Library Progress International
Vol.44, No.3, **November** *2024: P. 22814-22822*
DOI: xyz

Print version ISSN 0970 1052
Online version ISSN 2320 317X

Original Article

Available online at www.bpasjournals.com

A Gender Based Analysis of Gingival Biotype in the Maxillary and Mandibular Anterior Region of People with Varying Crowding Levels

Derangula Likhitha[1*], Sri Krishna Chalasani[2], Raghu Devanna[3], Vasudevan S.D[4], Dharmitha Sali[1], Sanjana Chelle[1]

[1*]Pg Student, Department of Orthodontics and Dentofacial Orthopedics, KIMS Dental College and Hospital, Amalapuram, B.R. Ambedkar Konaseema Dt. Pin: 533201. Andhra Pradesh, India.
[2]Professor and Head, Department of Orthodontics and Dentofacial Orthopedics, KIMS Dental College and Hospital, Amalapuram, B.R. Ambedkar Konaseema Dt. Pin: 533201. Andhra Pradesh, India.
[3]Reader, Department of Orthodontics and Dentofacial Orthopedics, KIMS Dental College and Hospital, Amalapuram, B.R. Ambedkar Konaseema Dt. Pin: 533201. Andhra Pradesh, India.
[4]Professor and Head, Department of Orthodontics and Dentofacial Orthopedics, AME Dental College and Hospital, Raichur, pin-584103, Karnataka, India.

How to cite this article: Derangula Likhitha, (2024). A Gender Based Analysis of Gingival Biotype in the Maxillary and Mandibular Anterior Region of People with Varying Crowding Levels. Library Progress International, 44(3), ***22814-22822.***

ABSTRACT

Background-To avoid post orthodontic periodontal complications careful assessment of gingival biotype is necessary, so to know the relation between the type of malocclusion and gingival biotype among males and females this study was planned and conducted.

Aim and objective: To evaluate and compare the gingival biotypes in males and females with crowding in maxillary and mandibular arches.

Materials and Methods: A sample of 100 individuals with equal distribution of males and females with crowding were selected. (50 in each group). Crowding was classified as mild/ moderate/severe based on littles irregularity index. Transgingival probing was done using endodontic file(10mm) for assessing the biotype, gingival thickness of each tooth was measured from 2nd premolar on one side to the other in both the arches using a digital vernier caliper with 0.01mm sensitivity.

Results: when compared between genders with crowding gingival thickness is higher in the males than the females, statistical significance was found in all the teeth. Irrespective of the gender canines have thin gingiva when compared to the remaining teeth in both the arches.

Conclusion: The gingival thickness has significant gender predilection and careful planning is needed to avoid post treatment complications.

Keywords-Gingival thickness, gingival biotype, transgingival probing, crowding.

INTRODUCTION

Orthodontic therapy aims to foster greater dental health by positioning teeth in the center of alveolar housing and achieving good occlusion which will lead to healthier periodontium. Improving the facial appearance is one of the main objectives of orthodontic treatment[1]. Correction of dental irregularities and reduction or elimination contributes to improved oral hygiene. A healthy periodontium is required for a normal response to orthodontic pressures.

The gingival/periodontal biotype is one of the variables that influences periodontal health. The size, shape and position of the teeth, along with

genetic factors, all affect the biotype[2], as does the thickness and width of the facial gingiva in various parts of oral cavity. The morphology of gingiva plays a major role in regulating the final aesthetic result [3]which depends on number of variables, including the anterior teeth's shape, biotype, and gingival architecture. In aesthetic-driven dentistry, clinician should know more about gingival reaction to various restorative, prosthetic, periodontal, and orthodontic procedures. The final outcome is influenced significantly by gingival morphology[4].

