

## Clinical importance of gingival biotype (Review of literature)

Hiba M. Jameel, B.D.S. <sup>(1)</sup>

Maha Sh. Mahmood, B.D.S., M.Sc. <sup>(2)</sup>

### ABSTRACT

This review discusses the gingival biotypes, their characteristics, analysis based on the measurement of the dentopapillary complex. Also discuss their response to inflammation, surgery, and ridge healing after tooth extraction, their influence in the behavior of the peri-implant tissue. (J Bagh Coll Dentistry 2015; 27(3):93-101).

### INTRODUCTION

The gingival perspective depends on gingival complex, tooth morphology, contact points, hard and soft tissue considerations, and periodontal biotype <sup>(1)</sup>. In 1969, Ochsenbein & Ross, indicated that there were 2 main types of gingival anatomy categorized into flat and highly scalloped <sup>(2)</sup>. While Claffey and Shanley defined the thin tissue biotype as a gingival thickness of <1.5 mm, and the thick tissue biotype was referred to as having a tissue thickness 2 mm (measurements of 1.6 to 1.9 mm were not accounted) <sup>(3)</sup>. The term "gingival biotype" was introduced by Seibert and Lindhe to categorize the gingiva into "thick-flat" and "thin-scalloped" biotypes as shown in figure (1) <sup>(4)</sup>. But Becker *et al.* 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 midfacial, their findings are as follows: (Flat= 2.1 mm, Scalloped= 2.8mm, Pronounced Scalloped= 4.1 mm) <sup>(5)</sup>.

The morphologic characteristics of the gingiva depends on several factors like the dimension of the alveolar process, the form of the teeth, events that occur during tooth eruption, the eventual inclination and position of the fully erupted teeth <sup>(6,7)</sup>.

The gingival biotypes respond differently to inflammation, restorative, trauma and parafunctional habits <sup>(8)</sup>. These traumatic events result in various types of periodontal defects which respond to different treatments. So it is believed that tissue biotype is a critical factor that determines the result of dental treatment <sup>(9,10)</sup>.



Figure 1: Gingival biotypes.

### Gingival biotypes and their characteristics:

It has been suggested in 1991 that the thick periodontal biotype was more prevalent (85%) than the thin scalloped form (15%) <sup>(11)</sup>. Studies showed that patients with thick-flat biotypes demonstrate short papillae whereas thin-scalloped biotypes show long papillae. This morphometric disparity could result in a more papilla loss in the latter. The other distinctive features of a tissue with thick biotypes include flat soft tissue and bony architecture, denser and more fibrotic soft tissue curtain, large amount of attached masticatory mucosa, resistance to acute trauma and respond to disease with pocket formation and infra bony defect. Moreover, the teeth with thick gingival biotype are more square in shape and shows flatter posterior cusps. The contact areas of adjacent teeth are larger facio-lingually and inciso-gingivally <sup>(12)</sup>.

While thin gingival biotypes are delicate, highly scalloped and translucent in appearance. The soft tissue appears delicate and friable with a minimal amount of the attached gingiva. The underlying bone is thin or minimal bone over the labial roots with possible presence of fenestrations and dehiscence. Thin scalloped biotypes are considered at risk as they have been associated with a compromised soft tissue response following surgical and or restorative treatment. Unlike in thick biotypes, the teeth are more triangular with steeper posterior cusps. The contact areas of adjacent teeth are small facio-lingually and inciso-gingivally and are located

(1) High diploma Student, Department of Periodontics, College of Dentistry, University of Baghdad.

(2) Professor, Department of Periodontics, College of Dentistry, University of Baghdad.

towards incisal or occlusal third <sup>(12)</sup> Figure 2 (a & b)



a) Thick biotype (clinical picture)



b) Thin biotype.

**Methods to determine gingival thickness:**

The gingival thickness can be assessed by:

**A. Direct methods include:**

**1. Probe transparency (TRAN) 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. This method is minimally invasive& it was found to be highly reproducible with 85% intra examiner repeatability<sup>(13)</sup>(Figure 3) .



**Figure 3: Probe transparency (TRAN) method. a) Probe visible through the sulcus (thin biotype). b) Probe not visible (thick biotype).**

**2. 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) 5 -20 minutes after injection .The measurements were then rounded up to the nearest millimeter, and carried out by a single periodontist <sup>(14,15)</sup> (Figure 4).



