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GINGIVAL BIOTYPE - COMPARATIVE ANALYSIS OF DIFFERENT EVALUATION METHODS

BIOTIP GINGIVE – KOMPARATIVNA ANALIZA RAZLIČITIH METODA ISPITIVANJA

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Abstract

Background/Aim. Gingival biotype can have a significant impact on the outcome of the periodontal therapeutic procedures and on the predictability of their aesthetic outcome. There is a strong correlation between the types of biotype and the potential gingival recession after restorative, periodontal and implant surgical procedures. Therefore, accurate identification of gingival biotypes, before initiating these procedures, is one of the significant predictive factors for their success. The aim of this study was to evaluate reliability of accurate gingival biotype determination with the use of visual method, periodontal and trans-gingival probing compared to the direct measurement method.

Methods. This prospective study involved 33 patients indicated for the apical root resection in the intercanine sector of the upper jaw. Gingival biotype identification was performed in all of the patients using the following techniques: 1) visual method; 2) periodontal probe technique; 3) trans-gingival probing; 4) direct measurement after flap elevation was performed. Statistical analysis of the obtained data was performed to assess the diagnostic accuracy of the visual method, periodontal probing method and trans-gingival probing method, in relation to the direct measurement method, used as a gold standard, to discriminate the gingival thickness biotype (thin versus thick). Results. The overall accuracy of the tested diagnostic procedures, compared to direct gingival biotype measurement, was: 66.7% for visual method; 78.8% for periodontal probing; and 97.0% for trans-mucosal probing. Conclusion. Periodontal probing method can be recommended for gingival biotype determination as a routine method, due to the fact that its sensitivity and overall accuracy is higher compared to the visual method. The trans-gingival method, in terms of sensitivity and comprehensive accuracy, almost completely coincides with the direct method, but it is more invasive compared to periodontal probing method and it has to be conducted in local anesthesia.

Key words: Gingival biotype, evaluation; Periodontal probing.

Apstrakt

Uvod/Cilj. Biotip gingive može imati značajan uticaj na ishod parodontalnih terapijskih postupaka i predvidljivost njihovog estetskog ishoda. Postoji visoka korelacija između
biotipa i potencijalne recesije gingive nakon restaurativnih, parodontalnih i implantoloških hirurških zahvata. Stoga je tačna identifikacija biotipa gingive, pre započinjanja ovih postupaka, jedan od značajnih prediktivnih faktora njihovog uspeha. Cilj ove studije bio je da proceni pouzdanost određivanja biotipa gingive primenom vizuelne metode, metoda parodontalnog i transgingivalnog sondiranja u odnosu na direktnu metodu merenja.

**Metode.** U ovoj prospektivnoj studiji učestvovalo je 33 pacijenta kod kojih je bila indikovana resekcija vrha korena zuba u interkaninom sektoru gornje vilice. Identifikacija gingivalnog biotipa izvršena je kod svih pacijenata primenom: 1) vizuelne metode; 2) tehnike parodontnog sondiranja; 3) transgingivalnog sondiranja; i 4) nakon odizanja režnja, direktnog merenja. Statistička analiza dobijenih podataka izvršena je radi procene dijagnostičke tačnosti vizuelne metode, parodontnog sondiranja i transgingivalnog sondiranja u odnosu na direktnu metodu, koja se koristi kao zlatni standard u cilju evaluacije biotipa gingive (tanak nasuprot debelom). **Rezultati.** Ukupna tačnost testiranih dijagnostičkih postupaka u određivanju biotipa gingive, u poređenju sa metodom direktnog merenja, bila je: vizuelna metoda - 66,7%; parodontno sondiranje - 78,8%; transmukozno sondiranje - 97,0%. **Zaključak.** Parodontna metoda sondiranja može se preporučiti za određivanje biotipa gingive kao rutinska metoda s obzirom na činjenicu da je njena senzitivnost i ukupna tačnost veća u odnosu na vizuelnu metodu. Transgingivalna metoda, u pogledu senzitivnosti i sveobuhvatne tačnosti, gotovo se u potpunosti poklapa sa direktnom metodom, ali je invazivnija u poređenju sa metodom parodontnog sondiranja i mora se sprovesti uz prethodnu primenu lokalne anestezije.

**Ključne reči:** Biotip gingive, procena; Parodoncijum, sondiranje

**Introduction**

In recent years, the characteristics of the oral mucosa, especially gingival thickness, has become the subject of interest for both implantologists and periodontists, epidemiologists and many others. The term “gingival biotype” has been used to describe
the thickness of gingiva in vestibulo-oral direction\textsuperscript{1,2,3}. The first analysis of gingival anatomy, in this sense, was given in 1969, by Ochsenbein and Ross, who described two main types of gingival morphology: flat and thick, and thin and scalloped gingiva \textsuperscript{4}. They have indicated a connection between the gingival contour and the contour of the underlying alveolar bone. Based on this classification, Seibert and Lindhe later introduced the term "periodontal biotype", which further categorized gingiva into thick-flat and thin-scalloped biotypes\textsuperscript{5}.

