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# ASSESSMENT OF GINGIVAL BIOTYPE AND PHENOTYPE IN MANDIBULAR CENTRAL INCISOR BEFORE AND AFTER ORTHODONTIC TREATMENT: AN OBSERVATIONAL PROSPECTIVE STUDY

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## ABSTRACT

**Introduction:** The term gingival biotype is used to describe the gingiva's thickness in facio-lingual dimension. Gingival thickness determined by size and shape of root and contour of alveolar bone. Thick gingival biotype is characterized by dense tissue more than 2 mm and thin gingival biotype is translucent less than1.5 mm. It is considered an important factor in periodontal and orthodontic therapy success. During orthodontic tooth movement, if the mandibular teeth are moved in labial direction, it may lead to resorbtion of labial cortical plate and eventually gingival recession.

**Objective:** To assess the gingival biotype and phenotype in mandibular central incisor before and after orthodontics treatment.

**Material and Methods:** This study evaluated gingival thickness on mandibular central incisor on 10 orthodontic patients before and after treatment using two different methods:1) transgingival probing method and 2) visual method.

**Result:** It was observed that no statistically significant difference in the transgingival probing method from the visual method.

**Conclusion:** Gingival phenotype changes before and after orthodontic treatment.

**KEYWORDS:** Biotype, Phenotype, trans gingival probing, visual inspection.

## INTRODUCTION

Gingiva is the part of oral mucosa that covers the alveolar process of the jaws and surrounds the neck of the teeth.[1] Generally, it is thin in the anterior region than the posterior region due to the presence of a thin labial plate depending on the patient's genotype. One can have thin, moderately thick, and thick gingival epithelium.[2]

The term gingival biotype was given by Seibert & Lindhe, who classified the gingiva as either thin scalloped or thick-flat. In 1969, Ochsenbein & Ross stated that there were 2 main types of gingival anatomy-flat and highly scalloped. Later it was reported that flat gingiva was associated with a square tooth form, while scalloped gingiva was associated with a tapered tooth form and the gingival contour was associated with the contour of the underlying alveolar bone.[2]

Generally, facial gingiva is thicker in the maxilla than in the mandible. The normal scalloped gingiva is 4-5 mm coronal to the free gingival margin.[3] Gingival biotype is a term used to define the buccolingual thickness of the gingiva. Gingival thickness is determined by the shape and the size of the dental root, and contour of the alveolar bone. It can be classified into two types: thick and thin. A gingival thickness of $\leq$ 1.5 mm is classified as a thin biotype, while a gingival thickness of > 2 mm is classified as a thick biotype.[3]

The thick gingival tissue is associated with a broad zone of the keratinized tissue and flat gingival contour suggestive of thick bony architecture and also is more resistant to inflammation and trauma. The thin gingival tissue is associated with a thin band of the keratinized tissue, scalloped gingival contour suggestive of thin bony architecture, and is more sensitive to inflammation and trauma. However, Tissue biotype is a critical factor that determines the result of dental treatment.[4]

Various invasive and non-invasive methods were proposed to measure tissue thickness. These include direct measurement, probe transparency method, ultrasonic devices, and cone-beam computed tomography scan. Placing a periodontal probe in the gingival sulcus and observing the transparency is a simple method to determine tissue thickness. Thick

gingival biotypes are usually associated with periodontal health. Thin gingival biotypes are delicate, highly scalloped, and translucent in appearance. Patients with thin scalloped biotypes are considered at risk as they have been associated with a compromised soft tissue response following surgical and or restorative treatment.[5]

However, during orthodontic treatment mandibular teeth when migrate labially lead to continuous thinning of the labial plate which may cause the gingival recession, fenestration, and dehiscence. Patients with such clinical picture can have bleeding after brushing or flossing, exposure of root surface lead to sensitivity, loosening of teeth, bad breath, etc. can manifest as a result of compromised periodontal health. Orthodontic treatment may improve periodontal health by aligning teeth, but it also causes some potential harm to the periodontal tissues by excessive orthodontic force and prolonged treatment time. It has been found that orthodontic treatment may be associated with small amounts of alveolar bone loss, gingival recession, and increased pocket depth.[6]