The gingival thickness in the facio palatal dimension has been referred to as gingival biotype. The phrase periodontal biotype refers to a variety of characteristics, including gingiva thickness as well as other aspects like gingiva contour, root size and shape, alveolar bone thickness and contour, amount of keratinized gingiva, and crown shape[5]. Lindhe coined the term periodontal biotype, that distinguished between "thick-flat" and "thin scalloped" biotypes of the gingiva [3]. Periodontal inflammation manifests as gingival recession in thin tissues and increased pocket development in thick biotypes. Many periodontal problems occur after the orthodontic treatment which results in failure of the orthodontic treatment. To overcome this situation, knowledge about biotype is important.[6]

Early detection of aberrant tooth position prevents the development and progression of periodontal diseases by providing information to guide treatment.[7,8] It was observed that marginal tissue recession and periodontal detachment[8] are significantly influenced by decreased gingival thickness[9].

When it comes to levelling the gingival margins, orthodontic intrusion, extrusion, or periodontal surgery may be utilized depending on the crown heights, lip line, and gingival levels of nearby teeth.[10] While orthodontic treatment can correct skeletal and dental malocclusions, the insertion of any orthodontic appliances in the patient's mouth is frequently linked to changes in the patient's habits regarding oral hygiene and periodontal health.

Thicker gingival biotype is preferred over Thin gingival biotype because Thick gingival biotype has thicker alveolar bone and gingiva in the labial and palatal regions at all levels compared to Thin Gingival Biotype. Inflammatory hyperplasia, irreversible loss of attachment, gingival recession, and chronic infection are all potential side effects of orthodontic appliance placement. It has been shown that soft tissue loss results from gingival recession and interproximal bone resorption, which invariably degrades aesthetics. Numerous invasive and non-invasive techniques are available for measuring gingival thickness like the trans gingival probing method[9] which is more reliable.

Not many studies are available that studied the association between gingival thickness and teeth with crowding in the current population. Also, scanty literature is available comparing the biotypes between crowding among males and females and hence the study. Study's objective is to assess and contrast the crowding related gingival biotypes in males and females.

OBJECTIVES:

To Evaluate gingival Biotype in Males with Crowding.

To Evaluate gingival Biotype in Females with Crowding.

To Compare gingival Biotype in Male and female individuals with Crowding

MATERIALS AND METHODS

After obtaining the institutional ethical clearance study was done to evaluate gingival biotype in males and females with different levels of crowding. This study was carried out in the department of orthodontics general OPD and has been conducted irrespective of the ethnic origin of the subject and 'informed consent' was taken from all subjects who participated in the current study.

Sample Selection: A minimum 'sample' size of 29 subjects for each group was needed, with an alpha level of 0.05 and power of 0.80.

A sample of 100 individuals with equal distribution of males and females is considered with 50 subjects in each group i.e., 50 males individuals with crowding and 50 females individuals with crowding were selected.

INCLUSION CRITERIA: Individuals with Age group of 18 years- 28 years, Individuals who are Periodontally healthy, Individuals with Permanent dentition, Individuals with crowding

EXCLUSION CRITERIA: Individuals who underwent orthodontic treatment, Individuals with Congenital anomalies, Individuals with a depth of pocket more than 4mm, Pregnancy and lactating women, Individuals who Use medication which leads to gingival enlargement, Individuals with smoking habit.

MATERIALS:

1. Pressure sensitive periodontal probe(Figure.1) for constant probing pressure and accuracy
2. lignocaine local anesthetic spray Nummit lidocaine USP 15%
3. Endodontic file with stopper (or)spreader with stopper
4. Digital vernier caliper with 0.01 accuracy (Aerospace) (Figure.2)

