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Gingival biotypes and orthodontic treatment

A Project Submitted to

The College of Dentistry, University of Baghdad, Department of Orthodontics in Partial Fulfillment for the Bachelor of Dental Surgery

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Certification of the supervisor

I certify that this project entitled **"Gingival biotypes and orthodontic treatment"** was prepared by **Zainab Firas Fadhel** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

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Dedication

In God we put our trust, as he and only he can surround us with all these blessings. We shall always be as grateful and thankful as he created and made us as a part of this universe and its experience to live throughout this journey with all its emotions rather sadness or happiness.

We dedicate this research to all our professors at Baghdad University College of Dentistry in recognition of their great efforts Furthermore, we dedicate it to our parents and all our family members and my unique husband who helped us throughout this journey and made us who we are today. Last but not least, we dedicate all our friends who stood beside us, supported us and were as the guiding stars throughout this journey.

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Introduction

Nowadays there is a remarkable increase in people's awareness regarding the importance and impact of healthy teeth, gum and beautiful smile. The smile is vital for various aspects of life such as social acceptance and self-confidence **(Van der Geld *et al*., 2007 and Del Monte *et al*., 2017)**. Frequent exposure to patterns advertised as a measure of beauty in social networks has increased the demand for a smile makeover procedure **(Wooi, 2021 and Dorfman, 2006)**. It is very important that when planning treatment for esthetics cases, smile design cannot be isolated from a comprehensive approach to patient care. Achieving a successful, healthy and functional result requires an understanding of the interrelationship among all the supporting oral structures, including the muscles, bones, joints, gingival tissues and occlusion **(Dawson, 1983)**. There are two types of smile, a white smile that includes the teeth, and a pink smile that includes the gums. The gingival perspective depends on gingival complex, tooth morphology, contact points, hard and soft tissue considerations, and periodontal biotype **(Ahmad, 2005).**

The term periodontal biotype introduced by **Seibert and Lindhe,** they have categorized the gingiva into thick-flat and thin scalloped biotypes (**Seibert and Lindhe, 1989**). It is crucial to maintain periodontal health in patients undergoing orthodontic treatment. Biotype is a critical factor to be considered in this regard. Pretreatment assessment of the biotype prior to orthodontic tooth movement is important step because it defines the soft and hard tissues surrounding teeth especially thin biotype can lead to gingival recession and exposure of root s during and after orthodontic treatment **(Slutzkey and Levin 2008)**

Aims of the study

Our primary aim is to explore the relationship between the gingival biotype and orthodontic treatment. Give an overview about gingival biotype is another objective of this study.

Chapter 1 Review of literature

1.1 Periodontium

The periodontium is the specialized tissues that both surround and support the teeth, maintaining them in the maxillary and mandibular bones. The word comes from the Greek term peri, meaning "around" and odont, meaning "tooth". It means that which is "around the tooth". Periodontics is the dental specialty that relates specifically to the care and maintenance of these tissues. It provides the support necessary to maintain teeth in function. It consists of four components, Gingiva, Periodontal ligament (PDL), Cementum and Alveolar bone proper **(Kumar, 2011)**. Each of these components is distinct in location, architecture, and biochemical properties, which adapt during the life of the structure **(Newman et al., 2012).**

1.2 Periodontal biotype

Periodontal biotype is one of the most important parameters that determine the course and prognosis of periodontal diseases. Gingival thickness, keratinized tissue, and bone morphology are the main characteristics of the periodontal biotype **(Grudyanov, 2009)**.

The term periodontal biotype introduced by **Seibert and Lindhe in 1989,** they have categorized the gingiva into thick-flat and thin scalloped biotypes. Thick gingival biotypes usually consist of broad zone of keratinized tissue with flat gingival contour which indicates thick underlying bony architecture and is more resilient to any inflammation or trauma. On the other side, thin gingival biotype is related with a thin band of the keratinized tissue and scalloped gingival contour which suggest thin bony architecture and is more sensitive to any inflammation or trauma. The biotype depends on many factors, including age, sex, genetic factors, as well as the shape, position, and size of the teeth **(Zawawi *et al*., 2013)**.