**Figure 4: Trans gingival probing method (TGP) . a)The UNC 15( University of North Carolina Screening Probe) has millimeter markings at 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,13, 14, and 15 millimeters and color coding at 5 th ,10th ,and 15 th mm. b).Intra oral photograph showing trans gingival probing method using a UNC-15 probe at central incisor, lateral incisor and canine. The measurement points on the buccal gingiva were marked with a water-resistant marking pencil.**

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 midbuccally 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 e 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 <sup>(16)</sup> (Figure 5).



**Figure 5: Measurement of thickness of gingiva using an endodontic spreader**

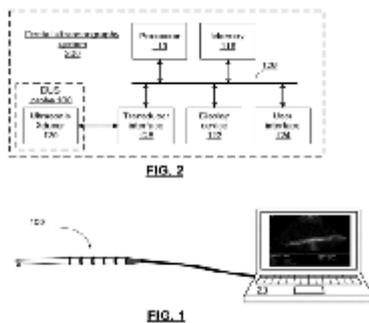
**B. indirect methods:**

**1 .Ultrasonic devices:**

The use of ultrasonic devices to determine gingival thickness is a non-invasive method. The difficulty to determine the correct position for attaining reproducible measurements, and the unavailability and a high cost of the device limit the use of this method.

Kydd *et al* in 1971 reported that ultrasonic devices appear to be the least invasive method and offer excellent validity and reliability<sup>(17)</sup>.

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<sup>(18)</sup>. Ultrasound machine consist of ultrasound scan including a digital display, scan display, a transducer probe, built in printer and footswitch (Figure 6).



**Figure 6: Dental ultrasound machine.**

In the 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<sup>(14)</sup> (Fig. 7).



**Figure 7: The intra oral transducer probe was adapted to the gingival surface (using (A-scan) probe with the frequency of 10MHz).**

Rakhi *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, recorded to the nearest 0.1mm<sup>(15)</sup> (Fig. 8) .

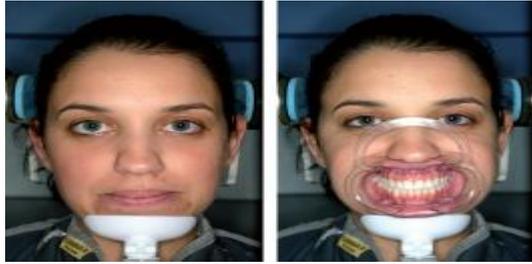


**Figure 8: Ultrasonic measurements using ultrasound B-scan . a) The region of interest was scanned by an extra-oral probe. The transducer probe was adapted to the gingival surface coinciding with the bleeding point created during trans gingival probing method. b) Ultra sonogram of maxillary anterior region**

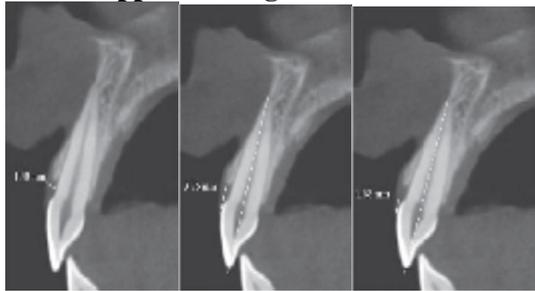
**2.ST- CBCT (soft tissue –cone beam computed tomography):** Cone beam computed tomography is used to visualize and measure thickness of both hard and soft tissues and can be used for determining the width, height and distance to the anatomical structures of alveolar process in pre-surgical dental implant planning.

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 dentogingival unit<sup>(19)</sup>.

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 the tongue remained lower in the oral cavity (Figure 9).

