Gingival Biotype Classification, Assessment, and Clinical Importance: A Review

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ABSTRACT

A normal scalloped gingival line at the cement enamel junction of the teeth forms one of the components of an aesthetic smile. Clinicians handle gingiva in several periodontal procedures and the resulting gingival architecture is not always ideal. In the era of aesthetic-driven dental therapy, it is important that a clinician should be well aware of all the prognostic factors that may affect the final aesthetic outcome of dental treatment. Gingival biotype is one of the important factors which influences indications and outcome of various periodontal, restoratives, surgical, and implant therapy. Thin gingival biotype responds differently than thick gingival biotype. Gingival biotype assessment before various dental-related procedures is mandatory now to achieve a predictable and stable gingival margin position. This review describes the various classifications, methods of assessment, and clinical importance of gingival biotype during dental treatment.

Keywords: Gingival biotype; gingival biotype assessment; gingival biotype classification; gingival biotype clinical importance.

INTRODUCTION

Gingiva is the part of the oral mucosa that covers the alveolar processes of the jaws and surrounds the necks of the teeth.[1] It is mandatory that a clinician should be well aware of all the factors that may influence the aesthetic outcome of treatment in the era of aesthetic-driven dentistry. One factor that clinicians should consider before starting any dental treatment procedure is the gingival biotype.

In 1969 Ochsenbein and Ross in their study indicated that there were two main types of gingival morphology, namely the scalloped and thin or flat and thick gingiva.[2] The periodontal biotype term was later presented by Seibert and Lindhe in 1989 to divide the gingiva into "thick flat" and "thin scalloped" biotypes.[3] The gingival biotype has been used to describe the thickness of the gingiva in the faciopalatal dimension[4,5] and it is a genetically determined trait.[6] While periodontal biotype incorporates not just the thickness of gingiva in faciopalatal measurement but also the form of gingiva, the measure of keratinised gingiva present, alveolar bone form and thickness, and crown shape.[7] In a study by De Rouck et al. (2009), the thin gingival biotype occurred in one-third of the study population, while the thick gingival biotype occurred in two-thirds of the study population.[8]

DIFFERENT CLASSIFICATIONS OF GINGIVAL BIOTYPE

The 2017 World Workshop on the Classification of Periodontal and Peri-Implant Disease and Conditions has recommended adoption of the term "periodontal phenotype." Periodontal phenotype is determined by gingival phenotype (gingival thickness and keratinised tissue width), and bone morphotype (thickness of the buccal bone plate). This term is based on both gingival phenotype (three-dimensional gingival volume such as gingival thickness and keratinised tissue width and thickness of the facial and/or buccal bone plate (bone morphotype).[9]

Various classifications have been suggested for gingival/periodontal biotypes. Gingival/periodontal biotype may contrast from tooth to tooth in an individual or may differ with age, sex and dental arch location.[10] During each classification gingival thickness is one of important factors. There are many classifications suggested for gingival biotype and each classification shows lack of agreement for defining gingival biotype as thick and thin biotype. However, many classifications of gingival biotypes have been proposed over time (Table 1).[11-15]

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Citation

Shah HK, Sharma S, Shrestha S. Gingival Biotype Classification, Assessment and Clinical Importance: A Review. J Nepal Soc Perio Oral Implantol. 2020;4(8):83-88

DOI: https://doi.org/10.3126/jnspoi.v4i2.34303

Table 1: Gingival biotype classification.

Authors	Classification		
Ochsenbein and Ross (1969)[2]	Scalloped and thin	Flat and thick	
Claffey and Shanley (1986)[13]	Thick ≥2 mm	Thin <1.5 mm	
Seibert and Lindhe (1989)[3]	Thick ≥2 mm	Thin <1.5 mm	
Becker et al. (1997)11 (distance between interproximal and midfacial level of alveolar bone)	Flat: 2.1 mm	Scalloped: 2.8 mm	Pronounced scalloped: 4.1 mm
Muller and Eger (1997)[16]	Normal: normal tooth dimension (TD) of 11 and 12, normal width of keratinised tissue (KT) and gingival thickness (GT)	Thick: quadratic shape of 11 and 12, wide KT and thick GT	Thin: quadratic shape of 11 and 12, narrow KT, normal GT
Muller et al. (2000)[17]	Thin: slender TD, narrow width of KT and thin GT	Thin: slender TD, normal KT and thin GT	Thick: quadratic shape TD, wide KT and thick GT
Kois (1996)[18]	Normal (crestal bone level is 3 mm apical to the cementoenamel junction, CEJ)	High (crestal bone level is <3 mm apical to the CEJ)	Low (crestal bone level is >3 mm apical to the CEJ
Aimetti et al. (2008)[19]	Thin <1 mm	Thick flat > 1mm	
Fu et al. (2010)[20]	Thick: probe not seen through gingiva	Thin: probe seen through gingiva	
Kan et al. (2010)[12]	Thick >1mm	Thin ≤1 mm	
Egreja et al. (2012)[3]	Thick >1mm	Thin ≤1 mm	