The gingival biotype was described differently by different researcher, **in 1969, Ochsenbein & Ross**, indicated that there were two main types of gingival anatomy categorized into flat and highly scalloped. While **in 1986, Claffey and Shanley** defined the thin tissue biotype as a gingival thickness of <1.5mm, and the thick tissue biotype was referred to as having a tissue thickness of 2mm. **Becker *et al*., *1997*,** proposed three different periodontal biotypes which are flat, scalloped and pronounced scalloped gingiva, measuring from the height of the bone interproximally to the height at the direct mid facial, their findings are as follows: (Flat= 2.1 mm,Scalloped= 2.8mm, Pronounced Scalloped= 4.1mm) **(Becker et al., 1997)**.

1.2.2 Anatomical characteristics of the gingiva biotype

The gingival thickness, gingival width and alveolar bone morphology, determine the behavior of periodontium when submitted to physical, chemical, or bacterial insult or during therapeutic procedures, periodontal surgeries, implant and orthodontic treatment. A direct correlation exists between gingival biotype and susceptibility to gingival recession following surgical and restorative procedures. Specifically, it was pointed out, how thick and thin gingival biotypes respond differently to inflammation, restorative trauma and parafunctional habits **(Fu JH *et al*., 2010)**.

Gingival biotype refers to four features of the soft tissues and teeth these are **(Sammut, 2013)**: -

- The gingival width (keratinized tissue width): Which refers to the width of the keratinized tissue when measured from the gingival margin to the muco-gingival junction.
- Gingival thickness (thick or thin): The thickness of the tissue in a bucco-palatal dimension. If you insert a probe into the mid-buccal sulcus of the maxillary central incisor and you can see it through the tissue then it is thin by this definition. If you can't see it, it is thick.
- Papilla height: The part of the gum that fits in between teeth.
- Crown width/height ratio: Long, slender teeth tend to be associated with contact points distant from the alveolar crest and long papillae that fill the embrasures.

1.2.2 Thickness of gingival biotype

The gingival thickness affects the treatment outcome possibly because of the difference in the amount of blood supply to the underlying bone and susceptibility to resorption. Gingival thickness can affect the results of restorative therapy and root coverage procedures. It is necessary to determine the gingival biotype before initiating treatment **(Kao and Pasquinelil, 2002).** The gingival biotype is classified as thin or thick.

Thin biotype

Thin gingival tissue tends to be delicate and almost translucent in appearance, the tissue appears friable with a minimal zone of attached Gingiva. Which escalates the risk of recession following orthodontic treatment, crown preparation and periodontal or implant surgery. Spatial care must be taken when planning treatment for case with a thin biotype **(Nagaraj *et al*., 2010)** (Figure1).

FIGURE 1 THIN GINGIVAL BIOTYPE (ROSA VALLETTA ET AL., 2019).

Thick gingival biotypes

The tissue here is dense and fibrotic with a large zone of attached gingiva. making it resistant to surgical procedures with a tendency for pocket formation. The thick gingiva usually comes with low or high gingival scalloping. A gingival thickness greater than 2mm can be categorized as the thick biotype **(De Rouck et al., 2009).**

Thick gingival biotype characterized by relatively flat soft tissue and bony architecture, dense fibrotic soft tissue, relatively large amount of attached gingiva, thick underlying osseous form, relatively resistant to acute trauma, reacts to disease with pocket formation and infra-bony defect formation **(Goldstein et al., 1997, Richard *et al* 2008) (**Figure2).

FIGURE 2 THICK GINGIVAL BIOTYPE (FISCHER ET AI., 2018).

1.3.2 Tissue biotype response to treatment

Tissue biotype response to periodontal treatment

Tissue biotype is a significant factor that influences the esthetic treatment outcomes. In root coverage procedures, a thicker flap was associated with a more predictable prognosis. An initial gingival thickness was found to be the most significant factor that influences the prognosis of a complete root coverage procedure **(Baldi *et al*., 1999)**. A flap thickness of 0.8–1.2mm was associated with a more predictable prognosis **(Hwang and Wang, 2006)**.