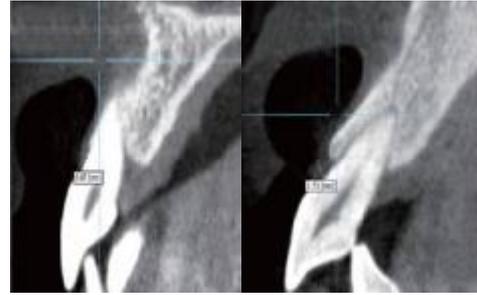


**Figure 9:** a) Patient positioned for a regular cone-beam computed tomography (CBCT) scan .b) The same patient positioned for the second CBCT scan wearing the plastic lip retractor (soft tissue CBCT) in an inverted position to avoid hitting the chin stabilizer. ST-CBCT allowed measurements of the distance of the gingival margin to the facial bone crest, the gingival margin to the CEJ, and width of the facial gingiva. It allowed a clear visualization, measurement of the dimensions, and analysis of the relationship of the structures of the periodontium and dentogingival attachment apparatus Fig10 &11<sup>(19)</sup>.



**Figure 10:** Soft tissue cone-beam computed tomography measurements (ST-CBCT) (a) Measurement of the thickness of the facial gingiva performed on the image of the patient with a thick periodontal biotype (soft tissue cone-beam computed tomography scan). (b), Measurement of the distance of the gingival margin to the facial bone crest represents the biologic width. (c), Measurement of the distance of the gingival margin to the cemento-enamel junction. Dotted lines represent the long axis of the tooth.

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<sup>(19-21)</sup>.



**Figure 11:** Comparison between the gingival biotypes in ST-CBCT measurements .a) Thin biotype representing a gingival thickness under 1.5 mm in a soft tissue cone-beam computed tomography image. Gingival thickness was assessed at 2 mm apical from the gingival margin. b) Thick biotype representing a gingival thickness of over 1.5 mm in a soft tissue cone-beam computed tomography image. Gingival thickness was assessed at 2 mm apical from the gingival margin.

### 3. 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, according to the method reported by Alpiste- Illueca<sup>(22)</sup>.

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 (5.0 x 1.0 x 0.1 mm) was used as reference for all measurements on the photograph and the radiograph<sup>(23)</sup> (Fig.12&13)



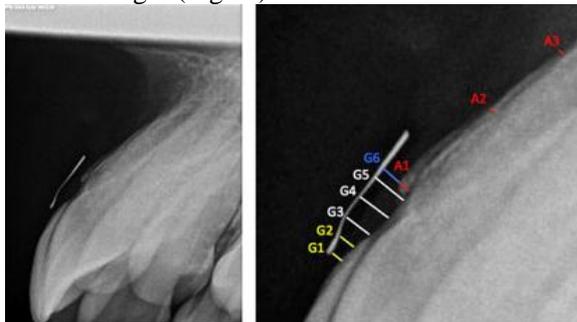
**Figure 12:** Clinical view of index tooth with fixed transfer lead plate.



**Figure 13: Bite block fixed with the anterior teeth so that the film was positioned on the lateral vestibule by paralleling orientation of the film towards the long axis of the tooth ,and this was achieved by viewing the lead plate through the aiming ring only the profile of the lead plate had to be seen.**

**The following measurements were made on the radiographs:**

- Thickness of the free gingiva: distance between the enamel surface to the palatal side of the lead plate measured at the coronal margin (G1) and the base (G2) of the free gingiva.
- Thickness of the gingiva at the supracrestal attachment: distance between the root surface and the palatal side of the lead plate measured at the cemento-enamel junction (G3), the middle third (midpoint between the distance CEJ - bone crest)(G4)and directly above the bone crest level (G5).
- Thickness of the attached gingiva: distance between the buccal margin of the bone crest and the palatal side of the lead plate(G6)
- Thickness of the buccal alveolar bone plate: distance between the buccal surface and the palatal side (Lamina Dura) of the buccal bone plate measured at the bone crest level (A1), at the border between the coronal and middle third (A2) ,and between the middle and apical third (A3) of the root length (Fig.14).



**Figure 14: Parallel profile radiography. a) Radiographic view. b) Radiographic measurement points for assessment of gingival (G1–G6) and alveolar bone (A1–A3)thickness values.**

The limitation of this technique is that it cannot be used in posterior teeth and unhealthy

periodontal tissues. Since this study was on radiographic images, it was not possible to measure the length of either the junctional epithelium or the connective tissue attachment <sup>(22)</sup>.

