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REVIEW

Gingival biotype and its clinical significance – A review

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Abstract Gingival biotype has a significant impact on the outcome of restorative and regenerative therapy. The disparity in treatment outcome is possibly because of the difference in tissue response to trauma. Hence in clinical practice identification of the periodontal biotype is significant. Gingival thickness can be assessed by various invasive and non invasive methods. Thick and thin tissues often respond differently to inflammation and trauma. Periodontal surgical technique can improve the tissue quality and treatment outcome. This review paper highlights the general aspects of gingival biotype, methods to assess gingival thickness, response to treatment, techniques to improve tissue quality and its clinical significance.

1. Introduction

The long term success of esthetic restorations depends on several factors like gingival biotype, architecture of the gingival tissue and shape of the anterior teeth. The gingival morphology plays an important role in determining the final esthetic outcome. Therefore during treatment planning, it is important to recognize differences in gingival tissue. Different gingival biotypes respond differently to inflammation, restorative, trauma and parafunctional habits.[1,2] These traumatic events result in various types of periodontal defects which respond to different treatments. Long back, Ochsenbien and Miller discussed the importance of "thick vs. thin" gingiva in restorative treatment planning.[1]

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.[3,4] A gingival thickness of $\geqslant 2$ mm is defined as thick biotype and a gingival thickness of < 1.5 mm as thin biotype.[5] A clinician's knowledge in identifying gingival biotypes is paramount in achieving optimal treatment outcomes. Various invasive and non invasive methods were proposed to measure tissue thickness. These include direct measurement,[6] probe transparency method,[7] ultrasonic devices,[8] and cone-beam computed tomography scan.[9] Placing a periodontal probe in the gingival sulcus and observing the transparency is a simple method to determine tissue thickness.

The term periodontal biotype introduced by Seibert and Lindhe categorized the gingiva into "thick-flat" and "thin-scalloped" biotypes. Thick gingival tissue is associated with a

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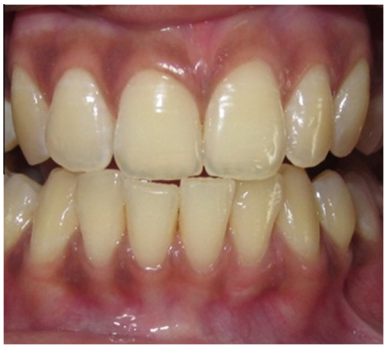

Figure 1 Thick periodontal biotype.

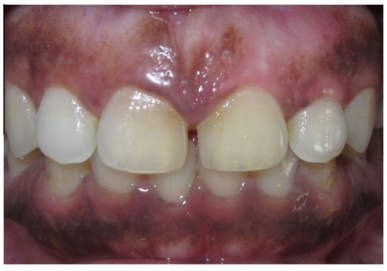

Figure 2 Squarish teeth with flat gingival architecture.

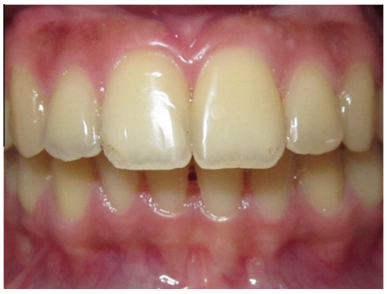

Figure 3 Thin periodontal biotype.

broad zone of the keratinized tissue and flat gingival contour suggestive of thick bony architecture and also is more resistant to inflammation and trauma. 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. Inflammation of the periodontium results in increased pocket formation and gingival recession in thick and thin tissues respectively.[5]

Tissue biotype is a critical factor that determines the result of dental treatment. The initial gingival thickness is significant as it may predict the outcome of root coverage procedures and restorative treatments.[10,11] However periodontal surgical techniques can enhance tissue quality resulting in a more favorable treatment outcome.

2. Gingival biotypes and their characteristics

According to Ochsenbien and Ross (1969), gingival biotypes are of two types.[1] They are scalloped and thin or flat and thick gingiva. They proposed that the contour of the gingiva closely followed the contour of the underlying bone. Later Siebert and Lindhe categorized the gingiva into "thick - flat" and "thin – scalloped" biotypes. A gingival thickness of $\geqslant 2$ mm (measurements of 1.6–1.9 mm were not accounted for) was considered as thick tissue biotype and a gingival thickness of < 1.5 mm was referred as thin tissue biotype.[5]

Becker et.al proposed three different periodontal biotypes: 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 = 2.8 mm, pronounced scalloped = 4.1 mm.[12]