Tissue biotype response to surgical treatment

The two tissue biotypes respond differently to inflammation, trauma and surgical treatment. Thick bony plates associated with thick biotypes and thin bony plates with thin biotypes respond differently to extraction. There is minimal ridge atrophy after extraction in thick biotypes. However, the trauma induced by extraction, is likely to result in fracture of the labial plate and traumatic ridge resorption in the apical and lingual direction in thin biotypes **(Kao and Pasquinelil, 2002)**.

As osseous and gingival tissues are different for thick and thin tissue biotypes, these distinctions would significantly influence implant site preparation and treatment planning. The stability of osseous crest and soft tissue is directly proportional to the thickness of bone and gingival tissues **(Tarnow *et al*., 1992)**. Ridge preservation should be considered in thin biotype and thick biotype cases where excessive trauma or a previous history of endodontic surgery or fistula tracts may have compromised the alveolar plate. In a thick biotype environment, an immediate placement of an implant can be considered with predictable results. An immediate implant placement can help to preserve the osseous structures. To achieve the best esthetic outcome, along with immediate implant placement, simultaneous soft and hard tissue augmentation should be carried out **(Sammartino *et al*., 2007)**. Construction of an esthetically pleasing restoration involves not only harmonizing the size, shape, position and color of each prosthetic tooth with the adjacent teeth but also establishing perimplant soft tissue compatibility with the surrounding gingiva and mucosa **(Denissen et al., 1993)**.

Tissue biotype response to orthodontic treatment

Understanding Periodontal biotype is also of importance in orthodontic treatment. Alteration of mucogingival dimensions may occur during orthodontic treatment. **Wennstrom *et al***. found no relationship between the initial width of the keratinized gingiva and the tendency for the development of gingival recession during orthodontic tooth movements in monkeys. Instead, it is the buccolingual thickness that determines gingival recession and attachment loss at sites with gingivitis during orthodontic treatment. In cases with thin gingiva caused by the prominent position of the teeth, there is no need for pre orthodontic gingival augmentation procedures. The recession and bone dehiscence will decrease when the tooth is moved in a more proper position within the alveolar bone **(Wennstrom *et al*., 1987)**. However, it has been demonstrated that the gingival tissue with a little horizontal diameter in the presence of a dental plaque is more susceptible to apical migration of connective tissue attachment with marginal gingiva especially near teeth under the influence of orthodontic force **(Wennstrom, 1987)**.

1.3 Methods to determine gingival thickness

Many methods were proposed to measure gingival thickness. The gingival thickness can be assessed by:

1.3.2 Direct methods

Probe transparency method

Periodontal probe inserted in the sulcus to evaluate gingival tissue thickness. It is the simplest way to determine gingival biotype; with a thin biotype, the tip of the probe is visible through the gingiva while in thick biotype is not. May require administration of local anesthesia **(De Rouck *et al*., 2009)**.

Trans gingival probing (TGP)

The gingival thickness was assessed by using a UNC-15 probe or probe with the rubber stopper, gingival thickness was assessed at the measurement points (at midpoint of the labial attached gingiva and at the base of distal interdental papilla) after injection anesthesia **(Savitha and Vandana, 2005, Issrani *et al*.,2013)** (Figure3).

FIGURE 3 TRANS GINGIVAL PROBING (HIROJ BAGDE, 2013).

Kolte *et al*. in 2014 estimate gingival thickness using trans gingival probing method using an endodontic spreader fitted with a rubber stopper. After anesthetizing the facial gingiva, gingival thickness was assessed mid-buccally halfway between the mucogingival junction and the free gingival groove in the attached gingiva, using an endodontic spreader fitted with a rubber stopper inserted perpendicularly into the gingival surface at the marked location. The stopper remained at the gingival surface while the spreader proceeded through the soft tissue until bone or cementum was hit, then removed and the distance between the rubber stopper and the tip of the spreader was measured on the ruler. Measurements were not rounded off to the nearest millimeter. The thickness of the gingiva was recorded only on the mid-facial aspect, as there could be existing variations in respect of mid-facial and interdental recordings, because the alveolar bone contours are different in these areas, which might influence the soft tissue (Figure4).