**C. Analysis of the gingival biotype based on the measurement of the dentopapillary complex:**

The characteristics of gingival thickness, gingival width and subjacent alveolar bone thickness have been used as a base for the classification of periodontal biotypes. However, for some authors, use of the term periodontal phenotype more correct to describe features of the periodontium, which are influenced by both genetic and environmental factors <sup>(24)</sup>.

In recent studies, gingival thickness, gingival width and the shape of the dental crown are taken to relate & define the classification of periodontal biotype .The characteristics of gingival thickness, gingival width and subjacent alveolar bone thickness have been used as a base for the classification of periodontal biotypes <sup>(25)</sup>.

Gingival biotype refers to an aggregate of four features of the soft tissues and the teeth they surround that build up to a specific picture <sup>(26)</sup>.

These are:

1. 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.
2. Gingival thickness (thick or thin): The thickness of the tissue in a bucco-palatal dimension.
3. Papilla height (PH)/proportion: The part of the gingiva that fits in between teeth.
4. 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.

Malhotra, *et al.* in 2014 correlated gingival biotype with dentopapillary complex. They recorded the following parameters which were the same as recorded by Lee *et al.* <sup>(27)</sup>. These parameters are important to determine gingival biotype:

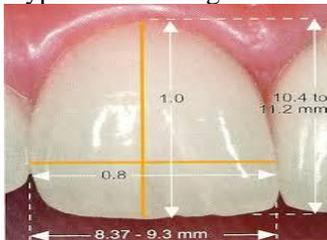
- Crown length (CL) was measured between the incisal edge of the crown and the free gingival margin, or if discernible, the cemento-enamel junction.
- Crown width (CW) i.e., the distance between the approximal tooth surfaces, was recorded at the border between the middle and the cervical portion.
- Papillary height (PH) was assessed to the nearest 0.5 mm using the same periodontal probe at the mesial and distal aspect of both central incisors. This parameter was defined as the distance from

the top of the papilla to a line connecting the mid-facial soft tissue margin of the two adjacent teeth. The mean value will be calculated for the three papilla.

- Papillary width (PW) was calculated at the base of papilla between two approximated tooth surfaces.
- From canine to canine, the area of the facial papilla (AP), the facial surface area of the anterior tooth (AT), the proportion of the dento-papillary complex (AP/AT).

Data collected and the existence and correlation of different gingival biotypes and dentopapillary complex dimension has been confirmed. The results showed that average crown length was the best single determinant of biotype and area of papilla was the next best choice and highly significant correlation between gingival biotype and crown length and area of papilla<sup>(25,27)</sup>.

The results were similar to findings have been reported earlier by Anand *et al.* who correlated the prevalence of thick and thin biotype with gender and tooth morphology<sup>(28)</sup>. Results showed that patients with slender tooth form have less crown width/crown length (CW/CL), less gingival width (GW), and more papillary height (PH) resulting in thin gingiva. While subjects showed a more quadratic tooth form, more crown width/crown length (CW/CL), broad zone of keratinized tissue (GW), and low papillae (PH) showed thick gingival biotype as seen in figure 15 below.



#### Association of gingival biotype with the results of scaling and root planing:

The concept of gingival biotype has been used as a predictor of periodontal therapy outcomes since the 1980s. Scaling and root planing (SRP) has been used in periodontal therapy. It includes the removal of plaque and calculus through repetitive instrumentation on the root surface. It is generally accepted that the dimensions of the gingiva in both the facial and interproximal areas shrink following scaling and root planing.

Although gingival shrinkage (GSH) after SRP is a common complication in periodontal patients, few studies on gingival biotypes have focused on alterations of the gingiva after SRP using a traumatic method to examine the gingival thickness. Fu *et al.* in 2011 proposed differences in the tissue reaction with each biotype, such that the

thick gingiva is more prone to resulting in a periodontal pocket and the thin gingiva, in GSH after any type of trauma<sup>(29)</sup>.