GINGIVAL BIOTYPE ASSESSMENT

There are many assessment methods proposed for gingival biotype. Most common methods have been explained below.

Direct measurements or Bone sounding: The gingiva is anaesthetised by a topical local anaesthetic gel. An endodontic spreader/probe/needle with a rubber stop is inserted at a point at the centre of the gingival margin and mucogingival junction in a perpendicular direction and measurement is recorded against a digital caliper.[14] This method is easy to perform, convenient, cheap, and accurate. However, it is an invasive technique, requires application of local anaesthesia, depends upon angulations and precision of probe and there is poor precision of tissue thickness assessment. The validity of using a periodontal probe for the transgingival probing or sounding of the alveolar peak level has been exhibited for buccal surfaces of the jaw.[21] The estimations from the occlusal surfaces of the teeth to the evaluated level of the alveolar peak using in this technique precisely reflected the actual distances evaluated after surgical exposure of the alveolar peak at these sites.[18] Savitha et al. stated that the value of gingival thickness assessed with a probe was on average larger by 0.5 mm than the one obtained using measurements with an ultrasound device.[22]

Visual examination: Visual assessment is a technique which is frequently used to determine the gingival biotype. In this technique, no tools are necessary and it is quite simple and straightforward since each biotype exhibits its typical features. In this method, gingival biotype is clinically evaluated on the basis of general appearance of gingiva around teeth. The gingival biotype was considered as thick if the gingiva was dense and fibrotic and thin if the gingiva was delicate, friable, and almost translucent. The advantage of this method is that it is non-invasive. However, it has been found that it has low accuracy and high intraexaminer variability.[23]

Probe transparency: Periodontal probe is placed in the sulcus of midfacial aspect of tooth and gingival biotype is categorised on the basis of the visibility of underlying periodontal probe through gingival tissue. It is considered as thick if not visible and thin if visible. This technique is minimally invasive and has good accuracy. Kan et al. identified gingival thickness based on its transparency and direct measurements with a slide caliper. They observed no differences in gingival biotype assessment between two methods.[24]

Ultrasonic devices: Ultrasonography is a non-invasive diagnostic tool that is based upon a phenomenon of ultrasound wave distribution, dispersion, and reflection on an interface. Utilising ultrasound devices, it is possible to get a cross-section of the measured tissue and to estimate desired lengths. A thin and sensitive probe attached with ultrasonic device measures gingival biotype. The advantages include: an accurate measurement, digital display, avoids interexaminer variability, and non-invasiveness. However, limited availability and high cost make it less feasible.

Eger et al. and Muller et al. presented an ultrasound system that made it possible to determine thickness of the mucous membrane of the oral cavity and gingiva with the accuracy of 0.1 mm, without any discomfort to the patient.[25] Bednarz and Zielinska compared measuring accuracy of an ultrasound method and that of bone sounding. Thickness of periodontal soft tissues was tested with an ultrasound with the accuracy of 0.01 mm, and with a direct method with an endodontic tool with the accuracy of 0.1 mm. The results of both measurements were similar but the differences between values were statistically significant, the authors concluded that an ultrasonographic method was more reliable.[26]

Cone beam computed tomography (CBCT): This technique is used for the measurement and visualisation for both hard and soft tissues. With this technique, highly accurate results obtained with no intraexaminer variability. However, radiation exposure, high costs,[27] and expertise need make it clinically unfeasible. The study done by Fu et al. in 2010 demonstrated that the clinical measurements of labial gingiva and bone thickness corresponded to radiographic measurements, thereby showing that CBCT could be used to determine both soft and hard tissue thickness.[20]

