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ORIGINAL ARTICLE

Assessment of Gingival Biotype and Keratinized Gingival Width of Maxillary Anterior Region in Individuals with Different Types of Malocclusion

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ABSTRACT

Objective: The aim of the present study is to evaluate the relationship of gingival thickness and width of keratinized gingiva with different malocclusion groups and amount of crowding.

Methods: A total of 181 periodontally healthy subjects were enrolled in the present study. The study participants were divided into three malocclusion groups: Angle Class I, Angle Class II, and Angle Class III. Each group was divided into subgroups according to the amount of dental crowding, namely mild, moderate, and severe. The width of keratinized gingiva was calculated as the distance between mucogingival junction and free gingival margin, whereas gingival thickness was determined by a transgingival probing technique.

Results: Tooth numbers 13 and 23 were observed to have thin gingival biotype. The width of keratinized gingiva for tooth numbers 13 and 23 was narrower in the severe crowding group than in the moderate and mild crowding groups. The relationship of gingival thickness and width of keratinized gingiva with Angle classification was not found to be significant.

Conclusion: Although it is thought that there is a relationship between gingival thickness, width of keratinized gingiva, and Angle classification with regard to malaligned teeth, this cross-sectional evaluation of 181 patients failed to show a significant relationship.

Keywords: Malocclusion, crowding, gingival biotype, transgingival probing

INTRODUCTION

Some researchers consider the position of the upper incisors as a fundamental parameter during orthodontic diagnosis and treatment planning (1). Since the upper incisors support the upper lip and affect the vertical lip thickness, the correct position of these teeth is very important esthetically (2). Vertical positioning of the upper incisors is sufficient to permit the exposure of the incisal edge 4-5 mm beneath the upper lip. Horizontally, several clinical and cephalometric parameters, such as nasal projection, upper lip support, and thickness and angulation of the upper lip, should be taken into consideration for positioning the upper incisors (2, 3).

Anteroposterior tooth movements, for positioning the upper incisor, made in the anatomical limits of the alveolar bone by controlled orthodontic forces do not cause any pathological problems (4). However, dehiscence and fenestrations are observed as a result of tooth movements exceeding the anatomical limits of the alveolar bone. Such tooth movements enhance susceptibility to gingival recession particularly in individuals with thin gingival biotype due to the gingiva losing its alveolar bone support (4, 5).

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'Gingival biotype' is a term used to define buccolingual thickness of the gingiva (6). Gingival thickness, which is determined by the shape and size of the dental root and contour of the alveolar bone, is classified into two types: thin and thick (6, 7). The thin biotype is identified as gingival thickness <1 mm, whereas the thick biotype is identified as gingival thickness ≥1 mm (8).

The width of keratinized gingiva is one of the other factors that need to be evaluated in order not to encounter any periodontal problems during orthodontic treatment (9, 10). The width of keratinized gingiva, which has been recommended to be at least 2 mm to maintain periodontal health, could be increased by mucogingival surgical procedures such as free gingival grafts, coronal advancement flaps, subepithelial connective tissue grafts, acellular dermal grafts, and enamel matrix proteins in cases with narrow keratinized gingiva (4, 10).

The present study aims to investigate the relationship of gingival thickness, which is considered to be a significant risk factor for periodontal problems that may be observed in the maxillary anterior region due to orthodontic tooth movements, and width of keratinized gingiva with different malocclusion groups and amount of crowding. The hypothesis was that different malocclusion groups may have a relationship with gingival thickness and keratinized gingival width of the maxillary anterior region.

METHODS

A total of 181 subjects aged 11-28 years, who presented to Yüzüncü Yıl University Faculty of Dentistry, Department of Orthodontics, were enrolled in the study. A total of 118 of the patients in the study group were females (mean age: 17.27±3.96 years) and 63 were males (mean age: 15.82±2.56 years). The study was commenced after obtaining approval from the Yüzüncü Yıl University School of Medicine, Research Ethics Committee (B.30.2.YYU.0.01.00.00/141).

The study group consisted of periodontally healthy subjects, who have not undergone orthodontic treatment before, have completed permanent dentition, and had no congenital anomaly, dental structural disorder, loss of attachment, or a pocket deeper than 4 mm. In addition, informed consent was obtained from all patients.