After observation of different variations of keratinized tissue and with the increasing use of dental implants, in 1997, Muller joined the term gingival and periodontal biotype into a soft tissue biotype, which includes both tooth tissue and tissue around implants\textsuperscript{6}.

In general, it can be said that a gingival thickness of $\leq 1\text{mm}$ is defined as thin biotype and a gingival thickness of $\geq 1\text{mm}$ as thick biotype\textsuperscript{7}. Thick biotype exists in about 85% of cases; it is characterized by thick gingival tissue and is usually associated with good periodontal health. It has a sufficient width of the attached gingiva, it is more resistant to trauma, and thus to recessions, and it is much easier to be manipulated with during surgical procedures (Fig.1). This is explained by the presence of a high percentage of extracellular matrix and collagen that allows tissue contraction, as well as good vascularization. The thin biotype is present in the remaining 15% of cases. It is usually transparent and has a small attachment zone (Fig.2). It is usually characterized by bone defects, such as dehiscence and fenestration under it, and it is less resistant to inflammation and trauma\textsuperscript{8,9}.

Numerous studies have shown that gingival biotype can have a significant impact on the outcome of the therapeutic procedures and on predictability of the aesthetic outcome. There is a strong correlation between gingival biotype and possible gingival recession after restorative, periodontal and implant surgical procedures\textsuperscript{10,11,12,13,14,15}. Therefore, accurate identification of gingival biotype before initiating these procedures is one of essential predictive factors for their success. In that sense, there is a number of methods for determining the gingival biotype: the visual method\textsuperscript{2,10}, biotype identification method with the use of periodontal probe\textsuperscript{11}, direct measurement of the gingival thickness\textsuperscript{16}, trans-gingival probing\textsuperscript{17}, ultrasonic measurement\textsuperscript{18,19} and CBCT radiographic examination\textsuperscript{20}. 


The aim of this study was to evaluate reliability of the gingival biotype determination by the use of: visual method, periodontal probe and trans-gingival probing in relation to the direct measurement method.

Methods

This prospective clinical study was performed at The Department of Oral Surgery of the Clinic of Dental Medicine, Faculty of Medicine, University in Pristina, Kosovska Mitrovica, Serbia and in the private dental practice "Radix" in Krusevac, Serbia. The selection of patients who participated in the study was done according to pre-established criteria. All patients were older than 18 years, had good oral hygiene and previously were indicated for apical surgery in the intercanine sector of the upper jaw, due to chronic periapical lesion that could not be treated endodontically. In addition, an important parameter was the existing indication for the use of flap design with a horizontal intrasulcular incision. Additional parameters were the presence of attached gingiva > 5 mm wide, as well as a negative history of previous interventions in the intercanine sector of the upper jaw, in terms of the soft tissue augmentation, treatment for gingival recessions, or esthetic extension of the clinical tooth crowns. Patients having fixed prosthetic works, marginal gingiva inflammation, as well as patients with systemic diseases and bad habits, that could compromise the results of the study, such as smoking, alcoholism, or oral breathing due to airway obstruction, were excluded from the study. Systemic therapy with medications that might have an effect on the oral and gingival condition, also represented an exclusive factor.

The study included 33 patients (20 males and 13 females), aged 18-72 years. Gingival biotype identification was performed in the lateral incisor zone in 17 patients, in the central in 11 patients, and in the canine in 5 patients. The evaluation was performed first by visual method and then by periodontal probing. After administration of infiltration anesthesia in order to perform oral surgery, gingival biotype identification was performed by using trans-gingival probing. At the end, immediately after a full thickness mucoperiosteal flap elevation, direct measurement of gingival thickness was performed.
with the use a modified caliper. The entire testing procedure was performed by the same researcher as it follows:

Visual method

Visual method of gingival biotype assessment was performed by observing the appearance of the gingiva in the dental area where oral surgery was indicated and by observing, as well, other teeth of the upper intercanine region, as follows:

- **Thick biotype** - the gingiva around the observed tooth is thickened and fibrous, the interdental papillae towards the adjacent teeth are short, the contact points are wide, teeth are of square shaped, with pronounced cervical convexity (Fig. 1);
- **Thin biotype** - the gingiva around the observed tooth looks thin and delicate, the interdental papillae are narrow and long, the contact points to adjacent teeth are narrow and more incisally displaced, while the teeth are elongated and triangular in shape.

Periodontal Examination

Periodontal assessment of gingival biotype was performed with the use of periodontal probe (WHO Probe 550b, LM Dental). Clinical evaluation was done by sulcus probing in the central part of the vestibular side of the tooth, on which oral surgery was indicated (Fig. 3). The gingival biotype was classified according to the visibility of the periodontal probe through the gingival tissue, as follows:

- **Thick biotype** - the periodontal probe is not visible through the gingival tissue;
- **Thin biotype** - the periodontal probe is visible through the gingival tissue.