FIGURE.1 PRESSURE SENSITIVE PERIODONTAL PROBE

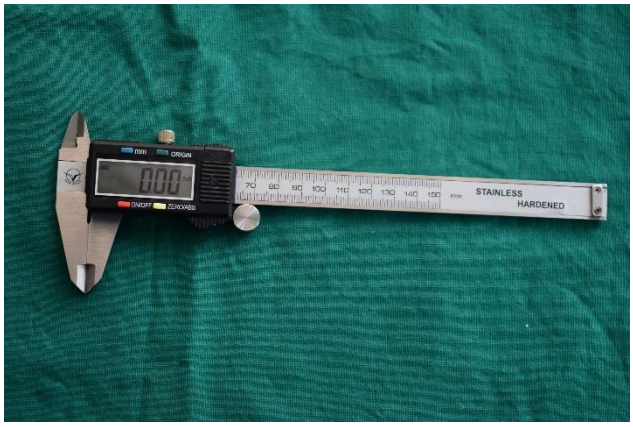

FIGURE.2 DIGITAL VERNIER CALIPER

METHODOLOGY

Following the verification of the inclusion and exclusion criteria and the acquisition of informed consent, the Littles irregularity Index[11] was utilized to classify crowding as mild, moderate, and severe.

Each mandibular incisor's anatomic contact point's horizontal linear displacement from the neighbouring anatomic point is measured by the Little's irregularity index.(Figure.3)

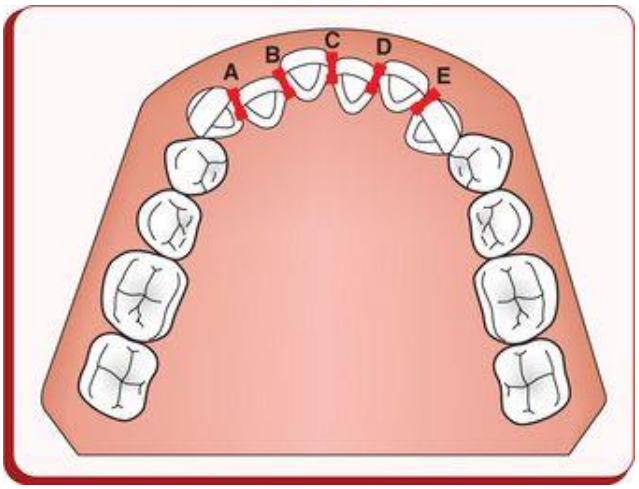

FIGURE.3. LITTLES IRREGULARITY INDEX

The value indicates the degree of anterior irregularity once it has been summed.

- Score 0 - Perfect alignment
- Score 1-3 - Minimal irregularity
- Score 4-6 - Moderate irregularity
- Score 7-9 - Severe irregularity
- Score 10 - Very severe irregularity

To ascertain the periodontal status gingival index, bleeding index, OHI-S index, plaque index, width of keratinized gingiva, recession was checked.
Lidocaine spray was sprayed on the examination site prior to trans-gingival probing in order to relieve pain. With an endodontic file 10 mm in length and a rubber stopper, soft tissue was punctured perpendicular to the tooth's long axis(Figure.4) to determine gingival thickness of each tooth that needed to be measured.