The participants were divided into three groups: Angle Class I, Angle Class II, and Angle Class III according to dental malocclusion. The mesiobuccal cusp of the maxillary first molar was noted to be occluded with the mesiobuccal groove of the mandibular first molar in Angle Class I malocclusion. Further, the mandibular first molar was distally positioned in Angle Class II malocclusion and mesially positioned in Angle Class III malocclusion relative to the upper first molar (11).

Each Angle classification group was divided into subgroups according to the amount of dental crowding in the maxillary anterior region as mild (0-3 mm), moderate (4-6 mm), and severe (>6 mm) (12). It was determined that there were 71 (39.2%), 80 (44.2%), and 30 (16.6%) patients in the Angle Class I, Class II, and Class III malocclusion groups, respectively. In addition, there were 57 (31.5%), 40 (22.1%), and 84 (46.4%) patients in the mild, moderate, and severe crowding groups, respectively (Table 1).

Figure 1. Transgingival probing with an endodontic file

Figure 2. Measurement points

Plaque index (PI; Silness and Löe, 1964), gingival index (GI; Löe and Silness, 1963), and probing depth (PD) measurements of the periodontal pocket were performed from the mesial and distal surfaces and vestibular and palatinal midpoints of the maxillary anterior teeth. In addition, keratinized gingival widths of the maxillary anterior teeth were determined by the distance between free gingival margin and mucogingival junction. All these measurements were achieved using a periodontal probe (PQW7; Williams, Hu Friedy, Chicago, USA).

For transgingival probing, if necessary, Xylocaine spray (Vemcain 10% Lidocaine) was applied over the examination area to relieve pain. Gingival thickness of each tooth was me asured by piercing the soft tissue perpendicular to the long axis of the tooth using a 10 mm endodontic file with a rubber stopper until the alveolar bone is reached (Figure 1). While in this position, the rubber stopper of the endodontic file was fixed on the soft tissue. After removal, gingival thickness was measured using a digital compass (Mitutoyo Corp., Kanagawa, Japan) with 0.01 mm sensitivity. Gingival thickness of each tooth was measured at the apical from

free gingival margin and coronal from mucogingival junction (Figure 2). After the measurements were repeated twice in these regions, gingival thickness of each tooth was determined by the arithmetic mean of these four measurements. If the gingival thickness was <1 mm, the gingiva was classified as thin biotype; if it was >1 mm, the gingiva was classified as thick biotype (8). The distributions of thin and thick gingival biotypes according to gender, Angle classification, and amount of crowding were evaluated in the present study.

All measurements were performed by the same researcher (YK). The intra-examiner repeatability of the researcher was analyzed at 20 patients and found to be high (Pearson correlation coefficient: 0.895, p<0.001).

Statistical Analysis

Power analysis was performed, and sample size was determined according to 80% power value. Descriptive statistics for the considered parameters were presented as mean, standard deviation, and maximum and minimum values. The normality test of data was evaluated using the Kolmogorov–Smirnov test, and the homogeneity was evaluated using the Levene test. After these tests, the distribution of data was observed to be normal, and the variances were homogeneous. Then, factorial variance analysis was performed to determine whether there was a difference according to Angle classification and amount of crowding. Following variance analysis, Duncan's multiple range test was performed to determine the crowding groups and different classes of Angle classification. The relationship of gingival biotype with Angle classification, amount of crowding, and gender was determined using chi-square test. Probability values <5% were considered as significant. Statistical analysis of data was completed using SPSS for Windows version 22.0 (IBM Corp.; Armonk, NY, USA) package software.