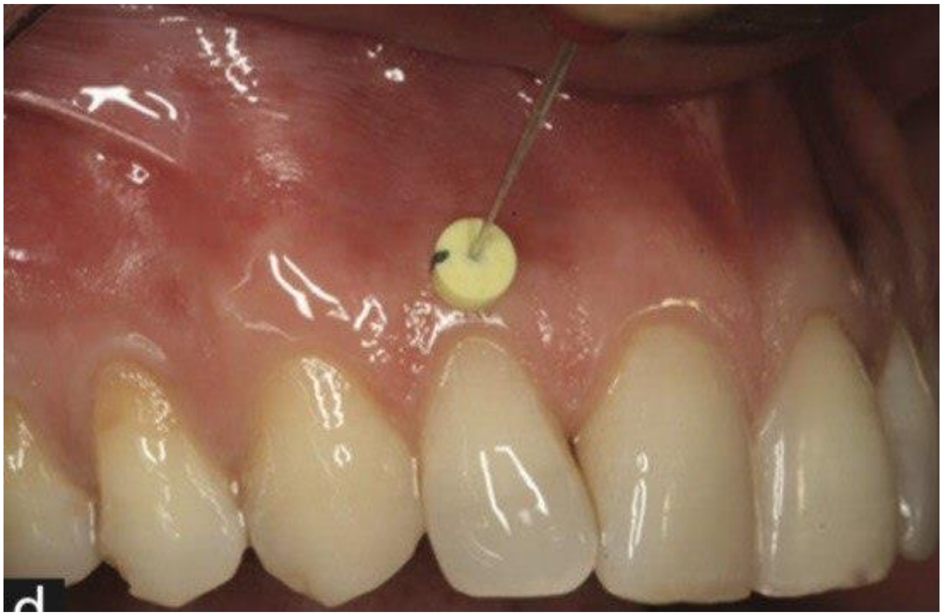

FIGURE (4) TRANS GINGIVAL PROPPING METHOD USING AN ENDODONTIC SPREADER FITTED WITH A RUBBER STOPPER (KOLTE *ET AL*., 2014).

1.4.2 Indirect methods

Ultrasonic devices

The use of ultrasonic devices to determine gingival thickness is a non-invasive method.

Kydd *et al* in 1971 reported that ultrasonic devices appear to be the least invasive method and offer excellent validity and reliability. However, such devices are no longer available commercially; in addition, they make it difficult to both determine the correct position for accurate measurement and successfully reproduce measurements **(Kan et al., 2011)**. Ultrasound machine consist of ultrasound scan including a digital display, scan display, a transducer probe, built in printer and footswitch.

In a study conducted by **Savitha *et al* in 2005**, using (A-scan) probe with the frequency of 10 MHz., the intra oral transducer probe was adapted to the gingival surface coinciding with the bleeding points that created in trans-gingival probing.

The ultrasonic measurement that done using (A–scan) makes use of pulse echo principle. The mechanism of action of ultrasound based on the transit time for the pulse (ultrasound wave) travel to the bone (hard tissue) and echoed back creates spikes on the monitor immediately. Utilizing the print out of this graph and with the help of the optical projector, the thickness of gingiva was determined (Figure 5).