The association between gingival recession and orthodontic treatment is more prevalent in individuals who have been treated orthodontically in mandibular incisors are more prone to gingival recession than other teeth. Gingival recession can be generalized or localized, affecting one tooth surface or more, and might lead to an esthetic impairment. Several factors were suggested to play a role in the development of gingival recession. The main known etiologic factors, among others, are periodontal diseases, and mechanical trauma.[7]

Periodontal health is a prerequisite prior to starting any orthodontic tooth movement. Several factors were suggested to modulate the incidence of gingival recessions following orthodontic therapy, for example: the total orthodontic tooth movement, the quality of oral hygiene, and the gingival biotype. The evaluation of the gingival biotype is essential, especially prior to orthodontic tooth movement because it defines the soft and hard tissues surrounding teeth. Reduction in gingival thickness is considered a predisposing factor to marginal tissue recession during orthodontic treatment, and proper clinical assessment of gingival biotype will ensure accurate decision-making during planned incisor inclination.

The role of orthodontic tooth movement in the development of gingival recession is still a debatable subject. Even though some found an increase in gingival recession in adolescents and adults, others did not find that gingival recession was induced by orthodontic fixed appliance therapy. However, gingival thickness is considered an important factor in the periodontal and orthodontic treatment success. However, the aim of the study is to evaluate the gingival biotype as well as a phenotype in the mandibular central incisor before and after orthodontic treatment.

## MATERIALS AND METHODS

This is an observational prospective study that has evaluated clinically gingival thickness in 70 people consecutively including orthodontic patients that visited the Department of Orthodontics and Dentofacial Orthopedics. Patients' recruitment started in December 2019. The study protocol was approved by the Institutional Ethics and Research Committee of the Institution. All participants, or their legal guardian, consented written to participate prior to any measurements. All the selected participants underwent oral health examinations.

- **Inclusion criteria**

1) Individuals of age 15 to 25 years will be selected.
2) Individuals presenting mandibular central incisor.
3) Individuals with good periodontal status.

- **Exclusion criteria**

1) Individuals who are already undergoing orthodontic and periodontal surgical treatment.
2) Presence of crown restoration and filling that involves the cervical portion of the mandibular central incisor.
3) Pregnant and lactating female.
4) Individuals with systemic diseases.

A total of 70 individuals with different skeletal and dental malocclusion (deep bite, crossbite, class1, class2, class3 malocclusion, diastema, etc.), periodontally healthy, and individuals with mandibular right central incisor, who are willing to undergo the orthodontic treatment were selected. Measurements were carried out at mandibular right central incisors. If the mandibular right central incisor were absent, then mandibular left central incisor were considered. Oral hygiene examination were carried out by recording Gingival index (Loe and Sillnes 1963), and plaque index (Sillness and Loe 1964), and periodontal examination for the selected index tooth were done by recording clinical attachment level, periodontal pocket and gingival recession. The measurement of gingival thickness on mandibular incisors was carried out by Trans-gingival method (Williams graduated periodontal probe) (Claffey and Shanley 1986) and phenotype by Visual method (colorvue biotype probe) (Giulio Rasperini et al 2015).

For trans-gingival probing, the measurement of the gingival thickness carried out on mandibular central incisor on mid-facial aspect of tooth and 2mm apical to free gingival margin under the topical local anasthetic (10% lidocain) by using williams graduated periodontal probe. The probe will be inserted perpendicular to the tooth until the resistance were felt and distance between the tip of the probe and marking of the probe were measured.

In visual assessment of the gingival phenotype (trans-gingival translucency) assess by color coded probe (COLORVUE BIOTYPE PROBE), this method does not directly measure GT, but classifies gingival phenotype based on the visibility of a periodontal probe with colored tip through the gingiva. Probing was done by inserting the probe 1mm into gingival sulcus. The probe has three different colors (white, green and blue color). if the white tip is visible, the phenotype is classified as thin; if the white tip is not visible, but the green tip is, then the phenotype is classified as medium; if the green tip is not visible, but the blue tip is, then the phenotype is classified as thick; finally if not even the blue tip is visible, then the tissue is classified as very thick.