RESULTS

No statistically significant difference was found between genders in terms of number and mean age of patient. In addition, there

Table 1. Distribution and percentage of patients

		Amount of crowding		
		Mild	Moderate	Severe
Angle Class I	Count	22	17	32
	% within Angle classification	31%	23.9%	45.1%
	% within crowding amount	38.6%	42.5%	38.1%
	% of total	12.2%	9.4%	17.7%
Angle Class II	Count	24	14	42
	% within Angle classification	30%	17.5%	52.5%
	% within crowding amount	42.1%	35%	50%
	% of total	13.3%	7.7%	23.2%
Angle Class III	Count	11	9	10
	% within Angle classification	36.7%	30%	33.3%
	% within crowding amount	19.3%	22.5%	11.9%
	% of total	6.1%	5.0%	5.5%

p<0.05

Table 2. Distribution of plaque index, gingival index, and probing depth measurements according to Angle classification and crowding amount

		Mild crowding	Moderate crowding			
Mean±SD	Mean±SD	Mean±SD	Mean±SD	Severe crowding	Total	p*
Plaque index	Angle Class I	1.20±0.34	1.08±0.11	1.14±0.20	1.14±0.24	0.334
	Angle Class II	1.18±0.23	1.06±0.12	1.13±0.12	1.11±0.16	
	Angle Class III	1.17±0.12	1.12±0.28	1.15±0.29	1.17±0.26	
	Total	1.18±0.26	1.08±0.18	1.14±0.19	1.13±0.21	
Gingival index	Angle Class I	0.38±0.48	0.41±0.50	0.40±0.47	0.39±0.48	0.634
	Angle Class II	0.39±0.51	0.39±0.67	0.38±0.42	0.38±0.49	
	Angle Class III	0.37±0.29	0.38±0.09	0.40±0.47	0.38±0.35	
	Total	0.38±0.46	0.39±0.53	0.39±0.44	0.35±0.47	
Probing depth	Angle Class I	1.89±0.53	1.60±0.63	1.77±0.55	1.75±0.56	0.086
	Angle Class II	1.86±0.40	1.78±0.68	1.87±0.35	1.82±0.44	
	Angle Class III	1.89±0.35	1.87±0.16	1.96±0.35	1.91±0.30	
	Total	1.87±0.45	1.75±0.58	1.84±0.44	1.79±0.48	

SD: standard deviation
*Two-way (factorial) ANOVA (interaction is not statistically significant)

Table 3. Distribution and percentage of gingival biotype according to Angle classification, amount of crowding, and gender

		Gingival biotype		
		Thick	Thin	p
Angle Class I	Count	50	21	0.895
	% of total	27.6%	11.6%	
Angle Class II	Count	57	23	0.895
	% of total	31.5%	12.7%	
Angle Class III	Count	20	10	0.895
	% of total	11%	5.5%	
Mild crowding	Count	39	18	0.794
	% of total	21.5%	9.9%	
Moderate crowding	Count	27	13	0.794
	% of total	14.9%	7.2%	
Severe crowding	Count	61	23	0.794
	% of total	33.7%	12.7%	
Females	Count	78	40	0.102
	% of total	66.1%	33.9%	
Males	Count	49	14	0.102
	% of total	77.8%	22.2%	
Total	Count	127	54	
	% of total	70.2%	29.8%	

p<0.05

was no statistically significant difference in terms of number of patients between Angle classification and amount of crowding groups (Table 1).

PI, GI, and PD measurements of patients and distribution of these parameters according to Angle classification and amount of crowding are shown in Table 2. No statistically significant difference was found between the groups.

Distribution of the patients with thin and thick gingival biotypes according to Angle classification, amount of crowding, and gender is shown in Table 3. The prevalence of thin gingival biotype was 29.8%. Although thin biotype was more common in the Angle Class II malocclusion group, severe crowding group, and females, the difference was not statistically significant (p<0.05).

The keratinized gingival width and gingival thickness of the maxillary anterior teeth according to Angle classification and amount of crowding are shown in Tables 4 and 5, respectively. The width of keratinized gingiva of tooth numbers 13 and 23 was determined to be narrower in the severe crowding group than in the mild and moderate crowding groups. The relationship between the width of keratinized gingiva and Angle classification was not found to be statistically significant.