FIGURE.4 TRANSGINGIVAL PROBING USING ENDODONTIC FILE

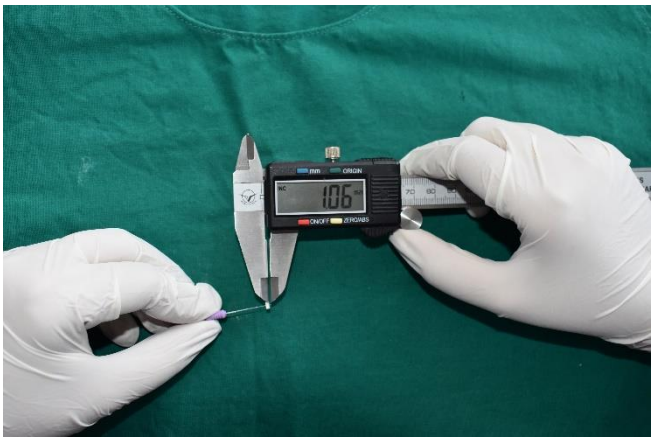

FIGURE.5. MEASUREMENT USING DIGITAL VERNIER CALIPERS

This process was repeated until the alveolar bone was reached. Following extraction, a digital vernier caliper with a 0.01mm sensitivity(Figure.5) was used to measure each tooth's gingival thickness. Every tooth's gingival thickness is measured apically from the coronal portion of mucogingival junction to free gingival margin.
Following two measurements, the gingival thicknesses of each tooth was ascertained. Gingival thickness was classified as thin biotype if it measured less than 1 mm, and thick biotype if it measured equal to or more than 1 mm. Scoring was given to each tooth in the maxillary and mandibular arches starting with the second premolar on one side and going to the other and independent T test statistical analysis was conducted.

RESULTS

The data was analysed using SPSS version 26.0 software. Mean scores between males and females with Crowding were compared using independent t test. A statistically significant value was defined as $p<0.01$.

TABLE.1 MEAN AGE GROUP OF FEMALES AND MALES IN CROWDING GROUP.

	CONDITION	N	Mean	Std. Deviation	Std. Error Mean
Age	CROWDING (F)	50	21.1000	1.32865	.18790
	CROWDING (M)	50	20.3400	1.81389	.25652

TABLE.2 COMPARISON OF GINGIVAL BIOTYPE BETWEEN MALES AND FEMALES IN MAXILLARY ARCH

	CONDITION	N	Mean	Std. Deviation	Std. Error Mean	T value	p value
U15	CROWDING (F)	50	1.0052	.21901	.03097	-4.61	0.000 HS**
	CROWDING (M)	50	1.2184	.24283	.03434		
U14	CROWDING (F)	50	1.0150	.16625	.02351	-4.32	0.000 HS**
	CROWDING (M)	50	1.2004	.25380	.03589		
U13	CROWDING (F)	50	.8342	.15438	.02183	-6.22	0.000 HS**
	CROWDING (M)	50	1.0826	.23626	.03341		
U12	CROWDING (F)	50	1.1198	.23041	.03258	-2.22	0.02 S*
	CROWDING (M)	50	1.2256	.24466	.03460		
U11	CROWDING (F)	50	1.1282	.20672	.02923	-4.30	0.000 HS**
	CROWDING (M)	50	1.3014	.19583	.02770		
U21	CROWDING (F)	50	1.1310	.20921	.02959	-3.88	0.000 HS**
	CROWDING (M)	50	1.2936	.20886	.02954		
U22	CROWDING (F)	50	1.1042	.22031	.03116	-3.64	0.000 HS**
	CROWDING (M)	50	1.2674	.22709	.03212		
U23	CROWDING (F)	50	.8622	.15131	.02140	-5.60	0.000 HS**
	CROWDING (M)	50	1.1012	.26073	.03687		
U24	CROWDING (F)	50	1.0010	.15915	.02251	-5.02	0.000 HS**
	CROWDING (M)	50	1.2170	.25890	.03661		
U25	CROWDING (F)	50	1.0176	.20866	.02951	-4.48	0.000 HS**
	CROWDING (M)	50	1.2312	.26476	.03744		

The mean scores in study participants with crowding is higher in males compared to females and this difference was found to be highly significant in all maxillary right and left teeth (p-0.000) except for upper lateral right incisor where significant difference was observed (p-0.02)

