Olsson et al.[18] used the CW/CL-ratio to select the 10 individuals ranked lowest and the 10 ranked highest and put them into two groups. The long-narrow teeth were accompanied with a GW of 4.50 mm and short-wide teeth were accompanied by 5.85 mm of keratinized gingiva. These results are in harmony with the GW values in our study were it was 4.85 ± 0.84 in cluster A and 6.30 ± 1.10 in cluster C.

In the present study, low PD values were recorded; as only periodontally healthy volunteers participated. The mean value increased significantly from 1.52 ± 0.50 mm in cluster A to 2.3 ± 0.71 mm in cluster C. This confirms that shallower PD may be expected in patients with thin scalloped biotype and deeper PD coincide with thick flat biotype. These results are similar to the study by De Rouck et al.[9], where the corresponding buccal PD was 1.23 mm in slender teeth with thin gingiva, and 1.55 mm in wide teeth with thick gingiva. Older literature suggested that patients with quadratic crown forms

have thicker periodontium and may respond to gingival inflammation by means of pocket formation; in contrast, individuals with a tapered crown form and a comparatively thinner gingiva may be more susceptible to gingival recessions.[2,3]

CONCLUSION:

The results of this study confirm the existence of gingival biotype which could be determined by the thickness of the buccal gingiva and the contour of the gingival margin. A clear thin gingiva was found in 27 % of the sample, who also had slender teeth, narrow keratinized tissue and highly scalloped gingival margin, corresponding to the features of the previously introduced "thin-scalloped biotype" (cluster A). A clear thick gingiva was found in 29 % of sample which also had quadratic teeth, broad zone of keratinized tissue and flat contour of the gingival margin corresponding to the features of "thick-flat biotype" (cluster C). The different biotypes are equally distributed between the two genders and there is an equal chance for a young adult to have a thin-scalloped or thick-flat biotype. Values of CW/CL, GW, and PD may vary significantly according to biotype. These variations should be examined and recorded clinically by the surgeon or restorative dentist to be noticed before performing their procedures, especially in the esthetic zone.

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TABLES:

Table 1. Clinical characteristics of tooth form and gingiva in 88 central incisors [mean (SD)].

	Male participants n =12	Female participants n=32	Total	Minimum-maximum	*P*-value
Crown width/Crown length ratio	0.80 (0.09)	0.76 (0.06)	0.78 (0.07)	0.75 - 0.83	0.214
Gingival width (mm)	5.90 (1.15)	5.75 (1.35)	5.82 (1.25)	3.75 - 8.50	0.667
Probing depth (mm)	1.64 (0.38)	1.47 (0.43)	1.56 (0.40)	0.87 – 2.00	0.048 *

SD: standard deviation, n: number of individuals.

* Significant difference between male and female participants (p<0.050).

Table 2. Frequency distribution for gingival thickness.

	Male participants n = 12	Female participants n = 32	Total n = 44
Score 2 (%)	3 (25.0%)	10 (31.2%)	13 (29.5%)
Score 3 (%)	3 (25.0%)	3 (9.4%)	6 (13.6%)
Score 4(%)	6 (50.0%)	19 (59.4%)	25(56.8%)

n: number of individuals.

Table 3. Clinical characteristics of tooth form and gingiva [mean (SD)].

	Cluster A (thin-scalloped)	Cluster B (thick-scalloped + thin-flat)	Cluster C (thick+flat)
Prevalence (%)	12 (27.2%)	19 (43.1%)	13 (29.5%)
Crown width/Crown length ratio	0.70 (0.01)	0.78 (0.06) §	0.81 (0.07) †, ‡
Gingival width (mm)	4.85 (0.84)	5.50 (1.40) §	6.30 (1.10) †, ‡
Probing depth (mm)	1.52 (0.50)	1.40 (0.34) §	2.30 (0.71) †, ‡

SD: standard deviation.

§ Significant difference compared to cluster A (p<0.05)
† Significant difference compared to cluster A (p<0.05)
‡ Significant difference compared to cluster B (p<0.05)

Table 4. Frequency distribution for gingival thickness per cluster.

	Cluster A n=12	Cluster B n=19	Cluster C n=13
Score 2 (%)	9 (75.0%)	4 (21.0%)	0 (0.0%)
Score 3 (%)	3 (25.0%)	3 (15.8%)	0 (0.0%)
Score 4 (%)	0 (0.0%)	12 (63.2%)	13 (100.0%)

n: number of individuals.