**THIN PHENOTYPE** **MEDIUM PHENOTYPE** **THICK PHENOTYPE**

**RESULT**

This study included 70 patients 34 males (48.5 %) and 36 females (51.5 %) seeking orthodontic therapy, with a mean age of 20.74 (15-25 years). Gingival thickness was measured in a mandibular central incisor with written informed consent from patients and all clinical parameters were evaluated at baseline and 1 year postoperatively which include a gingival index, plaque index, clinical attachment level, periodontal pocket, and gingival recession. The gingival thickness was measured by using a Trans gingival probing method with Williams graduated periodontal probe and gingival phenotype evaluated by visual method with colorvue biotype probe.

The mean gingival index at baseline was 0.66 mm which increases to 0.84 mm postoperatively. There was found to be a highly statistically significant difference ($p<0.001$) pre to post-intervention (Table 1). The plaque index at baseline, was 0.765 mm which increases to 1.04 mm at postoperatively and a mean difference of 0.28 was obtained (Table2). Mean Clinical attachment loss at baseline was 0.271 and 0.128 mm post orthodontic treatment and the mean difference was 0.142 mm (Table 3). Mean periodontal pocket depth at baseline was 0.0286 and 0.0 post orthodontic treatment. There was found to be no statistically significant difference from baseline to post orthodontic treatment ($p>0.05$) (Table 4). Mean gingival recession at baseline was 0.0286 and 0.2857 post orthodontic treatment with a mean difference was 0.257. There was found to be a statistically significant difference at baseline and post orthodontic treatment ($P< 0.05$) (Table 5). Mean gingival thickness at baseline was 0.942mm and 0.992mm postoperatively. There was found to be no statistically significant difference from baseline to post orthodontic treatment ($p>0.05$) (Table 6). Mean gingival phenotype at baseline was 54.3 % (38) of the patient have shown thin gingival phenotype, 37.1% (26) of the patient have shown medium phenotype and 8.6% (6) of the patient have shown thick gingival phenotype. At post orthodontic treatment 15.7% (11) of the patient have shown thin gingival phenotype, 67.1% (47) of the patient has shown medium phenotype, and 17.1% (12) of the patient have shown thick gingival phenotype. There was found to be a highly statistically significant difference from baseline to post orthodontic treatment ($p<0.05$) (Table 7).

**Table 1: Mean Gingival index score before and after orthodontic treatment in the mandibular central incisor.**

| GI scores | Mean | SD | Mean Difference (SE) |
|---|---|---|---|
| Pre | 0.66 | 0.099 | 0.18 (0.018) |
| Post | 0.84 | 0.116 | |
| | Paired t- test = -10.06, p <0.001** | | |

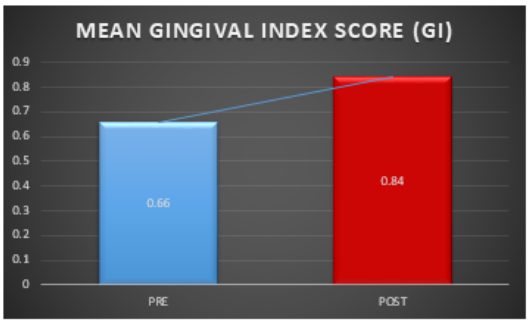



**Table 2: Mean Plaque index score before and after orthodontic treatment in the mandibular central incisor.**

| PI scores | Mean | SD | Mean Difference (SE) |
|---|---|---|---|
| Pre | 0.765 | 0.147 | 0.28 (0.026) |
| Post | 1.04 | 0.165 | |
| | Paired t- test = -10.567, p <0.001** | | |