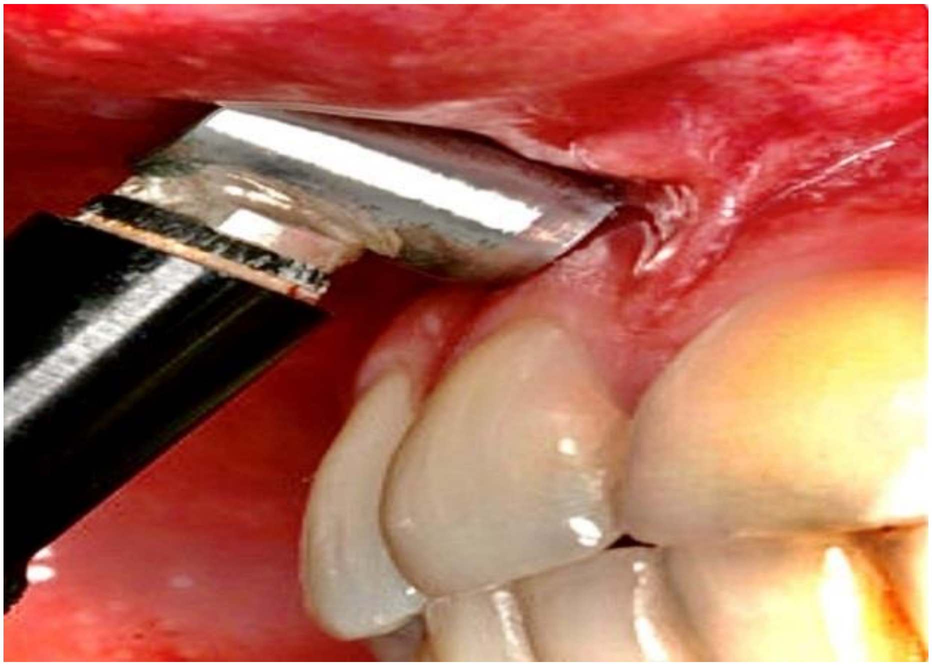

FIGURE (5) ULTRASONIC METHOD (FIRAS YOUNES, 2015).

Issrani *et al* in 2013 used ultrasound (B-scan), the region of interest was scanned by an extra-oral probe and the frequency of B-scan was 10MHz. In the oral cavity, water was used as sound coupling medium between the probe and selected area for examination. The extra oral transducer probe adapted to the gingival surface coinciding with the bleeding points that created during trans-gingival probing method, the probe delivers ultrasonic waves at right angle to the tissues to be measured in the facial gingiva of anterior teeth. Extra-oral ultrasonic transducer probe was used for the first time for the assessment of gingival thickness and measurements were made directly on the screen at the time of scanning **(Issrani *et al*., 2013)**.

ST- CBCT (soft tissue –cone beam computed tomography)

Cone beam computed tomography is used to visualize and measure thickness of both hard and soft tissues.

In 2008, Januário *et al*., developed soft tissue cone-beam computed tomography (ST-CBCT), to improve soft tissue image quality and allow the determination of the dimensions and relationships of the structures of the dento-gingival unit.

With these procedures, the patients were asked to wear a plastic lip retractor and to retract their tongues toward the floor of their mouths. This approach was called ST-CBCT, the soft tissues of the lips and cheeks were positioned away from the gingival tissue and so as the tongue (Figure 6).

Many studies conducted using the ST-CBCT concluded that the soft tissue cone-beam computed tomography has great value on the evaluation of the dimensions and relations between the several periodontal structures and the complex of dento-gingival insertion **(Barriviera, 2009, Januário *et al*., 2008)** (Figure7).

FIGURE (6) A - PATIENT POSITIONED FOR REGULAR (CBCT) B-THE SAME PATIENT POSITIONED FOR THE SECOND CBCT SCAN WEARING THE PLASTIC LIP RETRACTOR (JANUÁRIO *ET AL*., 2008).