The measurements of the periodontal parameter are mandatory for successful dental treatment. The visual method is a simple and frequently used method for determining gingival biotype. When comparing reliability of gingival biotype of maxillary anterior teeth with and without periodontal probe and direct measurements, Kan et al. (2010) found assessment of gingival biotype with periodontal probe as adequately reliable whereas visual assessment of the gingival biotype is not sufficiently reliable compared with direct measurement.[12]

The validity of visual method was also assessed in a study by Eghbali et al. with experienced and inexperienced clinicians.[28] The authors concluded that visual inspection may not be regarded as valid method to identify the gingival biotype as nearly 50% of the high aesthetic risk patients were overlooked. One of the simplest and effective method is transgingival probing and having accuracy to the nearest of 0.5 mm. Although this technique must be performed under local anesthesia, which could result into local volume increase of tissue and chances of patient inconvenience.[29] To get rid of this problem an ultrasonic device was introduced for measuring GT with a resolution of 0.1 mm.[25] This method shows high reproducibility (0.5-0.6 mm) but a mean intraindividual assessment error was revealed in second and third molars. A repeatability coefficient of 1.20 mm was calculated by Muller.[30] Similarly, the diameter of transducer probe results had problems in assessing difficult posterior sites. Next way to assess the GT was introduced by Kan et al. in 2003 by placing the probe in the facial sulcus.[24] Based on the visibility of the periodontal probe through the gingiva was considered as either thin or thick. This technique was found to have high reproducibility in the investigation of the De Rouck et al. (2009) and shows 85% interexaminer repeatability.[8] Finally, the usage of the CBCT shows high diagnostic accuracy in determining GT, and shows a minimal discrepancy with clinical measurements.[12,31] However, all the dental treatment and diagnostic procedures cannot justify the usage of exposure to radiation of a CBCT.

Considering all the pros and cons of the various assessment methods, direct measurement, and probe transparency are feasible and good technique to detect gingival biotype clinically.

CLINICAL IMPORTANCE

In spite of a lack of agreement for the classification method, most of the studies attribute similar features to a thick and a thin biotype. Each biotype possesses its own unique characteristic.

Characteristics of thick gingival biotype[5,13,18,32,33]

1. Relatively thick flat soft tissue and bony architecture.
2. Thick heavy periodontium.
3. Gingival margin usually placed coronal to CEJ.
4. Wide zones of keratinised gingiva, flat gingival contour.
5. Broad apical contact areas in teeth, and square anatomic crowns.
6. Mostly associated with periodontal health.
7. The tissue is dense with a wide zone of attached gingiva.
8. Thick underlying osseous form.
9. Tissue response to thick biotype:
    - Inflammation:
        a. Soft tissue: It results into marginal inflammation, cyanosis, bleeding on probing, and oedema/fibrotic changes.
        b. Hard tissue: Bone loss with pocket formation/ intrabony defects seen.
    - Surgery: Predictable soft and hard tissue contour after healing.
    - Extraction: Minimum ridge atrophy reported.

Characteristics of thin gingival biotype[5,13,18,33]

1. Highly scalloped gingival tissue usually may present with slight gingival recession.
2. Highly scalloped osseous contour.
3. Delicate and thin periodontium.
4. Small incisal contact areas in the teeth, and triangular anatomic crowns.
5. Tissue appears friable with a minimal zone of attached gingiva.
6. Soft tissue is highly accentuated and often suggestive of thin or minimal bone over the labial roots.
7. Demonstrates thin labial bone with an increased incidence of fenestration and dehiscence.
8. Tissue response to thin biotype:
   - Inflammation:
     a. Soft tissue: It shows thin marginal redness and gingival recession.
     b. Hard tissue: It results into rapid bone loss and with soft tissue recession.
   - Surgery: Difficult to predict where tissue will heal and stabilise.
   - Tooth extraction: Ridge resorption in the apical and lingual direction.

INFLUENCE OF GINGIVAL BIOTYPES ON TREATMENT PLAN AND OUTCOME

Thick biotype is characterised by thick gingival tissue and is generally related with good periodontal health. It is quite dense in appearance with an adequate zone of attached gingiva. There are evidences which suggest that thick tissue resists trauma and recession, enhances creeping attachment, improves implant aesthetics, allows tissue manipulation, exhibits less clinical inflammation, and improves surgical outcomes.[17,32,33] These are factors which are responsible for favourable characteristics in thick gingival tissue