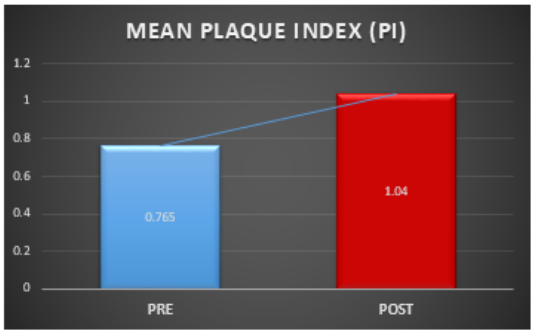



**Table 3: Mean Clinical attachment loss before and after orthodontic treatment in the mandibular central incisor.**

| CAL scores | Mean | SD | Mean Difference ± SE |
|---|---|---|---|
| Pre | 0.128 | 0.75 | 0.162(0.198) |
| Post | 0.471 | 2.35 | |
| | Paired t- test = 0.846, p = 0.399 | | |

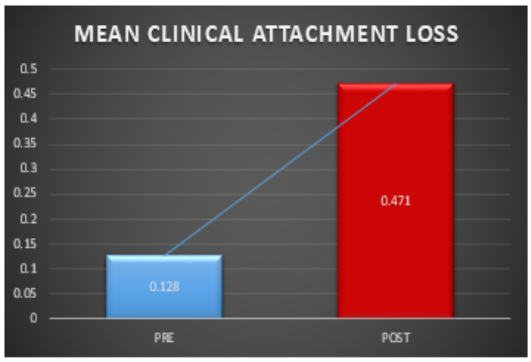



**Table 4: Mean Periodontal Pocket Depth before and after orthodontic treatment in the mandibular central incisor.**

| PPD | Mean | SD | Mean Difference ± SE |
|---|---|---|---|
| Pre | 0.0286 | 0.23 | 0.0286 (0.0285) |
| Post | 0.0 | 0.0 | |
| | Paired 't'- test = 1.00, p = 0.319 | | |

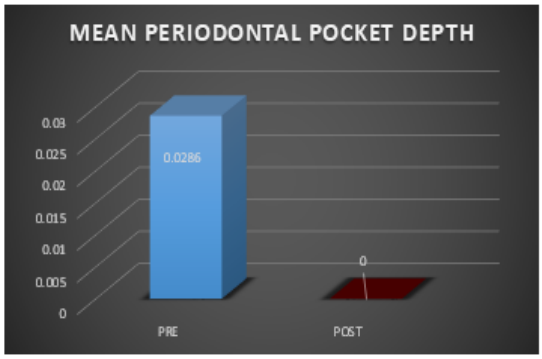


**Table 5: Mean Gingival Recession before and after orthodontic treatment in the mandibular central incisor**

| Gingival Recession | Mean | SD | Mean Difference ± SE |
|---|---|---|---|
| Pre | 0.0286 | 0.239 | 0.257 (0.076) |
| Post | 0.2857 | 0.593 | |
| | Paired 't'- test = -3.364, p = 0.001* | | |

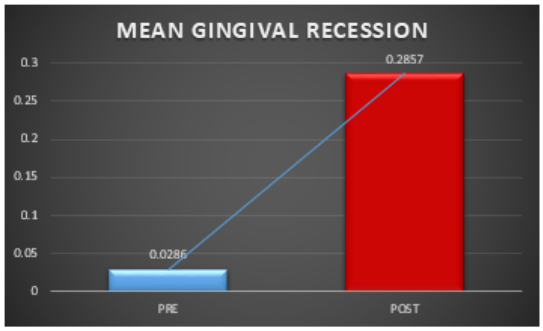



**Table 6: Mean gingival thickness by trans gingival probing before and after orthodontic treatment in the mandibular central incisor.**

| Gingival thickness | Mean | SD | Mean Difference ± SE |
|---|---|---|---|
| Pre | 0.942 | 0.160 | 0.05 (0.02) |
| Post | 0.992 | 0.059 | |
| | Paired 't'- test = -2.446, p =0.016* | | |