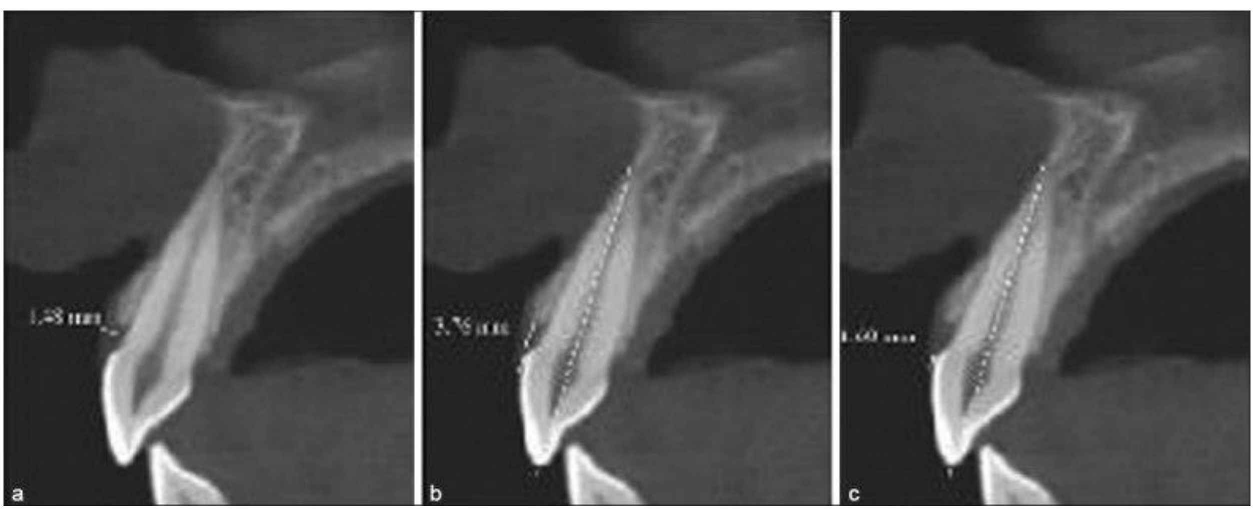

FIGURE (7) SOFT TISSUE CONE-BEAM COMPUTED TOMOGRAPHY MEASUREMENTS (ST-CBCT) (JANUÁRIO *ET AL*., 2008).

Parallel profile radiography (PPRx)

Parallel profile radiography used to analyze the dimensions of the soft and hard tissue structures in the coronal aspect of the periodontium around the index tooth, parallel profile radiographs were obtained from a lateral position with the use of lead plate **(Alpiste-Illueca, 2004)**.

All clinical oral examinations have been performed on the left central incisor (index tooth) both with direct measurements and analyses of a clinical photograph taken from the region of the index tooth. Prior to the photograph, a lead plate was used as reference for all measurements on the photograph and the radiograph **(Stein et al., 2013)** (Figure 8, 9).

FIGURE (8) BITE BLOCK FIXED WITH THE ANTERIOR TEETH (GALGALI AND GONTIYA, 2011).

FIGURE (9) FIXED TRANSFER LEAD PLATE (GALGALI AND GONTIYA, 2011).

Four measurements were taken on each radiograph **(Stein et al., 2013)**:

1 Gingival thickness on the upper incisor.

2 Bone thickness on the upper incisor.

3 Gingival thickness on the lower incisor.

4 Bone thickness on the lower incisor.

1.4 Gingiva recessions

Gingival recessions defined as the displacement of the marginal tissue apical to the cemento-enamel junction. The resulting root exposure is not esthetically pleasing and may lead to sensitivity and root caries **(joss-vassalli *et al*., 2011).**

Dorfman in 1978 suggested that mandibular incisors may be more prone to recession than any other teeth. He attributed this recession to a thin or nonexistent labial plate of bone, inadequate or absent keratinized gingiva, and labial prominence of teeth. With increasing age, they are more frequent at facial than on lingual surfaces. The main causes for the occurrence of gingival recessions are related to mechanical factors or periodontal factors or to inflammatory periodontal disease. Calculus association between gingival recession with supragingival and subgingival calculus can be cause gingival recession because of inadequate access to prophylactic dental care **(Van Palenstein Helderman *et al*., 1998)**. Traumatic tooth brushing is one of the most often factor associated with gingival recessions. An aggressive cleaning technique may lead to mechanical destruction, which is influenced by horizontal scrubbing with excessive force and the use of hard tooth brushes **(Khocht *et al*., 1993**). Tooth movement by orthodontic forces such as excessive proclination of incisors and expansion of the arch are associated with greater risk of gingival recession **(Årtun and Krogstad, 1987)**. Subgingival restoration margins increase the plaque accumulation, gingival inflammation, and alveolar bone loss **(Parma-Benfenati *et al*., 1985)**. Gingival recession has also been related to microbial induced inflammation in periodontal connective tissue, Inflammation of the periodontium results in increased pocket formation in thick biotype and gingival recession in thin tissues. **(Quart *et al*., 1991)** (Figure10).