Table 4. WKG of maxillary anterior teeth according to Angle classification and amount of crowding

		Mild crowding	Moderate crowding	Severe crowding	Total
	Angle classification	Mean±SD	Mean±SD	Mean±SD	Mean±SD
WKG of tooth number 11	Angle Class I	5.20±1.71	5.22±1.47	4.70±1.88	4.98±1.74
	Angle Class II	4.94±1.41	5.43±1.83	4.74±1.18	4.92±1.39
	Angle Class III	4.18±0.98	5.00±2.24	4.90±1.37	4.67±1.56
	Total	4.89±1.49	5.24±1.75	4.75±1.49	4.90±1.56
WKG of tooth number 12	Angle Class I	7.41±2.56	7.06±1.48	7.28±2.02	7.27±2.08
	Angle Class II	7.23±1.96	7.79±1.85	6.93±1.95	7.17±1.94
	Angle Class III	5.91±2.34	6.56±3.09	6.80±2.20	6.40±2.49
	Total	7.04±2.31	7.21±2.07	7.05±1.99	7.08±2.10
WKG of tooth number 13	Angle Class I	5.05±1.81	3.72±1.62	3.28±2.45	3.94±2.21
	Angle Class II	5.06±2.13	4.54±1.93	3.44±2.00	4.13±2.14
	Angle Class III	3.14±1.47	3.72±2.93	2.70±1.48	3.17±1.99
	Total	4.68A±2.02	4.01AB±2.07	3.29B±2.12	3.89±2.15
WKG of tooth number 21	Angle Class I	4.89±1.68	4.84±1.06	4.70±1.47	4.79±1.44
	Angle Class II	4.83±1.58	5.07±1.64	4.56±1.29	4.73±1.44
	Angle Class III	4.23±1.25	5.06±2.40	4.70±1.40	4.63±1.69
	Total	4.74±1.56	4.97±1.61	4.63±1.36	4.74±1.48
WKG of tooth number 22	Angle Class I	7.14±2.10	6.22±1.82	6.56±1.90	6.66±1.95
	Angle Class II	6.90±1.78	7.71±1.94	6.51±2.01	6.84±1.96
	Angle Class III	6.00±2.14	6.17±2.83	7.10±2.28	6.42±2.38
	Total	6.82±1.99	6.74±2.19	6.60±1.99	6.70±2.02
WKG of tooth number 23	Angle Class I	5.25±2.78	4.25±1.85	3.50±2.21	4.22±2.43
	Angle Class II	5.00±2.38	4.21±2.15	3.38±1.87	4.02±2.18
	Angle Class III	3.82±2.04	4.17±2.21	2.80±1.34	3.58±1.92
	Total	4.87A±2.50	4.22A±1.99	3.36B±1.95	4.03±2.24

WKG: width of keratinized gingiva; SD: standard deviation
Two-way (factorial) ANOVA (interaction was not statistically significant)
A and B: Statistically significant difference between amount of crowding (p<0.05)
a, b, c: Statistically significant difference between Angle classification (p<0.05)

Table 5. GT of maxillary anterior teeth according to Angle classification and amount of crowding

		Mild crowding	Moderate crowding	Severe crowding	Total
	Angle classification	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**
GT of tooth number 11	Angle Class I	1.16±0.27	1.22±0.24	1.21±0.24	1.20±0.25
	Angle Class II	1.28±0.30	1.30±0.43	1.22±0.27	1.25±0.31
	Angle Class III	1.12±0.17	1.11±0.20	1.48±0.22	1.24±0.26
	Total	1.20±0.27	1.22±0.32	1.25±0.26	1.23±0.34
GT of tooth number 12	Angle Class I	1.00±0.37	1.13±0.40	1.39±0.53	1.21±0.49
	Angle Class II	1.01±0.28	1.19±0.47	1.38±0.49	1.23±0.46
	Angle Class III	1.11±0.36	1.21±0.39	1.60±0.53	1.30±0.47
	Total	1.02B±0.33	1.17B±0.42	1.41A±0.51	1.24±0.55
GT of tooth number 13	Angle Class I	0.94±0.23	0.88±0.26	0.83±0.26	0.88±0.26
	Angle Class II	0.96±0.22	0.99±0.17	0.83±0.29	0.89±0.26
	Angle Class III	0.86±0.28	0.78±0.33	0.94±0.25	0.86±0.29
	Total	0.93±0.25	0.90±0.26	0.84±0.28	0.88±0.30
GT of tooth number 21	Angle Class I	1.27±0.40	1.19±0.27	1.21±0.26	1.22±0.32
	Angle Class II	1.35±0.35	1.18±0.27	1.24±0.28	1.27±0.31
	Angle Class III	1.17±0.27	1.13±0.43	1.43±0.27	1.25±0.33
	Total	1.27±0.36	1.17±0.31	1.26±0.28	1.25±0.32
GT of tooth number 22	Angle Class I	1.10±0.45	1.11±0.50	1.33±0.46	1.20±0.47
	Angle Class II	1.14±0.40	1.27±0.47	1.45±0.64	1.33±0.56
	Angle Class III	1.15±0.48	1.16±0.49	1.60±0.55	1.30±0.54
	Total	1.13B±0.43	1.18B±0.49	1.25A±0.23	1.23±0.53
GT of tooth number 23	Angle Class I	0.92±0.33	0.89±0.26	0.81±0.26	0.86ab±0.28
	Angle Class II	0.98±0.32	1.01±0.33	0.88±0.32	0.93a±0.32
	Angle Class III	0.83±0.21	0.77±0.24	0.81±0.33	0.81b±0.25
	Total	0.93±0.31	0.90±0.30	0.84±0.29	0.88±0.30

