Gingival biotype: a review

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Among the factors that may impede success in dental treatments, gingival biotype is the greatest cause of concern, particularly affecting the outcomes of periodontal therapy, root coverage procedures, and implant placement. Different tissue biotypes respond differently to inflammation and to surgical and restorative treatment; consequently, it is crucial to identify tissue biotype before treatment. Special care must be taken when treatment planning for cases with a thin gingival biotype. This article reviews the characteristics of various gingival biotypes and the many ways to determine them.

Received: December 7, 2011
Accepted: March 19, 2012

Keywords: gingiva, teeth, implant, bone

In 1969, Ochsenbein & Ross indicated that there were 2 main types of gingival anatomy—flat and highly scalloped. The authors reported that flat gingiva was associated with a square teeth form, while scalloped gingiva was associated with a tapered teeth form. The authors also proposed that the gingival contour closely mimics the contour of the underlying alveolar bone. The term periodontal biotype was used later by Seibert & Lindhe, who classified the gingiva as either thin-scalloped or thick-flat. In a study by De Rouck et al, the thin gingival biotype occurred in one-third of the study population and was most prominent among women, while the thick gingival biotype occurred in two-thirds of the study population and occurred mainly among men.

Studies have confirmed that central incisors with a narrow crown form are at greater risk of recession than incisors with a wide, square form. According to the literature, the alveolar bone and the gingival margin surrounding a tooth with pronounced cervical convexity are located more apically than they would be in teeth with flat surfaces, suggesting that the gingival margin is affected by the cervical convexity of the crown.

Generally, facial gingival is thicker in the maxilla than in the mandible. Maxillary canines and mandibular first premolars have the thinnest gingiva (0.7-0.9 mm), with a relatively high incidence of gingival recession. According to Weisgold, individuals with a thin, scalloped gingiva demonstrated a greater prevalence of recession. Scalloped gingiva can be categorized as high, normal, and flat. The normal scalloped gingiva is 4-5 mm coronal to the free gingival margin. The alveolar crest in a healthy periodontium is positioned approximately 2 mm more apically than the cementoenamel junction (CEJ) and mimics the scallop of the CEJ. In the normal and high scalloped gingival form, there is more tissue coronal to the interproximal bone than the facial bone. As such, higher scalloped gingiva are at greater risk for gingival loss after tooth extraction.

In a 1994 article, Kois examined crestal bone levels and classified them as normal (crestal bone level is 3 mm apical to the CEJ), high (crestal bone level is <3 mm apical to the CEJ), and low (crestal bone level is >3 mm apical to the CEJ and found in patients with recession). Gingival biotype can affect the results of periodontal therapy, root coverage procedures, and implant placement. It has been shown that patients with thin gingival biotype were more likely to experience gingival recession following nonsurgical periodontal therapy. Mucogingival problems may result from orthodontic movement of teeth away from the alveolar process, particularly among patients with thin periodontium. The level of gingival thickness before regenerative surgery was found to be a predicting factor for further recession. Kois proposed that postsurgery clinical results were strongly associated with the gingival and alveolar crest form. In cases with low alveolar crest position, an increased susceptibility for gingival recession may expose restorative margins when finish lines are placed intracrevicularly. Patients with thick gingiva appear less likely to experience gingival recession after surgical or restorative therapy.

Differences in gingival and osseous architecture have a significant impact on the outcome of treatments. Therefore, gingival biotype should be evaluated at the start of the treatment plan for the most esthetic results. The characteristics of thin and thick gingiva are listed in the Table.

Gingival biotype and labial plate thickness

For patients with a thin gingival biotype, extreme care should be taken during extraction to prevent labial plate fracture. Cook et al evaluated the correlation between labial plate thickness and thin or thick gingival biotypes—using information obtained from cone beam computed tomography (CBCT), diagnostic impressions, and clinical examinations of maxillary anterior teeth—and concluded that a significant association existed between gingival biotype and labial plate thickness. According to Fu et al, the thickness of the labial gingival tissue has a moderate association with the underlying bone.