FIGURE (10) GINGIVAL RECESSIONS (GEORGE GHIDRAI, 2023).

1.5 Periodontal pocket

The periodontal pocket is defined as a pathologically deepened gingival sulcus. It is the primary and definitive sign of all forms of periodontitis except necrotizing ulcerative periodontitis **(Carranza et al., 2006)**. There are two types of pockets: -

1-Gingival pocket (pseudo pocket or false pocket): This type of pocket is formed by gingival enlargement without destruction of the underlying periodontal tissues. The sulcus is deepened because of the increased bulk of gingiva especially of the marginal gingiva **(Glossary of Periodontal Terms, 2001)**.

2-PeriodontalPocket (True pocket or Absolute pocket): This is the type of pocket that occurs with the destruction of the supporting periodontal tissue. Loss of attachment can be measured. The pathological changes have reached beyond the confines of the gingival compartment **(Glossary of Periodontal Terms, 2001)**.

Pocket formation provoked by micro-bacterial plaque, seemed to be initiated by the gingivitis, gingivitis can progress to a more serious stage of gum disease called periodontitis. Periodontitis causes damage to the tissues surrounding the teeth, including bone, periodontal ligaments and the gum tissues (**Patricia, 2010**).

In a case of periodontitis, pockets allow infection to spread, resulting in bone loss underneath the gums. These are the kind of "deep pockets" that no one wants, so it's important to diagnose and treat them before orthodontic treatment, if left untreated, the orthodontic treatment increases bone loss resulting in tooth loss (**Preoteasa *et al*, 2012 and Talic, 2011)**.

1.6 Relationship between gingival biotype and orthodontic treatment

The human periodontium is comprised specialized hard and soft tissues such as the periodontal ligament, cementum, gingiva, and alveolar bone surrounding the tooth socket. Fixed appliance orthodontic therapy has been shown to produce deleterious effects on the periodontium, ranging from gingivitis to bone loss **(Trentini *et al*., 1995)**. Many of these sequelae can be attributed to plaque accumulation due to the difficulty of maintaining adequate oral hygiene in the presence of bands and brackets. One long‐term complication of orthodontic treatment, however, is gingival recession. Numerous studies have shown that irreversible recession can be caused by fixed appliance therapy in 1.3%–10% of treated cases **(Alstad and Zachrisson, 1979, Dorfman 1978)**. Gingival recession can be generalized or localized, affecting one tooth surface or more, and might lead to an esthetic impairment **(Al‐Zahrani and Bissada, 2005, Zawawi *et al*., 2013)**.

Orthodontic treatment generally leads to an improved periodontal status. It seems reasonable that straighter teeth are easier to clean, and perhaps having all teeth centered in the alveolar bone and occluding correctly may promote a healthier periodontium **(Bollen *et al*., 2008)**. Although, orthodontic treatment improves dental and skeletal problems, placement of an orthodontic appliance in a patient's mouth is often associated with alterations in the oral hygiene habits and periodontal health. Orthodontic appliances, as well as mechanical procedures, are prone to evoke local soft tissue responses in the gingiva. The proximity of orthodontic appliances to the gingival sulcus, plaque accumulation, and the impediments they pose to oral hygiene habits further complicate the process of efficient salutary orthodontic care **(Zachrisson and Zachrisson, 1972, Willmot, 2008).**

Gingival biotype varies with tooth position in the arch and with the position of the teeth during the eruption period. With the increasing age, these changes will reduce because the connective tissue becomes denser, the epithelium becomes thinner, the cell count decreases, and keratinization increases **(Wennström, 1990, Rasperini *et al*., 2015)**.