TABLE.3 COMPARISON OF GINGIVAL BIOTYPE BETWEEN MALES AND FEMALES IN MANDIBULAR ARCH

	CONDITION	N	Mean	Std. Deviation	Std. Error Mean	T value	p value
L35	CROWDING (F)	50	.9856	.21925	.03101	-4.69	0.000 HS**
	CROWDING (M)	50	1.2044	.24594	.03478		
L34	CROWDING (F)	50	.9838	.18986	.02685	-4.71	0.000 HS**
	CROWDING (M)	50	1.1932	.25010	.03537		
L33	CROWDING (F)	50	.7778	.19823	.02803	-5.61	0.000 HS**
	CROWDING (M)	50	1.0544	.28635	.04050		
L32	CROWDING (F)	50	.9618	.20769	.02937	-4.20	0.000 HS**
	CROWDING (M)	50	1.1548	.24979	.03533		
L31	CROWDING (F)	50	.9082	.17537	.02480	-4.79	0.000 HS**
	CROWDING (M)	50	1.1052	.23196	.03280		
L41	CROWDING (F)	50	.9166	.17004	.02405	-4.39	0.000 HS**
	CROWDING (M)	50	1.0922	.22555	.03190		
L42	CROWDING (F)	50	.9522	.17541	.02481	-3.88	0.000 HS**
	CROWDING (M)	50	1.1098	.22664	.03205		
L43	CROWDING (F)	50	.7752	.19033	.02692	-5.10	0.000 HS**
	CROWDING (M)	50	1.0074	.25935	.03668		
L44	CROWDING (F)	50	.9710	.16253	.02299	-4.59	0.000 HS**
	CROWDING (M)	50	1.1394	.20185	.02855		
L45	CROWDING (F)	50	.9988	.18472	.02612	-4.18	0.000 HS**
	CROWDING (M)	50	1.1732	.22930	.03243		

Statistical test applied: Independent t test; HS – Highly significant at $p<0.01$; S – Significant at $p<0.05$

The mean scores in study participants with crowding is higher in males compared to females and this difference was found to be highly

significant in all mandibular right and left teeth (p-0.000).

The results suggest higher thickness of gingiva in male population when compared to females in all the teeth which were included in the study

DISCUSSION

Ochsenbein and Ross originally defined biotype as the gingival contour's anatomical structure.[12] Later, Seibert and Lindhe created the term periodontal biotype and classified the periodontium into two groups: thin scalloped biotypes, linked to narrower teeth and keratinized gingiva, and thick-flat biotypes, linked to wide keratinized gingiva and quadratic teeth[13].If a biotype's Gingival Thickness is more than 1 mm it is categorized as thick and if thickness is less than 1 mm, it is categorized as thin. The literature showed that gingival thickness has been measured using visual evaluation, ultrasonic devices, cone beam computed tomography, periodontal probing, and transgingival probing techniques [14,15,16,17,18]. It has been noted that the straightforward method of visual assessment is unreliable because clinical experience is a significant factor and thin biotype identification is not always accurate [19]. Moreover, ultrasonographic devices provide more accurate and repeatable assessments[20]. Cone beam computed tomography is seen to yield the most accurate results, but is not recommended in routine clinical practice due to possible radiation side effects[21]. For the purpose of identifying gingival biotype, periodonta and transgingival probing are typically preferred. In Kan et al.'s[22] study comparing the reliability of visual assessment, periodontal probing, and transgingival probing techniques in determining gingival thickness of maxillary anterior teeth, similar and reliable results were found with these methods. The trans-gingival approach requires anesthesia to be applied in the area being examined, it has the highest overall accuracy and sensitivity of all the methods studied. As a result, it nearly matches the direct method so transgingival probing method was selected for measuring the thickness of gingiva in the current study.

Research indicates a strong correlation between gingival health and smoking as it augments the risk of gingival recession.[23] In order to prevent variations in gingival thickness, smokers were not included in the current study as Smoking habit and gingival biotype are strongly correlated.

Position of the teeth within the dental arch, however, may have an impact on gingival thickness, according to Wennstrom [24] and Hirschfeld [25]. While Melsen and Allais[26] showed that gingival morphology plays a significant role in recession following orthodontic correction.

Gingival recession is more common in upper cuspid, upper bicuspid, lower cuspid, and lower bicuspid teeth. Cuspids were the teeth most likely to develop it. Thin periodontal phenotypes are more likely to experience gingival recession. Recession of the anterior teeth compromises their aesthetics. The root surface may be more susceptible to root caries, dentine hypersensitivity, non-carious cervical lesions, and an increase in dental plaque deposition because it is exposed to the oral environment.