Gingival biotype and Schneiderian membrane thickness

The most common complication during sinus graft procedures is perforation of the sinus membrane. This condition may occur after the sinus floor is accessed through the lateral wall or the ridge crest. Clinical observations have prompted clinicians to suggest a correlation between the sinus membrane thickness and the risk of perforation. A 2008 study by Aimetti et al took maxillary mucosal biopsies from the sinus floor during otorhinolaringologic surgical interventions, and measured gingival...
thickness in the area of the maxillary anterior teeth. The authors reported that the average thickness of the Schneiderian membrane was 0.97 ± 0.36 mm. Patients with thick gingiva had a sinus mucosa that was 1.26 ± 0.14 mm thick, compared to 0.61 ± 0.15 mm thickness among patients with thin gingiva. The results showed that gingival thickness is a reliable factor for predicting sinus membrane thickness. Additional research must be performed to confirm these data.

**Tissue biotype in implant treatment planning**

Studies have examined how mucosal thickness and biologic width affect crestal bone loss around implants. A 1996 animal study by Berghlund & Lindhe concluded that thin gingival tissue can lead to marginal bone loss during formation of the peri-implant biologic width. Another histologic study by Huang et al reported that implant sites with thin mucosa were prone to angular bone defects, while stable crestal bone was maintained in implants surrounded by thick mucosa. According to Abrahamsson et al, thick tissues (that is, ≥2.5 mm) can avoid significant crestal bone recession; however, the authors recommend avoiding supracrestal placement of implants if an implant is surrounded by a thin biotype.

Gingival recession is one of the most common complications resulting from single anterior tooth implant placement. Gingival biotype is a diagnostic key for predicting the esthetic success of an implant. According to Evans & Chen, gingival recession increases in patients with thin biotypes immediately after single implant restorations. Furthermore, papilla between immediate single implants and adjacent teeth is significantly associated with a thick gingival biotype. Patients with thick-flat mucosa tended to maintain the implant papillae height.

Dramatic alveolar resorption in the apical and lingual direction is possible in patients with a thin biotype. The loss of peri-implant tissues may result in facial plate loss, with the implant taking on a grayish color; additional bone and soft tissue grafting surgeries may be necessary in such cases. Immediate placement of an implant in a thick gingival biotype offers predictable results.

A 2007 study by Jung et al evaluated different materials (titanium, ceramized titanium, zirconium, and ceramized zirconium) that were placed under the vestibular mucosa of mandibles of pigs, along with connective tissue grafts of varying thickness. Tissue color was measured by a spectrophotometer. All of the materials changed the color of the thin (1.5 mm) mucosa, with titanium producing the greatest change. In normal (2.0 mm) mucosa, only titanium altered the color. In thick (30 mm) mucosa, no changes were observed from any of the materials. The results suggest that it is preferable to use pillars of zirconium for thin peri-implant mucosa, to avoid color changes of the mucosa.

Gingival biotype and ridge preservation

A thin gingival biotype is associated with a thin alveolar plate; more ridge remodeling has been found in this biotype when compared with thick periodontal biotype. Ridge preservation should be considered for most thin biotype cases. Preservation of alveolar dimensions (such as socket preservation or ridge preservation techniques after tooth extraction) is critical for achieving optimal esthetic results in thin biotypes; atraumatic extraction also may be necessary.

**Tissue biotype and root coverage**

According to McFall, tissue thickness in the recipient site and the donor site are key factors in how mucogingival defects are treated. In cases involving root coverage surgeries, a flap thickness of 0.8-1.2 mm produced more predictable outcomes. An initial gingival thickness was found to be the most predictable factor for predicting the success of complete root coverage procedures. There is a correlation between flap thickness and complete root coverage.

**Gingival biotype assessment**

Many methods (both invasive and non-invasive) have been used to evaluate the thickness of facial gingival and other parts of the masticatory mucosa. These methods include conventional histology on cadaver jaws, injection needles, transgingival probing, histologic sections, cephalometric radiographs, probe transparency, ultrasonic devices, and CBCT.

**Visual evaluation**

Simple visual evaluation is used in clinical practice to identify the gingival biotype; however, it may not be considered a reliable method, as it cannot be used to assess the degree of gingival thickness.