Data in a study suggest that in 85% of the population, the thick periodontal biotype was more prevalent than the thin scalloped form (15%).[13] Thick periodontal biotypes are usually associated with periodontal health. The tissue here is dense and fibrotic with a large zone of attached gingiva. Surgical evaluation reveals a thicker and flatter underlying osseous form. The thick gingiva usually comes with low or high gingival scalloping[14]

Patients with thick-flat biotypes demonstrate short papillae whereas thick-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 (Fig. 1), resistance to acute trauma and respond to disease with pocket formation and infra bony defect. Moreover, the teeth are more square in shape (Fig. 2) and shows flatter posterior cusps. The contact areas of adjacent teeth are larger faciolingually and incisogingivally.[15]

Thin gingival biotypes are delicate, highly scalloped and translucent in appearance (Fig. 3). 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.[15] 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.[13,16–20] Unlike in thick biotypes the teeth are more triangular with steeper posterior cusps. The contact areas of adjacent teeth are small faciolingually and incisogingivally and are located towards incisal or occlusal third.[15]

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.[2,21] Gingival or periodontal diseases are more likely to occur in patients with a thin biotype and the remodeling process, after tooth extraction results in more dramatic alveolar resorption in the apical and lingual directions.[2] An atraumatic extraction and preservation of the alveolar plates are essential, if the site is to be used for implant placement. When compromise of the alveolar plate is expected, it is then necessary to utilize ridge augmentation protocols.

3. Methods to determine gingival thickness

Many methods were proposed to measure gingival thickness. The gingival thickness can be assessed by the direct method,[6] Probe transparency (TRAN) method,[7] Ultrasonic devices[8] and Cone Beam Computed Tomography (CBCT) scans.[9]

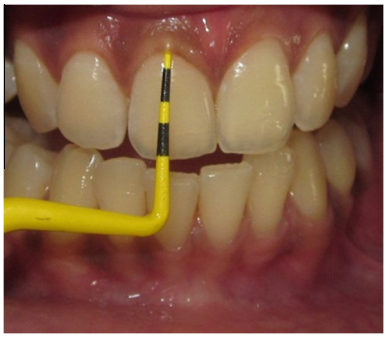

Figure 4 Probe not visible through the sulcus.

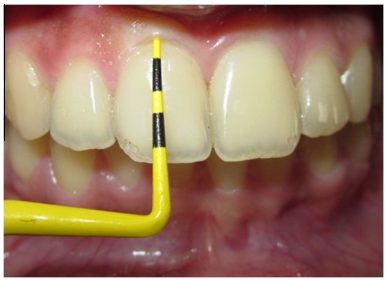

Figure 5 Probe visible through the sulcus.

In the direct method, the tissue thickness is measured using a periodontal probe. When the thickness is >1.5 mm, it was categorized as thick biotype and if less than 1.5 mm, it was considered as thin. This method has inherent limitations, such as precision of the probe, which is to the nearest 0.5 mm, the angulation of the probe during probing and distortion of tissue during probing.[6]

In the TRAN method, the gingival biotype is considered thin if the outline of the probe is shown through the gingival margin from the sulcus (Figs. 4 and 5). This method was found to be highly reproducible with 85% intra examiner repeatability (kappa-0.7, *p*-.002) in a clinical trial of 100 periodontally healthy subjects.[7,22]

The use of ultrasonic devices to determine 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. A study by Eger on numerous cadavers and human revealed that 95% of repeated measurements were within a limit of more than 1 mm with an overall repeatability coefficient of 1.20 mm.[8,23]

Recently CBCT was used to visualize and measure thickness of both hard and soft tissues. Fu et al. reported that CBCT measurements of both bone and labial soft tissue thickness are accurate and concluded that CBCT measurements might be a more objective method to determine the thickness of both soft and hard tissues than direct measurements.[9]

4. Tissue response to 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.[10] A flap thickness of 0.8–1.2 mm was associated with a more predictable prognosis.[11]

Data suggest that these two tissue biotypes respond differently to inflammation, trauma and surgical insult.[2] 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.[2]

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.[24] 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.

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 periimplant soft tissue compatibility with the surrounding gingiva and mucosa is essential. In a thick biotype environment, an immediate placement of an implant can be considered with predictable results.[25] An immediate implant placement can help to preserve the osseous structures.[26] To achieve the best esthetic outcome, along with immediate implant placement, simultaneous soft and hard tissue augmentation should be carried out.