In a new study done by Yeon *et al.* in 2013, prospective and controlled experiments were performed to compare periodontal pocket depth (PPD) reduction and gingival shrinkage (GSH) after scaling and root planing (SRP) according to gingival biotype<sup>(30)</sup>. It was found that the gingival biotype and PPD change after SRP did not show a relationship. This means that other factors may have a greater impact than gingival biotype on the outcomes of SRP. Such factors may include the three-dimensional morphology of the alveolar crest, remained calculus and plaque, and individual healing potential. There were no differences in the gingival shrinkage in groups with a PPD over 3 mm. Only normal gingival crevices, showed a significant difference, in which the thin gingiva had more GSH than the thick gingiva, and this could be interpreted in relation to the critical probing depth of nonsurgical therapy. This study suggested that the roles of gingival biotype in GSH and PPD after SRP were undefined in cases of periodontitis. Gingiva with a PPD over 3 mm failed to show a particular tendency in GSH and PPD by biotype. Only the gingiva with a PPD of less than 3 mm showed more GSH in the thin biotype than the thick biotype<sup>(30)</sup>. More studies will be needed to clarify the factors affecting the results of SRP.

#### Gingival biotype and response to inflammation, surgery, and ridge healing after tooth extraction:

It was suggested by Kao *et al.* in 2002, that since these two tissue biotypes have different gingival and osseous architectures, they exhibit different pathological responses when subjected to inflammatory, traumatic, or surgical insults. These different responses dictate different treatment modalities<sup>(8)</sup>. The tissue response to inflammation, surgery & ridge healing after extraction can be summarized in table 1:

**Table 1: Tissue response to inflammation, periodontal surgeries & tooth extraction**

<b>Comparison of Tissue Response to Inflammation, Periodontal surgeries &amp; Tooth Extraction</b>		
	<b>Thick gingiva</b>	<b>Thin gingiva</b>
Soft tissue to inflammation	Marginal inflammation, cyanosis, bleeding on probing, edema-fibrotic changes	Thin marginal redness & gingival recession
Hard tissue to inflammation	Bone loss with pocket formation/intra bony defects	Rapid bone loss associated with soft tissue recession
Response to periodontal surgical procedures	Easy & predictable result with hard & soft tissue contouring	Difficult to predict where tissue will heal & stabilize
Regenerative periodontal procedures	Enhance blood supply to osseous structures	Compromise the blood supply
Ridge healing after tooth extraction	Minimal ridge atrophy	Ridge resorption in the apical & lingual direction

**Influence of tissue biotype in the behavior of the peri-implant tissue:**

The current focus of implantology is the planning, besides the function, the esthetical success. The expectation is to create an esthetic restoration that is indistinguishable from the natural tooth, as well as returning the contour of peripheral structures (peri-implant mucosa and papilla) that resemble the same contralateral structures. The peri-implant tissues are directly or indirectly affected by five main large groups of determinants:

- 1 - Surgical (surgical trauma, implant position, use of graft or bone substitute and period of insertion)
- 2 - Prosthetic (type of provisionalization, shape, manipulation of components)
- 3 - Geometry of implants (macro geometry, interface implant/abutment and surface)
- 4 - Systemic (smoking, diabetes, chemotherapy);
- 5 - Local factors (hygiene, maintenance, bone quantity and quality, periodontal disease, radiotherapy, type of edentulism, smoking and periodontal biotype<sup>(31-33)</sup>).

Many studies have been conducted to evaluate the effect of gingival biotype on peri-implant tissues<sup>(18,34-38)</sup>.

Souza *et al.*, concluded from these studies that tissue biotype has influence on the esthetic in the therapy with implants, especially on the facial peri-implant mucosa levels; presenting the thin biotype greater susceptibility to recession, the conversion of a thin biotype into a thick biotype, through grafting of conjunctive tissue seems to positively influence on the level of facial marginal mucosa. On the other hand, the tissue biotype showed little or no influence on the height of the interproximal papilla. The papillary filling of the interproximal niche. The papilla behaves with extremely sensibility to trauma and it is fundamental on the composition of the peri-implant morpho-functional and esthetic complex; therefore, it is suggested that each and every trauma must be avoided<sup>(39)</sup> (see figures 16&17).

**Figure 16: Thick biotype around implant.****Figure 17: Thin biotype around implant.**

As conclusion; evaluation of gingival tissue biotypes is important in treatment planning. Since thick and thin gingival biotypes are associated with thick and thin osseous patterns, the two tissue types respond differently to the inflammation and trauma and have different patterns of osseous remodeling following the extraction or implant procedure.