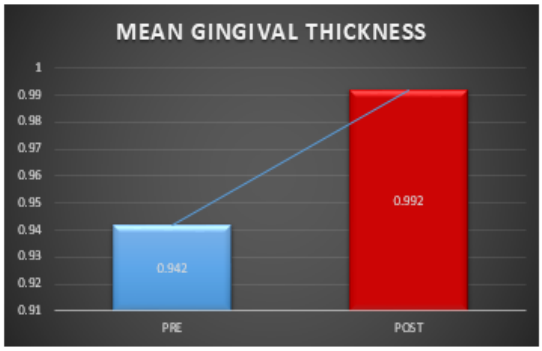
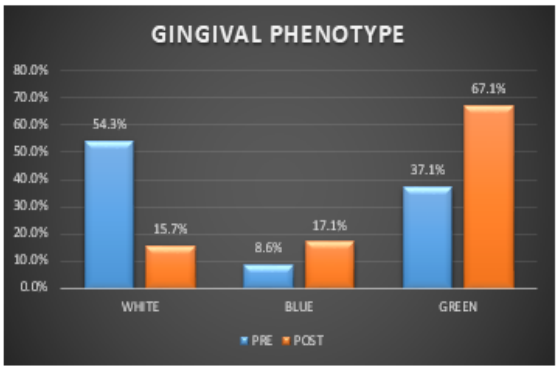



**Table 7: Gingival phenotype before and after orthodontic treatment in the mandibular central incisor.**

| Gingival phenotype | White n (%) (thin phenotype) | Blue n (%) (thick phenotype) | Green n (%) (medium phenotype) |
|---|---|---|---|
| Pre | 38 (54.3 %) | 6 (8.6 %) | 26 (37.1 %) |
| Post | 11 (15.7 %) | 12 (17.1 %) | 47 (67.1%) |
| | Chi square test value = 22.919, p <0.001** | | |




## DISCUSSION

Tissue biotype is one of the critical factors determining dental treatment results. The study suggests that the gingival biotype presents a stronger association with dental treatment. The gingival tissue is a major feature of the periodontium. Importantly, the tissue also covers the underlying bone. Gingival thickness varies from person to person and in different areas of the same mid-buccal cavity. Gingival biotype is also an indication of the underlying bony architecture.[9]

Moreover, different gingival biotypes respond differently to inflammation, trauma, and periodontal treatment. Gingival tissue can be divided into two broad categories: thick or thin gingival biotypes. A thick gingival biotype is most commonly associated with healthy periodontal health whereas, thin gingival tissue, increased susceptibility to inflammation and trauma, and thin underlying bone (Abraham et al., 2014).[3]

Understanding the differences in biotypes aid in the development of periodontal treatment planning to ensure the long-term health of natural teeth, restorations, and prosthetics. Wenström et al. and Yared et al. noted that the gingival biotype and phenotype is more important than other parameters, which should be evaluated during

treatment planning.[10] However, the present study aims to assess gingival biotype and phenotype in the mandibular central incisor before and after orthodontic treatment.

Since, the gingival biotype appears to influence the outcomes of various dental procedures including periodontal, implant, and orthodontic treatment, the precise measurement of gingival thickness is important for treatment planning. Among the others, the inspection method is not an accurate method for determining gingival biotype mostly because it largely relies on clinical experience, and therefore, it is highly subjective. Thus, the assessment of the gingival biotype should incorporate an easy and reproducible method for discriminating a "thin" from "thick" gingiva, although no distinct cut-off values have been yet determined. Claffey and Shanley 1986 reported that if the gingival thickness is less than 1.5 mm then it is considered a thin gingival biotype and if it is more than 2mm then it is a thick biotype while others reported that if the gingival thickness is less than 1mm considered as thin biotype and if it is more than 1 mm then it was considered as thick biotype[11], while in the present study Claffey and Shanley's classification were followed. It has been reported that patients with thick gingiva, in terms of more than 1mm in thickness, are relatively resistant to gingival recession following surgical and/or restorative therapy. On the other hand, patients with a thin-scalloped biotype are considered at risk as they have been associated with a compromised soft tissue response following surgical and/or restorative treatment. These findings point clearly to the need for a thorough identification of these high-risk patients before various interventions involving the gingiva.[9]