Similar to the results of this study, earlier research has demonstrated that, in comparison to incisors, canines had significantly smaller mean gingival and bone thickness as well and GM-CEJ distance.[29] Tomographic imaging evaluation of the periodontium is especially useful for treatment planning, particularly when orthodontic therapy is being considered for a change in the inclination of the central incisors and canines, or when the area to be treated already shows signs of loss of periodontal support / thin alveolar bone. [2]

Other factors influencing the Gingival Thickness are the alveolar process's size, the teeth's shapes, the processes involved in; tooth eruption, the final inclination, and the location of the fully erupted teeth.

Men showed statistically significant higher GT in the maxillary and mandibular anterior regions in the current study than did women and was significant. The findings are consistent with research by Muller et al[37]; De Rouck et al[16], Vandana et al[33]., which found that females generally had a thinner masticatory mucosa. Additionally, thin GT is represented by 64% of females and 25% of males, according to Zawawi KH et al[4]. In their investigation into the correlation between GT and gender discovered that women had considerably thicker gingiva than men which is against the results of this study. This discrepancy could be the result of ethnic differences between the studies conducted in Yemen and India, respectively.

On the other hand, Shah R. found no significant variation in gingival thickness between the sexes[28]. Furthermore, it was found that females with thin biotypes had long, thin teeth, whereas males had quadratic teeth with thicker biotypes, which was consistent with research done by a number of authors [30,31]

In a study, Zawawi et al.[32] evaluated the relationship between gingival biotype and different malocclusion types. In the meantime, Kaya et al.[10] investigated the connection between angle classifications and the gingival biotype of a lower anterior tooth. The different malocclusion groups and gingival biotypes do not significantly correlate with one another. Because the permanent

canine tooth bud and the deciduous canine root are located in the same location, the gingival biotype of permanent canines is thought to be lower than that of either of the incisors.[24], This study's findings, which are in line with those of studies by Younes et al [27] and Muller et al [37], indicate that gingival biotype of mandibular canines is smaller than that of laterals and centrals. These teeth are known to have thinner gingiva, less alveolar bone, and narrower keratinized gingiva. These results support the conclusion of present study.

Vandana et al[33] demonstrated thick biotype in mandibular teeth this result is not consistent with the current investigation.

Younger people had thicker gingiva than older people, according to Vandana and Savitha et al [33] study on gingiva thickness and age. Kolte and colleagues also reported similar findings: the gingiva in the younger age group was thicker than the older age group, and the gingiva in females was narrower and thinner than that of males[1].

Though most previous studies only evaluated gingival thickness in relation to anterior teeth, the present study included the first and second premolars due to the non-extraction trend in orthodontic treatment evaluation, raising the possibility that the gingival tissue may be more susceptible to long-term recession if the alveolar bone thins out as a result of expansion during orthodontic intervention. These data support previous research involving human subjects and suggest that gingival retraction may result from orthodontic expansion of the dental arch.

There was no discernible correlation found in studies by Staufer et al[35], Zawawi et al[15], Alkan et al [6,8] between gingival biotype and malocclusion. Minimum gingival thickness was found in Class III patients' mandibular central and lateral incisors, according to Kaya et al.[9] and Maroso et al[36]. The periodontal tissue response differs from class II to Class III malocclusion. It was concluded from the above studies that there is no significant correlation between the gingival biotype and type of malocclusion.

Fenestrations and bone dehiscences are associated with crowding, misaligned teeth. The periodontium and teeth may suffer negative consequences if there is insufficient bone support during orthodontic movement. The possibility of rupturing the alveolar bone's boundaries and resulting in buccal and lingual bone plate resorption is thus increased by buccal-lingual movements. so, bodily movement of lower incisors is preferred over tipping to avoid complications post treatment.