By understanding the nature of the tissue biotype, the practitioner can employ appropriate periodontal and surgical procedures to minimize alveolar resorption and provide more favorable environment for implant placement.

## REFERENCES

- Ahmad I. Anterior dental esthetics: the gingival perspective. *Br Dental J* 2005; 199:195-202.
- Ochsenbein C, Ross S. A reevaluation of osseous surgery. *Dent Clin North Am* 1969; 13(1): 87-102.
- Claffey N, Shanley D. Relationship of gingival thickness and bleeding to loss of probing attachment in shallow sites following nonsurgical periodontal therapy. *J Clin Periodontol* 1986; 13(7): 654-7.
- Seibert JL, Lindhe J. Esthetics and periodontal therapy. In: Lindhe J (ed.). *Textbook of Clinical Periodontology*. 2<sup>nd</sup> ed. Copenhagen Denmark: Munksgaard; 1989. p. 477-514.
- Becker W, Ochsenbein C, Tibbetts L, Becker BE. Alveolar bone anatomic profiles as measured from dry skulls Clinical ramifications. *J Clin Periodontol* 1997; 24: 727-31.
- Wheeler. Complete crown form and the periodontium. *J Prosthetic Dentistry* 1961; 11: 722-34.
- Weisgold AS. Contours of the full crown restoration. *Alpha Omegan* 1977; 70: 77-89.
- Kao RT, Pasquinelli K. Thick vs. Thin gingival tissue: a key determinant in tissue response to disease and restorative treatment. *J Calif Dent Assoc* 2002; 30(7): 521-6.
- Baldi C, Pini-Prato G, Pagliaro U, et al. Coronally advanced flap procedure for root coverage Is flap thickness a relevant predictor to achieve root coverage? A 19- case series. *J Periodontol* 1999; 70:1077-84.
- Hwang D, Wang HL. Flap thickness as a predictor of root coverage: A systematic review. *J Periodontol* 2006; 77: 1625-34.
- Olsson M, Lindhe J. Periodontal Characteristics in individuals with varying form of the upper central incisors. *J Clin Periodontol* 1991; 18: 78-82.
- Richard T, Kao, Mark C, Fagan, Gregory J. Thick vs. thin gingival biotypes: A key determinant in treatment planning for dental implants. *CDA J* 2008; 36: 193-8.
- 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(5): 428-33.
- Savitha B, Vandana KL. Comparative assessment of gingival thickness using transgingival probing and ultrasonographic method. *Indian J Dental Res* 2005; 16(4):135-9.
- Issrani R, Chavva S, Prabhu N, Keluskar V, Jirge V, Kumbujkar V, Patil S. Transgingival Probing and Ultrasonographic Methods for Determination of Gingival Thickness (A comparative study). *Adv Hum Biol* 2013; 3(3): 43-51.
- Kolte R, Kolte A, Mahajan A. Assessment of gingival thickness with regards to age, gender and arch location. *J Indian Soc Periodontol* 2014;18: 478-81.
- Kydd WL, Daly CH, Wheeler JB 3rd. The thickness measurement of masticatory mucosa in vivo. *Int Dent J* 1971; 21(4): 430-41.
- Kan JY, Rungcharassaeng K, Lozada JL, Zimmerman G. Facial gingival tissue stability following immediate placement and provisionalization of maxillary anterior single implants: A 2- to 8-year follow-up. *Int J Oral Maxillofac Implants* 2011; 26: 179-87.
- Januário AL, Barriviera M, Duarte WR. Soft tissue cone-beam computed tomography: A novel method for the measurement of gingival tissue and the dimensions of the dentogingival unit. *J Esthet Restor Dent* 2008; 20: 366-73.
- Mah J, Hatcher D. Current status and future needs in craniofacial imaging. *Orthod Craniofac Res* 2003; 6(Suppl.1):10-6.
- Barriviera M, Duarte WR, Januário AL, Faber J, Bezerra AC. A new method to assess and measure palatal masticatory mucosa by cone-beam computerized tomography. *J Clin Periodontol* 2009; 36: 564-568.
- Alpiste-Illueca, F: Dimensions of the dentogingival unit in maxillary anterior teeth: anew exploration technique (parallel profile radiograph). *International J Periodontics and Restorative Dentistry* 2004; 24: 386-96.
- Stein JM, Lintel-Hooping N, Hammacher C, Kasaj A, Tamm M, Hanisch O. The gingival biotype: measurement of soft and hard tissue dimensions - a radiographic morphometric study. *J Clin Periodontol* 2013; 40: 1132-1139.
- Egreja AM, Kahn S, Barceleiro M, Bittencourt S. Relationship between the width of the zone of keratinized tissue and thickness of gingival tissue in the anterior maxilla. *Int J Periodontics Restorative Dent* 2012; 32: 573-9.
- 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: 43-7.
- Sammur E. Soft tissue biotype and its implications- Dental Clinical Articles-PPD Magazine.htm.
- Lee SP, Kim TI, Kim HK, Shon WJ, Park YS. Discriminant analysis for the thin periodontal biotype based on the data acquired from three-dimensional virtual models of Korean young adult. *J Periodontol* 2013; 84(11):1638-45.
- Anand V, Govila V, Gulati M. Correlation of gingival tissue biotypes with gender and tooth morphology: A randomized clinical study. *Indian J Dent* 2012; 3: 190-5.
- Fu JH, Yen CY, Chan HL, Tatarakis N, Leong DT, Wang HL. Tissue biotype & its relation to the underlying bone morphology. *J Periodontol* 2010; 81: 569-74.
- Yeon-Woo Sin, Hee-Yung Chang, Woo-Hyuk Yun, Seong-Nyum Jeong, Sung-Hee Pi, Hyung-Keun You. Association of gingival biotype with the results of scaling and root planning. *J Periodontal Implant Sci* 2013; 43: 283-90.
- Belser UC, Schmid B, Higginbottom F, Buser D. Outcome analysis of implant restorations located in the anterior maxilla: a review of the recent literature. *Int J Oral Maxillofac Implants*. 2004; 19 Suppl: 30-42.
- Armitage GC, Lundgren T. Avaliação de Risco de Pacientes Candidatos a Implantes. In: Lindhe J, Karring T, Niklaus P, editores. *Tratado de Periodontia Clínica e Implantologia Oral*. 5a ed. Rio de Janeiro: Guanabara Koogan; 2010. p. 609-25.
- Barreto M, Sydney R, Rocha H, Leal M. Aspectos limitantes da estéticapéri-implantar. In: Tunes U, Dourado M, Bittencourt S. *Avanços em Periodontia e Implantodontia. Paradigmas e Desafios*. 1 ed. Nova Odessa: Napoleo; 2011. p. 92-121.
- Kan JY, Rungcharassaeng K, Morimoto T, Lozada J. Facial, gingival tissue stability after connective tissue graft with single immediate tooth replacement in the