GT: gingival thickness; SD: standard deviation.
Two-way (factorial) ANOVA (interaction is not statistically significant)
A and B: Statistically significant difference between amount of crowding ($p<0.05$)
a and b: Statistically significant difference between Angle classification ($p<0.05$)

When the gingival thickness of the maxillary anterior teeth was evaluated, only tooth numbers 13 and 23 were observed to have thin biotype, and that gingival thickness of tooth number 23 was higher in the Angle Class II group than in the Angle Class I and Angle Class III groups. However, not only the difference between Angle Class I and Angle Class II groups but also the difference between Angle Class I and Angle Class III groups was not found to be statistically significant. Gingival thickness of tooth numbers 12 and 22 with thick biotype was higher in the severe crowding group than in the mild and moderate crowding groups.

DISCUSSION

Careful evaluation of the periodontal tissues of the subjects is of critical importance in order not to be faced with pathological conditions such as gingival recession in cases undergoing protrusion of the incisors. While determining the amount of protrusion in such cases, biological factors such as biotype and quality of periodontal tissues in the relevant region should also be taken into account together with the width of keratinized gingiva (4, 13, 14). Wenström et al. (15) and Yared et al. (5) noted that the gingival biotype is more important than these other parameters, which should be evaluated during treatment planning. At this point, the present study aims to evaluate the relationship of the width of keratinized gingiva and gingival thickness of the maxillary anterior teeth that are prone to periodontal problems, with different malocclusion groups and amount of crowding.

The literature review demonstrated that visual assessment, ultrasonic devices, cone beam computed tomography, periodontal probe, and transgingival probing techniques have been used in determining gingival thickness (6, 12, 16-22). It has been observed that visual assessment, which is a simple method, is not reliable as clinical experience is an important issue and thin biotype cannot always be identified correctly (12, 17). Furthermore, small changes cannot be detected correctly by the measurements performed by ultrasonographic devices, which yield more reliable and repeatable assessments (18, 19). It is observed that cone beam computed tomography provides the closest results to reality, but is not preferred owing to the potential side effects of radiation in routine clinical practice (20).

Today, periodontal probing and transgingival probing are generally preferred in determining gingival biotype. Kan et al. (12) in their study in which they compared the reliability of visual assessment, periodontal probing, and transgingival probing techniques in determining gingival thickness of the maxillary anterior teeth determined similar and reliable outcomes with periodontal probing and transgingival probing techniques. However, Alkan et al. (23) compared the transgingival probing and periodontal probing in 2184 maxillary and mandibular anterior teeth and concluded that although similar results were obtained with both techniques for the teeth with thick biotype and teeth with gingival thickness <0.8 mm, the coherence was lower between two techniques for the teeth with gingival thickness of 0.8-1 mm. Further, Greenberg et al. (21) compared transgingival probing and surgical flap procedure in measuring gingival thickness and concluded that there was no significant difference between these two techniques, but transgingival probing technique was less traumatic. In the present study, we preferred transgingival probing technique, which allows assessment of gingival thickness from two points in millimeters.