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 preorthodontic gingival augmentation procedures. The recession and bone dehiscence will decrease when the tooth is moved in a more proper position within the alveolar bone.[27] 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.[28]

4.1. Treatment

The gingival thickness determines the final esthetic treatment outcome. Therefore it is essential for the clinician to identify the tissue biotype and to convert the thin biotype to a thick biotype. Periodontal surgical techniques can significantly improve the tissue quality and treatment outcome. Soft tissue grafting in areas of thin biotypes can enhance the quality of the gingival tissue. The best way to convert a thin soft tissue to a thick biotype is through subepithelial connective tissue

grafting.[29] Various other soft tissue augmentation procedures include: – modified roll technique and use of acellular dermal matrix.[29,30] Oral physiotherapy can improve tissue keratinization.

5. Clinical significance

During treatment planning the soft tissue biotype should be taken into consideration as it affects the final treatment outcome. Soft tissue thickness and contours are important diagnostic factors that influence the esthetic outcome of an implant restoration.[31] Evidence suggests that the percentage of the success rate of immediate implants in anteriors is more in individuals with thick biotypes.[32] However in patients with thin biotypes the frequency of gingival recession is high following implant restoration.[33]

Thick biotypes show greater dimensional stability during remodeling compared to thin biotypes. It is assumed that in thick biotypes, the presence of lamina bone adjacent to the outer cortical plate provides the foundation for metabolic support of the cortical bone and hence its stability and sustainability. In thin biotypes, where the lamina bone is scarce or absent, the cortical bone is subjected to rapid resorption. The long term stability of gingival margins around implants and adjacent teeth will depend upon the sufficient height and thickness of the facial bone.[34] The thicknesses of the crestal bone on the buccal aspect significantly influence remodeling during the initial four month healing period after immediate implant placement. Sites with >1 mm thickness showed minimal vertical resorption of buccal crest when compared to sites with thinner bones.[35] To form a stable epithelial connective tissue attachment a minimum of 3 mm of peri implant mucosa is required which serves as a protective mechanism for the underlying bone.[36,37] Hence, a delayed implant must be considered when there is not enough soft and hard tissue thickness. However immediate implants can be considered with predictable results in thick biotypes.

The thickness of bone and gingival tissue directly influences the stability of osseous crest and soft tissue.[24,38] Tooth extraction in thick biotypes result in minimal ridge atrophy, whereas, traumatic extractions may result in fracture of the labial plates and undue alveolar resorption in thin bony plates. If the site is to be used for implant placement, atraumatic extraction and ridge augmentation protocols should be considered.

Periodontal surgical procedures are more predictable in thick biotypes than in thin gingiva. With crown lengthening procedures and flap procedures, it is often difficult to predict the final position of the soft and hard tissues, due to the fact that each time when a flap is reflected, there is at least 0.5–0.8 mm of bone loss.[39,40] There could be undue gingival recession following surgery. So before placement of permanent restoration in the anterior region a healing period of at least six months is desirable. In an extremely thin gingival tissue, soft tissue grafting is recommended 6–8 weeks prior to surgical crown lengthening to improve the thickness of the keratanized tissue.[41] It has been suggested that a thick biotype may enhance the collateral blood supply to the underlying osseous structure whereas a thin biotype may compromise it.[42] Surgical trauma and periodontal flap management may influence the primary and collateral blood supply to the underlying onlay graft and insufficient new angiogenesis may result in ischemia.[43,44] Following regenerative periodontal procedures limited gingival recession has been observed in thick biotypes than in thin biotypes.[45] To achieve a predictable result with root coverage procedures a flap thickness of 0.8–1.2 mm is recommended. Thick gingival tissues ease manipulation, maintain vascularity and promote wound healing during and after surgery.[11] A thick tissue has an increased blood supply that will enhance the revascularization of bone grafts, leading to increased healing and graft incorporation. In these tissues it is able to attain and maintain primary closure. Thus the adequacy of soft tissue coverage is one of the prime factors in ensuring periodontal regeneration.

Thick gingival tissues are more resistant to mucosal recession or mechanical irritation and are capable of creating a barricade to conceal restorative margins. Hence there is a need to convert a thin tissue to a thick biotype.

6. Conclusion

Since 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. The current periodontal surgical techniques have the potential to improve the tissue quality, thereby enhancing the restorative environment. So by taking into consideration the gingival tissue biotypes during treatment planning, more appropriate strategies for periodontal management may be developed, resulting in more predictable treatment outcomes.

Conflict of interest

None declared.

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