- esthetic zone: consecutive case report. *J Oral Maxillofac Surg.* 2009; 67(11Suppl): 40-8.
35. Nisapakultorn K, Suphanantachat S, Silkosessak O, Rattanamongkolgul S. Factors affecting soft tissue level around anterior maxillary single-tooth implants. *Clin Oral Implants Res* 2010; 21(6): 662-70.
36. Wiesner G, Esposito M, Worthington H, Schlee M. Connective tissue grafts for thickening peri-implant tissues at implant placement. One-year results from an explanatory split-mouth randomized controlled clinical trial. *Eur J Oral Implantol* 2010; 3(1): 27-35
37. Tsuda H, Rungcharassaeng K, Kan JY, Roe P, Lozada JL, Zimmerman G. Peri-implant tissue response following connective tissue and bone grafting in conjunction with immediate single-tooth replacement in the esthetic zone: a case series. *Int J Oral Maxillofac Implants* 2011; 26(2): 427-36.
38. Raes F, Cosyn J, Crommelinck E, Coessens P, De Bruyn H. Immediate and conventional single implant treatment in the anterior maxilla: 1-year results of a case series on hard and soft tissue response and aesthetics. *J Clin Periodontol* 2011; 38(4): 385-94.
39. Souza OMM, Neri JFA, Freitas AC, Barreto MA. Influence of tissue biotype in the morpho-esthetic-functional behavior of the peri-implant tissue: A literature review. *Dental Press Implantol* 2012; 6(2): 56-66.