Some studies, which investigated the relationship of gingival biotype with different malocclusion groups and amount of anterior crowding, took the central teeth as the reference in determining gingival biotype of the subject (6, 24). However, Wennström (8) and Hirschfeld (25) reported that gingival thickness may change depending on the position of the teeth in the dental arch. For this reason, the present study evaluated the relationship of gingival thickness of each maxillary anterior tooth with different malocclusion groups and amount of crowding.

Gingival thickness is reportedly influenced by the changes in the location of the teeth during the eruption period, and that it decreases with increasing age as the connective tissue becomes denser, cell count decreases, epithelium becomes thinner, and keratinization increases (22, 26). Ramesh et al. (27), in their study in which they investigated the relationship between gingival thickness and age, allocated the subjects aged between 14 and 29 years to the young-age group and the subjects aged between 30 and 59 years to the advanced-age group. For this reason, the present study group consisted of subjects aged <29 years who had all permanent teeth erupted for gingival thickness to be less influenced by age-related changes.

Studies evaluating the relationship of gingival biotype with gender reported that gingival thickness is lower in females than in males (6, 22, 27). In the present study, it was also observed that thin gingival biotype was more common in 11.7% of females than males, with the difference being not statistically significant.

In the literature, there are different opinions on keratinized gingival width that would maintain periodontal health during orthodontic treatment. Lang and Löe (10) and Yared et al. (5) reported that keratinized gingival width <2 mm would be insufficient to maintain periodontal health, whereas Coatoam et al. (28) noted that keratinized gingival width <2 mm would be sufficient in the subjects with good oral hygiene. Wennström et al. (15) reported that whether the attached gingiva is sufficient cannot be determined by measuring only the width of keratinized gingiva, but that the gingival thickness should be measured as well. In the present study, keratinized gingival width of the maxillary anterior teeth was found between 3.29±2.12 mm and 7.21±2.07 mm. With regard to the relationship with different malocclusion groups and amount of crowding, it was determined that only the keratinized gingival widths of tooth numbers 13 and 23 were smaller in the severe crowding group than in the mild and moderate crowding groups. The relationship with Angle classification was not found to be statistically significant.

When the gingival thickness of the maxillary anterior teeth was evaluated, it was found that gingival thickness of the canine teeth was lower than that of the central and lateral teeth, which is consistent with the results of the studies conducted by Younes et al. (29) and Müller et al. (30) Since permanent canine tooth germs, which are localized in the same direction with the roots of deciduous canine teeth, show vestibular eruption when there is no adequate space in the dental arch, it is known that these teeth have less alveolar bone, narrow keratinized gingiva, and lower gingival thickness (8, 25, 31, 32).

The literature contains a limited number of studies evaluating the relationship of gingival biotype with the amount of crowding. Among these studies, Zawawi and Al-Zahrani (24) reported that there was no significant relationship between the amount of crowding and gingival thickness in the maxillary anterior region. Kaya et al. (33) observed that when the crowding increases in the mandibular anterior jaw, the gingival thicknesses of the mandibular incisors increased, whereas the gingival thicknesses of the canines decreased. In the present study, it was also observed that gingival thicknesses of tooth numbers 12 and 22 were greater in the severe crowding group than in the mild and moderate crowding groups. This was attributed to the greater amount of alveolar bone, wider keratinized gingiva, and increased gingival thickness due to the eruption of permanent lateral tooth germs, which are localized in the lingual aspect of the lateral deciduous teeth roots, without correcting their positions in the event of crowding (8, 31, 32).

Zawawi et al. (6) investigated the relationship between gingival biotype and Angle classification and reported no statistically significant relationship between them. In the present study, it was observed that gingival biotype of the individuals was determined only from the maxillary central teeth by periodontal probing. Further, Kaya et al. (33) investigated the gingival thickness of the mandibular anterior teeth, determined by transgingival probing, with different malocclusion groups. It was concluded that the mandibular anterior teeth have thin gingival biotype, and there was no association between Angle classification and mean gingival thickness of the mandibular anterior region. Since the gingival thicknesses of the upper and lower jaws may vary, the relationship between gingival thicknesses of the maxillary anterior teeth, determined by transgingival probing, with different malocclusion

groups was evaluated in the present study. No statistically significant relationship was found between Angle classification and gingival thickness excluding tooth number 23. Gingival thickness of tooth number 23 was found to be higher in the Angle Class II group than in the Angle Class I and Angle Class III groups. However, neither the difference between Angle Class I and Angle Class II groups nor the difference between Angle Class I and Angle Class III groups was found to be statistically significant. Even so, teeth movement in this region should be done within the anatomical limits of the alveolar bone with controlled orthodontic forces. When incisor protrusion is planned, it is necessary to increase the gingival thickness with mucogingival surgical methods (13).