In the maxilla, first premolars exhibited the most frequent fenestration. This distribution might be due to maxilla's anatomical features. An area that gets narrower upward is where the maxillary first premolars are found. The health of the teeth and periodontium may be negatively impacted by the buccal-lingual movement of maxillary first molars. In orthodontics, thickness of gingiva is a strong predictor of the clinical result of specific tooth movements[37]. To completely comprehend the possible effects of racial and genetic factors on gingival thickness, more research is necessary.

LIMITATIONS

Further studies with more sample size are recommended as the current study examined only 100 individuals (50 males and 50 Females) for better accuracy of the outcome.

SUMMARY AND CONCLUSION

- When compared between genders males have thicker gingiva than females in both the arches in crowding group and significance is seen in all the teeth and the gingival thickness of "canines" is less in both the arches when compared to that of other teeth.
- This result adds credence to the idea that patients with thin GTs need more thorough treatment planning

REFERENCES

1. KOLTE RA, KOLTE AP, KHARKAR VV, BAWANKAR P. Influence of facial index, facial profile, lip size, and angulations of teeth on gingival characteristics of anterior teeth: A gender-based evaluation. Journal of Esthetic and Restorative Dentistry. 2020 Jul; 32(5):496-504.
2. Montanha-Andrade K, Crusoé-Rebello IM, Barreto M, Neves FS, SANTOS JN, Cury PR. Assessment of the relationship between tooth inclination and gingival and alveolar bone dimensions using computed tomography of the maxillary anterior teeth: a cross-sectional study. Dental Press Journal of Orthodontics. 2022 Sep 23;27.
3. Vasishta PA, Gajendran PL, Murthykumar K, Ganapathy D. Association between gingival recession and its biotype among South Indian population-a retrospective study. Journal of Pharmaceutical Negative Results. 2022 Sep 29:864-70.
4. Zawawi KH, Al-Zahrani MS. Gingival biotype in relation to incisors' inclination and position. Saudi Med J. 2014;35(11):1378.
5. BOKE F, GAZIOGLU C, AKKAYA S, AKKAYA M. Relationship between orthodontic treatment and gingival health: A retrospective study. European journal of dentistry. 2014 Jul; 8(03):373-80