1. Thick gingival tissue consists of high amount of extracellular matrix and collagen which permits the tissue to withstand collapse and contraction.
2. There is an increase amount of vascularity in thicker tissue which enhances oxygenation, immune response, growth-factor migration, and clearance of toxic products, resulting into good healing response.
3. It also consists of increase in the layers of epithelial keratinisation in thicker tissue, which prevents microbial ingress and physical damage.[34]

However, thin biotype is characterised by thin gingival tissue making it delicate and almost translucent in appearance. Such a tissue appears friable, usually, having a minimal zone of attachment. The soft tissue is highly accentuated and often suggestive of thin or minimal bone over the roots labially and there are evidences which show that the thin gingival tissue is less resistant to any inflammatory, traumatic, or surgical insult and thus usually exhibits gingival recession.[5,13,18,33,35]

Treatment of non-bleeding sites in periodontitis patients with a thick biotype may show a less noticeable loss of attachment than treatment of non-bleeding sites in a thin gingival biotype which is more likely to result in recession.[13] A flap thickness of >0.8 mm was associated with complete root coverage, while a flap thickness of <0.8 mm was associated with partial root coverage.[36] A case report in which management of multiple recession simultaneously with modified coronally advanced flap having thicker gingival biotype shows 100% root coverage.[37] A critical threshold thickness of >1.1mm for complete root coverage was found.[38]

A chance for more gingival recession was found with immediate single tooth implant restoration in a population with a thin biotype and decrease risk of recession in patients with a thick biotype.[4] Recent evidence suggests stability of tissue after surgery when the thickness is >1.44 mm.[39] During crown lengthening procedure, significant postoperative tissue rebound has been observed in cases of thick biotype as compared to thin biotype.[40] Gingival thickness varies among different individuals and different areas of the mouth within the same individual.[41] There was also a positive correlation between the keratinised tissue width and gingival thickness in maxillary anterior teeth. Maxillary central incisors presented with the greatest mean gingival thickness, followed by lateral incisors and canines and in the same way maxillary lateral incisors have the greatest keratinised tissue width, followed by the central incisors, and canines.[25, 41-54]

In orthodontic therapy, teeth are aligned and moved in various directions. It has been seen that such tooth movement results in increased recession and increased incidence of dehiscence and fenestration formation in cases with thin biotype.[42] It has been seen that in relation to metal ceramic prosthesis over a period of five years, significantly increase gingival recession is seen after prosthesis placement in thin

biotype as compared to thick biotype.[43] This emphasises the importance of assessment and management of thin biotype cases at the time of prosthesis placement. In thick biotype, significantly, less bone loss is seen after implant placement as compared to thin biotypes.[44]

The tissue biotype is considered a key factor in implant aesthetics, preventing future mucosal recession, and improving immediate implant success. There are five diagnostic keys for implant success which incorporates relative tooth position, type of the periodontium, biotype of the periodontium, tooth shape, and position of the osseous peak.[32] Soft tissue gingival biotype is one essential parameter to evaluate in accomplishing aesthetic implant restoration, improving immediate implant success, and averting a future mucosal recession.[45] A thick biotype was significantly associated with maintaining the presence of the gingiva papilla in the immediate dental implants restored with a fixed single-crown prosthesis,[47] while there was a tendency toward greater recession in patients with a thin tissue biotype.[48] The most important factors affecting soft tissue contour are implant position and biotype.[50] As a result correct position on all dimension and conversion of thin biotype to thick biotype is essential to prevent aesthetic failures as metal showing through gingival tissue, soft tissue recession, loss of marginal bone around the implant, and loss of interdental papilla.

In case of thin biotype, it can be converted or enhanced into thick biotype by following procedures:

1. The use of connective tissue grafts.[46]
2. Acellular dermal matrix can also be used to enhance the biotype.
3. Use of platelet-rich fibrin (PRF) membrane. Shetty et al. in 2014 showed that placement of PRF membrane over receded root surface in combination with coronally advanced flap resulted in the improvement in the thickness of gingiva.[49]
4. Recently, utilisation of fetal membranes such as amnion and chorion membrane has exhibited to enhance gingival biotype.[51,52]

SUMMARY

Gingival thickness is one of the important parameters which predict the outcome of dental related treatment. Hence, along with the recording of gingival colour, consistency, texture, and position; gingival thickness measurement should be measured routinely for all patients. By knowing the nature of tissue biotype, a clinician can perform suitable clinical procedures to minimise recession (soft tissue loss) and alveolar bone resorption and provide a more favorable tissue environment.

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