Malocclusion is the third most prevalent oral health problem worldwide **(Gusmão *et al*., 2011, Staufer and Landmesser, 2004).** Orthodontic treatments facilitate oral hygiene measures and establish occlusal stability and lip competency by eliminating traumatic occlusion and crowding. Thus, some investigators have considered these interventions as potential means to improve periodontal health **(Sharma *et al*., 2017, Bock *et al*., 2018)**.

Orthodontic appliances might damage periodontal tissues by creating retentive areas for dental plaque even with excellent oral hygiene, the appliances cause a change in the intraoral microflora, leading to bacteria similar to that present in sites affected by periodontal disease **(Reichert *et al*., 2011)** (Figure11).

FIGURE (11) GINGIVAL RECESSION DURING ORTTHODONTIC TREATMENT (MARCELO *ET AL*., 2020).

1.7 Relationship between gingival biotype and incisors' inclination

In recent years, there have been several investigations regarding the limits of the degree of incisors' proclination in the dental arch **(Allais and Melsen, 2003, Renkema *et al*., 2013)**. There was decrease in the width of keratinized gingiva with either minimal movement or some labial movement of the mandibular incisors, whereas some cases had an increase in keratinized gingiva associated with significant lingual positioning of the lower incisors **(Dorfman, 1978)**. It is widely accepted that 2mm of keratinized gingiva is enough to withstand orthodontic forces and prevent recession, but preexisting mucogingival defects can be exacerbated during tooth movement. Therefore, it is important to recognize and correct areas of actual or potential stress before orthodontic therapy **(Coatoam *et al*., 1981).** It should be noted that the recession (<2mm) reported in some studies is usually not progressive and might be related to the heterogeneity of tissue quality. If gingival recession is observed after the orthodontic therapy, the treatment alternatives depend on its severity and the probability of elimination by orthodontic intervention.

Chapter 2: Discussion

For successful orthodontic treatment, periodontal status needs to be examined. It is important for the orthodontist to be able to accurately diagnose presence of a periodontal problem at initial stages, thus preventing evolution to other phases with irreversible effects **(Sada-Garralda and Caffesse, 2003)**.

In literature we found that there are different dental therapeutic procedures can compromise periodontal condition, gingival recession has been the main periodontal adverse outcome evaluated. Although this problem is not often attributable to the type of orthodontic appliance **(Aziz and Flores-Mir, 2011, Ruf et al., 1998)**. Some investigations have indicated that fixed appliances are associated with inflammation and even gingival recession **(Rody et al., 2016, Pandis et al., 2007)**, while some others have demonstrated no detrimental effects induced by the long-term presence of these appliances **(Juloski et al., 2017, Renkema et al., 2013)**. However, it should be noted that these controversies might be due to the complex etiology of gingival recession, in which orthodontic appliances and fixed retainers are only two contributing factors **(Ciok et al., 2015, Allais and Melsen, 2003)**. For example, thin soft tissues are more prone to the detrimental effects of environmental factors, such as plaque, calculus and gingivitis. Tooth position and alveolar bone anatomy might also play a role **(Bollen et al., 2008)**. In addition, there is insufficient evidence on some orthodontic parameters, such as force magnitude, location, and type of movement, which might result in dehiscence and gingival recession **(Choi and Chung, 2015)**.

Although some studies have demonstrated no significant association between malocclusion and gingival biotype **(Staufer and Landmesser, 2004, Zawawi et al., 2013)**, some authors have reported minimal gingival thickness in mandibular central and lateral incisors in class III patients. The periodontal tissue response has frequently been evaluated in class II patients, while it might be different in individuals with class III malocclusion **(Kaya et al., 2017, Szarmach et al., 2006)**.

Chapter 3 Conclusions

- Periodontium status for individual tooth and gingival biotypes are crucial for orthodontic treatment plan.
- Cases with thin gingival biotype need to be treated with precautions as it may go into gingival recession
- Sometimes gingival biotype got improved when the malposed teeth sit in proper position after orthodontic treatment.
- Failure to maintain good oral hygiene during treatment with orthodontic fixed appliance can worsen the condition of periodontium.
- Periodontal therapies may be required before orthodontic treatment to maintain periodontal health.

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