6. ALKAN Ö, KAYA Y, ALKAN EA, KESKIN S, COCHRAN DL. Assessment of gingival biotype and keratinized gingival width of maxillary anterior region in individuals with different types of malocclusions. Turkish Journal of Orthodontics. 2018 Mar; 31(1):13
7. Manjunath RG, Rana A, Sarkar A. Gingival Biotype Assessment in a Healthy Periodontium: Transgingival Probing Method. J Clin Diagn Res. 2015;9(5):ZC66-9.
8. Niyaz H, Jabbar A, Noor R, Naz S, Asim S, Mushtaq M, Shahid H. Assessment of Gingival Biotype in Mandibular Anterior Segment with Different Malocclusion. Foundation University Journal of Dentistry. 2023 Jul 24;3(2):56-62.
9. 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 dental malocclusion groups and levels of crowding. The Korean journal of orthodontics. 2017 May 1; 47(3):176-85.
10. JOSHI A, SURAGIMATH G, ZOPE SA, ASHWINIRANI SR, VARMA SA. Comparison of gingival biotype between different genders based on measurement of dentopapillary complex. Journal of Clinical and Diagnostic Research: JCDR. 2017 Sep;11(9): ZC40
11. Little RM. The irregularity index: a quantitative score of mandibular anterior alignment. American journal of orthodontics. 1975 Nov 1;68(5):554-63.
12. Ochsenbein C, Ross S. A re-evaluation of osseous surgery. Dent Clin North Am 1969;13(1):87–102.
13. Seibert J, Lindhe J. Esthetics and periodontal therapy. Textbook of clinical periodontology. 1989; 2:477–514.
14. La Rocca AP, Alemany AS, Levi PJr, Juan MV, Molina JN, Weis gold AS. Anterior maxillary and mandibular biotype: relationship between gingival thickness and width with respect to underlying bone thickness. Implant Dent 2012; 21: 507-15.
15. Zawawi KH, Al-Harthi ŞM, Al-Zahrani MS. Prevalence of gingival biotype and its relationship to dental malocclusion. Saudi Med J 2012; 33: 671-5,
16. 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.
17. 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.
18. 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.
19. Geiger AM. Mucogingival problems and the movement of mandibular incisors: A clinical review. Am J Orthod 1980; 78:511-27
20. Sallum EJ, Nouer DF, Klein MI, Gonçalves RB, Machion L, Wilson Sallum A, et al. Clinical and microbiologic changes after removal of orthodontic appliances. Am J Orthod Dentofacial Orthop 2004; 126:363-6
21. Artun J, Krogstad O. Periodontal status of mandibular incisors following excessive proclination. A study in adults with surgically treated mandibular prognathism. Am J Orthod Dentofacial Orthop 1987; 91:225-32.
22. 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.
23. Sreedevi M, Ramesh A, Dwarakanath C. Periodontal status in smokers and nonsmokers: a clinical, microbiological, and histopathological study. Int J Dent 2012; 2012:571590. DOI: 10.1155/2012/571590
24. Wennström JL, Lindhe J, Sinclair F, Thilander B. Some periodontal tissue reactions to orthodontic tooth movement in monkeys. J Clin Periodontol 1987; 14:121-9.
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
26. Melsen B, Allais D. Factors of importance for the development of dehiscences during labial movement of mandibular incisors: A retrospective study of adult orthodontic patients. Am J Orthod Dentofacial Orthop 2005; 127:552-61.
27. 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.
28. Shah R, Sowmya N, Mehta D. Prevalence of gingival biotype and its relationship to clinical parameters. Contemp Clin Dent. 2015;6(Suppl 1): S167
29. Amid R, Mirakhori M, Safi Y, Kadkhodazadeh M, Namdari M. Assessment of gingival biotype and facial hard/soft tissue dimensions in the maxillary anterior teeth region using cone beam computed tomography. Arch Oral Biol. 2017 Jul; 79:1-6.
30. Eghbali A, De Rouck T, De Bruyn H, Cosyn J. The gingival biotype assessed by experienced

and inexperienced clinicians. J Clin Periodontol. 2009;36(11):958-63
31. Malhotra R, Grover V, Bhardwaj A, Mohindra K. Analysis of the gingival biotype based on the measurement of the dentopapillary complex. J Indian Soc. Periodontol. 2014;18(1) 43–47
32. Zawawi KH, Al-Zahrani MS. Gingival biotype in relation to incisors' inclination and position. Saudi Med J. 2014; 35:1378-1383
33. Vandana KL, Savitha B. Thickness of gingiva in association with age, gender and dental arch location. J Clin Periodontol. 2005 Jul;32(7):828-30.
34. Ochsenbein C, Ross S. A re-evaluation of osseous surgery. Dent Clin North Am 1969;13(1):87–102. DOI: 10.1016/S0011-8532(22)02947-0
35. Staufer K, Landmesser H. Effects of crowding in the lower anterior segment- -a risk evaluation depending upon the degree of crowding. Journal of orofacial orthopedicsFortschritte der Kieferorthopadie: Organ/official journal Deutsche Gesellschaft fur Kieferorthopadie. 2004 Jan 1;65(1):13-25.
36. Maroso FB, Gaio EJ, Rösing CK, Fernandes MI. Correlation between gingival thickness and gingival recession in humans. Acta odontologicalatinoamericana. 2015 Aug;28(2):162-6.
37. Müller HP, Könönen E. Variance components of gingival thickness. J Periodontal Res. 2005 Jun;40(3):239-44.