One of the objectives of orthodontic treatment is to improve dental health and prolong the life of dentition. Orthodontic treatment contributes to aesthetics, better oral hygiene by correcting the dental irregularities and reducing occlusal trauma. The placement of an orthodontic appliance in the patient's mouth may provoke a local soft tissue response in the gingiva.[12] During the orthodontic treatment different types of skeletal and dental malocclusion (deep bite, crossbite, class1, class2, class3 malocclusion, a diastema, etc.), causes complications such as gingival recession, resorption of alveolar bone, and increased sulcular depth may occur. Mandibular incisors are more prone to gingival recession and alveolar bone resorption because of a thin cortical plate, more chances of plaque accumulation, and a reduced level of attachment. During orthodontic tooth movement, if the mandibular teeth are moved in the labial direction, it may lead to resorption of the labial cortical plate and eventually gingival recession. Fabienne Pernet evaluate the association between the development of labial and lingual recessions and inclination of the lower incisors during orthodontic treatment, and reported that on the buccal side, the lateral incisors have significantly fewer recessions than the central incisor.[13] In the present study also, the gingival recession was reported after orthodontic treatment.

Several invasive and non-invasive methods have been used to measure gingival thickness. Among which 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.[3] In other studies, visual evaluation grossly overestimated participants as having thick gingival biotype and underestimated classification of thin gingiva by approximately 30% when compared by direct assessment with a tension-free caliper (Kan et al., 2010).[14] Their results showed this margin of error was seen in participants that had gingival thickness <0.6 millimeters was classified as thin and thickness of > 1 millimeter was seen as thick. These results are in agreement with several recent studies which found visual assessment as being statistically significantly different from direct measurement (P< .05) (Cuny-Houchmand et al., 2013; Eghbali et al., 2009; Zawawi et al., 2012; Zeers et al., 2014). Thus, this model lacks precision and reliability.[15,16,17,18]

The present study was done by using two different methods, trans-gingival probing by Williams graduated periodontal probe, and visual method was done by colorveu biotype probe. Trans-gingival probing has many favourable features in contrast to the other methods of gingival measurements such as its cost-effectiveness, easy access to any location around all teeth, ease of interpretation, rounded tip to avoid tissue trauma, no exposure to radiation, no need for surgery to establish biotype and minimally invasive procedure.[19]

In trans-gingival probing, which requires anesthetizing the gingiva to follow up with the use of a periodontal probe. The calibrated periodontal probe has markings in 1-millimeter increments. Due to the 1-millimeter increments, studies have found that trans-gingival measurements are overestimated by 0.5-millimeter (Savitha et al., 2005; Bednarz, 2011).[20,21]

Kan et al.[14] compared the reliability of visual assessment, periodontal probing, and transgingival probing techniques to determine the gingival thickness of the maxillary anterior teeth which showed similar and reliable outcomes with periodontal probing and transgingival probing techniques. However, Alkan et al.[9] 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 a gingival thickness of 0.8-1 mm. Wennström[22] and Hirschfeld[23] 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

mandibular anterior tooth with different malocclusion groups.

Gingival thickness is reportedly influenced by the changes in the location of the teeth during the eruption period, and it decreases with increasing age as the connective tissue becomes denser, cell count decreases, the epithelium becomes thinner, and keratinization increases. Ramesh et al. in their study 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.[24] For this reason, the present study group consisted of subjects who had permanent mandibular central incisor erupted for gingival thickness to be less influenced by age-related changes.

There are different opinions on keratinized gingival width that would maintain periodontal health during orthodontic treatment. Lang and Löe[25] reported that keratinized gingival width <2 mm would be insufficient to maintain periodontal health, whereas Coatoam et al. noted that keratinized gingival width <2 mm would be sufficient in the subjects with good oral hygiene. Wennström et al.[22] reported whether attached gingiva is sufficient and cannot be determined by measuring only the width of keratinized gingiva, but that the gingival thickness should be measured as well.

Kaya et al.[26] observed that when the crowding increases in the mandibular anterior jaw, the gingival thickness of the mandibular incisors also increased, whereas the gingival thickness of the canines decreased, however, It was concluded that the mandibular anterior teeth have a thin gingival biotype, and there was no association between Angle classification and mean gingival thickness of the mandibular anterior region. In the present study, it was also observed that gingival thickness was greater in the severe crowding group than in the mild and moderate crowding groups and also found that also found that thin gingival biotype in mandibular central incisor due to presence of thin cortical plate.