**Probe transparency**

The gingival tissue's ability to cover any underlying material's color is necessary for achieving esthetic results, especially in cases of implant and restorative dentistry, where subgingival alloys are used.

<table>
<thead>
<tr>
<th>Table. Characteristics of thin and thick gingiva.</th>
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<td><strong>Characteristics of thin gingiva</strong></td>
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<tr>
<td>Narrow zone of keratinized tissue</td>
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<tr>
<td>Gingival thickness is &lt;1.5 mm, width is 3.5-5 mm</td>
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<tr>
<td>Pronounced scallped soft tissue and bony architecture</td>
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<td>Slight gingival recession</td>
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<td>Dehiscence and fenestrations are usual findings in thin underlying bone</td>
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<td>Thin marginal bone</td>
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<td>Small proximal contact areas located near the incisal edge</td>
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<td>Triangular anatomic crowns</td>
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<td>Slender tooth form</td>
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<td>Subtle cervical convexities in the crown</td>
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<td>Gingival recession following disease</td>
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<tr>
<td><strong>Characteristics of thick gingiva</strong></td>
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<tr>
<td>Large amount of keratinized tissue</td>
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<tr>
<td>Gingival thickness is ≥2.0 mm, width is 5-6 mm</td>
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<tr>
<td>Flat soft tissue and bony architecture</td>
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<td>Gingival margins usually are coronal to the cementoenamel junction</td>
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<tr>
<td>Thick bony plates</td>
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<tr>
<td>Thick marginal bone</td>
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<tr>
<td>Broad, more apically located contact areas</td>
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<td>Square anatomic crowns</td>
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<td>Quadratic tooth form</td>
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<td>Marked cervical convexities in the crown</td>
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<td>Deep pocket and intrabony defect formation</td>
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widely.\textsuperscript{59,60} Using a metal periodontal probe in the sulcus to evaluate gingival tissue thickness is the simplest way to determine gingival biotype; with a thin biotype, the tip of the probe is visible through the gingiva. This method is minimally invasive, and periodontal probing procedures are performed routinely during periodontal and implant treatments.\textsuperscript{50}

**Modified caliper**

A tension-free caliper can only be used at the time of surgery and cannot be used for pretreatment evaluation. A 2010 study by Kan et al of the facial gingival biotype in maxillary anterior teeth compared visual evaluations, the use of a periodontal probe, and direct measurements with a tension-free caliper.\textsuperscript{61} The authors reported a statistically significant difference between visual assessment and both the periodontal probe and the tension-free caliper; however, there was no statistically significant difference when comparing the periodontal probe assessment and the tension-free caliper. Based on these results, a periodontal probe in the sulcus is an adequately reliable and objective way to evaluate tissue thickness, whereas visual evaluation of the gingival biotype by itself is not as reliable as the periodontal probe or the tension-free caliper.\textsuperscript{44}

**Transgingival probing**

Gingival thickness can be measured by using a periodontal probe; a thick biotype has a thickness of ≥1.5 mm.\textsuperscript{45} However, such measurements can be affected by the precision of the probe, the angulation of the probe, and the distortion of the tissue during probing.\textsuperscript{26}

**Ultrasonic devices**

A 1971 study by Kydd et al was the first to measure the thickness of palatal mucosa using an ultrasonic device.\textsuperscript{23} Ultrasonic devices appear to be the least invasive method and offer excellent validity and reliability.\textsuperscript{48,62} 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.\textsuperscript{26,61}

**Cone beam computed tomography**

CBCT scans have been used extensively for hard tissue imaging because of their superior diagnostic ability. Fu et al measured the thickness of labial gingiva and bone and reported no statistically significant difference between the clinical measurements made with a caliper and radiographic measurements utilizing CBCT scans; however, CBCT measurements may be a more objective method than direct measurement.\textsuperscript{26} A plastic lip, tongue retractor, and wooden spatulas can be used to better visualize soft tissue margins.\textsuperscript{58}

**Conclusion**

By understanding the nature of tissue biotypes, clinicians can employ appropriately periodontal management to minimize tissue resorption and provide more favorable results after dental treatment. A clear cut classification system should be considered to facilitate gingival biotype diagnosis in a practical manner.

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