CONCLUSION

- No relationship was determined between Angle classification and gingival thickness and keratinized gingival width.
- The width of keratinized gingiva of the maxillary anterior teeth was determined to be wider than 2 mm, which was considered necessary for the maintenance of periodontal health.
- The width of keratinized gingiva of the maxillary canine teeth was determined to be smaller in the severe crowding group than in the mild and moderate crowding groups.
- The maxillary canine teeth were observed to have thin gingival biotype in all groups.
- Gingival thickness of the maxillary lateral incisors was determined to be higher in the severe crowding group than in the mild and moderate crowding groups.
- Gingival thickness and keratinized gingival width are observed to have been influenced by the position of the teeth in the dental arch.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of Yüzüncü Yıl University School of Medicine.

Informed Consent: Written informed consent was obtained from all the patients who participated in this study.

Peer-review: Externally peer-reviewed.

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REFERENCES

1. Arnett GW, Jelic JS, Kim J, Cummings DR, Beress A, Worley CM Jr, et al. Soft tissue cephalometric analysis: diagnosis and treatment planning of dentofacial deformity. Am J Orthod Dentofacial Ortop 1999; 116: 239-53. [CrossRef]
2. McNamara L, McNamara JA Jr, Ackerman MB, Baccetti T. Hard- and soft-tissue contributions to the esthetic of posed smile in growing patients seeking orthodontic treatment. Am J Orthod Dentofacial Ortop 2008; 133: 491-9. [CrossRef]
3. Gracco A, Lombardo L, Mancuso G, Gravina V, Siciliani G. Upper incisor position and bony support in untreated patients as seen on CBCT. Angle Orthod 2009; 79: 692-702. [CrossRef]
4. Renkema AM, Fudalej PS, Renkema A, Kiekens R, Katsaros C. Development of labial gingival recessions in orthodontically treated patients. Am J Orthod Dentofacial Orthop 2013; 143: 206-12. [CrossRef]
5. Yared KFG, Zenobio EG, Pacheco W. Periodontal status of mandibular central incisors after orthodontic proclination in adults. Am J Orthod Dentofacial Orthop 2006; 130: 1-6. [CrossRef]
6. Zawawi KH, Al-Harthi ŞM, Al-Zahrani MS. Prevalance of gingival biotype and its relationship to dental malocclusion. Saudi Med J 2012; 33: 671-5.
7. 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. [CrossRef]
8. Kan JY, Morimoto T, Rungcharassaeng K, Roe P, Smith DH. Gingival biotype assessment in the esthetic zone: visual versus direct measurement. Int J Periodontics Restorative Dent 2010; 30: 237-43.
9. Wennström JL. Mucogingival consideration in orthodontic treatment. Semin Orthod 1996; 2: 46-54. [CrossRef]
10. Lang NP, Löe H. The relationship between the width of keratinized gingiva and gingival health. J Periodontol 1972; 43: 623-7. [CrossRef]
11. Proffit WR. Malocclusion and dentofacial deformity in contemporary society. In: Proffit WR, Fields HW, Sarver DM, editors. Contemporary orthodontics. St. Louis, MO: Mosby Elsevier; 2007.p.2-24.
12. Sayın MÖ, Türkkahraman H. Malocclusion and crowding in an orthodontically referred Turkish population. Angle Orthod 2004; 74: 635-9.
13. Holmes HD, Tennant M, Goonewardene MS. Augmentation of faciolingual gingival dimensions with free connective tissue grafts before labial orthodontic tooth movement: An experimental study with a canine model. Am J Orthod Dentofacial Orthop 2005; 127: 562-72. [CrossRef]
14. Joss-Vassalli I, Grebenstein C, Topouzelis N, Sculean A, Katsaros C. Orthodontic therapy and gingival recession: a systematic review. Orthod Craniofac Res 2010; 13: 127-41. [CrossRef]
15. Wennström JL, Lindhe J, Sinclair F, Thilander B. Some periodontal tissue reaction to orthodontic tooth movement in monkeys. J Clin Periodontol 1987; 14: 121-9. [CrossRef]
16. La Rocca AP, Alemany AS, Levi PJr, Juan MV, Molina JN, Weisgold AS. Anterior maxillary and mandibular biotype: relationship between gingival thickness and width with respect to underlying bone thickness. Implant Dent 2012; 21: 507-15. [CrossRef]
17. Eghbali A, De Rouck T, De Bruyn H, Cosny J. The gingival biotype assessed by experienced and inexperienced clinicians. J Clin Periodontol 2009; 36: 958-63. [CrossRef]
18. Slak B, Daabous A, Bednarz W, Strumban E, Maev RG. Assessment of gingival thickness using an ultrasonic dental system prototype: a comparison to tradional methods. Ann Anat 2014; 199: 98-103. [CrossRef]