Results of the present study showed that there was a significant increase in plaque index and gingival index post orthodontic treatment. The increase of both indices showed that patients could not maintain their oral hygiene due to orthodontic appliances interfering with normal brushing habits. Similar observations were seen by Alice Souza Pintos,[27] assessing the effect of the duration of fixed orthodontic treatment on gingival enlargement (GE) in adolescents and young adults.

Concerning periodontal pocket depths no significant differences were found at baseline and post orthodontic treatment whereas, differences were found in clinical attachment loss and gingival recession before and after orthodontic treatment. Out of 70 patients, 15 patients were developed gingival recession after orthodontic treatment. Raffaele Acunzo[28] in 2015 where they assess the effect of gingival biotype during orthodontic treatment using colorvue biotype probe and measured clinical attachment level, gingival recession, and periodontal pocket depth. Among all these parameters gingival recession and clinical attachment loss were found to be increased after orthodontic treatment but no differences were found in periodontal pocket depth before and after orthodontic treatment. Meret Gebistorf where he investigated the long-term development of gingival recession in orthodontic patients and found that gingival recession increased during orthodontic treatment with further increases during the long-term post-treatment period; 98.9% of the orthodontically treated participants had at least 1 labial/buccal recession, and 85.2% of the patients had at least 1 lingual/palatal recession post-treatment.

According to the Trans gingival probing method no statistically significant differences were found at baseline and after orthodontic therapy. At baseline, the mean value was 0.951, and post orthodontic treatment the mean value was 0.971. Leticia Sala 2018[29] where they assessed the accuracy of two different methods for gingival thickness measurement by using the Trans gingival needle probing (TGNP) and the tension-free caliper (TFC) method, and concluded that the Trans gingival probing method constitutes an accurate method when measuring gingival thickness at different levels. A similar study was done by D Kloukos in 2018 where determine the accuracy, precision, and repeatability of four different methods for assessing gingival thickness on both central mandibular incisors with 1) trans gingival probing with a standard periodontal probe, 2) trans gingival probing with a stainless-steel acupuncture needle, 3) ultrasound and 4) a color-coded periodontal probe and reported that trans gingival probing with the periodontal probe is an accurate method while assessing gingival thickness.[30] However, it has been reported that the Trans gingival probing method is a standard method for assessing gingival thickness.

According to the gingival transparency method or visual method at baseline 54.3 % of the patients showed thin phenotype, 37.1 % of the patient showed medium phenotype and 8.6 % of patients showed thick phenotype. However, according to statistical analysis, most patients have shown at baseline thin phenotype and very few patients have shown the thick phenotype. In post orthodontic treatment, 15.7 % of patients showed thin phenotype, 67.1% showed medium phenotype, and 17.1 % showed thick phenotype. Statistical analysis showed a majority of the patient had a medium phenotype during orthodontic treatment. The phenotype was changed from baseline to postoperatively due to the presence of orthodontic appliances patient was unable to maintain their oral hygiene and they continuously irritate the gingiva and the gingiva was become inflamed because of increased epithelization, keratinization, and

vascularity, hence, the phenotype changed from thin to medium postoperatively. A similar study was done by Guilio Rasperini where they assess the effect of gingival biotype during orthodontic treatment using colorvue biotype probe and highly statistically significant differences found before and after orthodontic treatment.[28]

## LIMITATION

First, the study had a small sample size. Larger sample size would give rise to greater validity to the results, and secondly, the measurements were rounded up due to the 1-millimeters markings of the Williams graduated periodontal probe. Thus, the precision of measurement is of concern. Thirdly, angulation is subjective and thus, measurements may not be precise. Fourthly, the potential of volumetric changes post administration of local anesthetic was not accounted for thus measurements may have been inaccurate.

## CONCLUSION

Within the limitation of study, it was concluded that Gingival phenotype has changed after orthodontic treatment but no significant difference found in gingival biotype before and after orthodontic treatment. It was also concluded that visual method is an accurate method means to measure the gingival phenotype than the Trans gingival probing method. Due to the limitations of the study, the results were not statistically significant with respect to the Trans gingival probing method, but the data suggests that the periodontal probe can be used to produce accurate measurements of gingival thickness.

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