19. Abraham S, Deepak KT, Ambili R, Preeja C, Archana V. Gingival biotype and its clinical significance: A review. Saudi J Dent Res 2014; 5: 3-7. [CrossRef]
20. Fu JH, Yeh CY, Chan HL, Tatarakis N, Leong DJM, Wang HL. Tissue biotype and its relation to the underlying bone morphology. J Periodontol 2010; 81: 569-74. [CrossRef]
21. Greenberg J, Laster L, Listgarten MA. Transgingival probing as a potential estimator of alveoler bone level. J Periodontol 1976; 47: 514-7. [CrossRef]
22. Vandana KL, Savitha B. Thickness of gingiva in association with age, gender and dental arch location. J Clin Periodontol 2005; 32: 828-30. [CrossRef]
23. Alkan EA, Alkan Ö, Kaya Y, Keskin S. Comparison the reliability of two different measurement techniques used to determine the gingival biotype. Turkiye Klinikleri J Dental Sci 2016; 22: 42-7. [CrossRef]
24. Zawazi KH, Al-Zahrani MS. Gingival biotype in relation to incisors' inclination and position. Saudi Med J 2014; 35: 1378-83.
25. Hirschfeld I. A study of skulls in the American Museum of Natural History in relation to periodontal disease. J Dent Research 1923; 5: 241-65. [CrossRef]
26. Sobocki A, Bodin L. Changes of facial gingival dimension in children: a 2 years longitudinal study. J Clin Periodontol 1993; 20: 212-8. [CrossRef]
27. Ramesh KSV, Swetha P, Krishnan V, Mythili R, Alla RK, Manikkandan D. Assessment of thickness of palatal masticatory mucosa and maximum graft dimensions at palatal vault associated with age and gender - a clinical study. J Clin Diagn Res 2014; 8: 9-13.
28. Coatoam GW, Behrents RG, Bissada NF. The width of keratinized gingiva during orthodontic treatment: it's significance and impact on periodontal status. J Periodontol 1981; 52: 307-13. [CrossRef]
29. Younes F, Eghbali A, Raes M, De Bruyckere T, Cosyn J, De Bruyn H. Relationship between buccal bone and gingival thickness revisited using non-invasive registration methods. Clin Oral Implants Res 2015; 26: 1-6.
30. Müller HP, Schaller N, Eger T, Heinecke A. Thickness of masticatory mucosa. J Clin Periodontol 2000; 27: 431-6. [CrossRef]
31. Proffit WR. The development of orthodontic problems. Proffit WR, Fields HW, Sarver DM, editors. Contemporary Orthodontics. Elsevier: Mosby; 2007.p.72-106.
32. Boke F, Gazioğlu C, Akkaya S, Akkaya M. Relationship between orthodontic treatment and gingival health: A retrospective study. Eur J Dent 2014; 8: 373-80. [CrossRef]
33. Kaya Y, Alkan Ö, Keskin S. An evaluation of the gingival biotype and the width of keratinized gingiva in the mandibular anterior region of individuals with different malocclusion groups and levels of crowding. Korean J Orthod 2017; 47: 176-85. [CrossRef]