Trans-mucosal probing

Gingival biotype assessment, using trans-mucosal probing, was done by measuring its thickness with a root canal instrument number 25 with a rubber stopper (K-file Maillefer, Dentsply). After application of infiltration anesthesia in order to perform the planned oral-surgical intervention, a root canal instrument was used to pierce the soft tissue of the gingiva on the vestibular side of the tooth indicated for surgery, at a distance of 3 mm from
the marginal gingival edge, set perpendicular relative to the alveolar ridge till the bone contact. The rubber stopper of the root canal instrument was then placed on the surface of the alveolar ridge mucosa (Fig.4). After that, the distance from the tip of the needle to the rubber stopper was measured with a millimeter ruler, on the basis of which, the gingival biotype was identified, as follows:

- **Thick biotype** - the distance between the tip of the root canal instrument and the stopper was > 1mm;
- **Thin biotype** - the distance between the tip of the root canal instrument and the stopper was < 1mm.\(^2^2\)

**Direct measurement**

The modified caliper with a millimeter ruler (Wax caliper, Odontomed), the tips of which were blunted in order to minimize the pressure and trauma to the soft tissue was used for the direct measurement of the gingival thickness (Fig.5). After the full-thickness flap elevation, the gingival thickness on the vestibular side of the tooth, was measured at a distance of 3 mm from the edge of the marginal gingiva, on the basis of which the gingival biotype was classified, namely:

- **Thick biotype** - gingival thickness was > 1mm;
- **Thin biotype** - gingival thickness was < 1mm.\(^7\)

After all the measurements for each patient, the obtained results were statistically processed. Measures of sensitivity, specificity and overall accuracy were applied to assess the diagnostic accuracy of the visual method, periodontal biotype identification and trans-gingival probing, in relation to the direct measurement method, used as a gold standard and which is the most objective method to discriminate the gingival thickness biotype (thin versus thick).\(^7\)

**Results**

To assess the diagnostic accuracy of visual, periodontal and trans-mucosal probing methods for discrimination of gingival thickness biotype (thin in relation to thick),
measures of sensitivity, specificity and overall accuracy, in relation to direct measurement, were applied.

The direct method of measurement, although invasive, is considered the reference method in most studies. The success of all other methods is measured according to the direct method. The results obtained in this study showed that the average gingival thickness, measured by the direct method was 0.982 mm, with an almost uniform distribution of gingival thickness values larger or smaller than this average (51.5% larger and 48.5% smaller than the mean value). This almost coincides with the findings of Khan et al, who found the average gingival thickness of 1.06 mm. For this reason, we can agree with them that a border line value between the gingival thickness for thin and thick gingival biotype could be considered to be 1mm.

By examining the gingival biotype in 33 patients, using the visual method, a thin biotype was diagnosed in 8 (24.2%) cases, while a thick biotype was diagnosed in 25 (75.8%) cases (Table 1). When the periodontal examination was used, a thin biotype was found in less and a thick one in more cases, while, when the trans-gingival method was used, a thin biotype was found in the most and a thick one in the least number of respondents (Tables 2 and 3). Direct measurements of the gingival thickness, however, resulted as a thin biotype in 51.5% of respondents and a thick one in 48.5% (Table 4).

When examining the diagnostic accuracy of different methods for identifying a thin biotype, the compatibility of results between visual and direct method was determined in only 7 out of 17 cases. The statistical analysis showed that the value of sensitivity of this method was 41.2% for thin biotype identification, relative to the direct measurement, used as a gold standard. On the other side, the accuracy of this method in identifying the thick biotype, was noticed in 15 out of 16 cases identified using the direct method, which indicating the specificity values of 93.8%. Based on the presented results, the calculated overall accuracy value was 66.7% (Tables 5 and 8).

With the use of periodontal probing method, a thin gingival biotype was diagnosed in 11 out of 17 cases determined by the direct measurement. When examining the thick biotype, compatibility with the direct measurements was in 15 out of 16 cases, indicating its sensitivity of 64.7%, while the specificity was 93.8%. The overall accuracy of the periodontal probing method was 78.8% (Tables 6 and 8).
The sensitivity of the trans-gingival method in the thin gingival biotype identification, in relation to the direct measurement, was 100.0%, while the specificity was 93.8%. Its overall accuracy was 97.0% (Tables 7 and 8, and Figure 6).

Discussion

Gingival biotype is an important clinical parameter that can affect not only the success, but also planning and prognosis of the programmed restorative, periodontal or implant procedure. The thin gingival biotype around natural teeth increases the risk of gingival recession after surgical, restorative or even mechanical trauma, and a similar phenomenon has also been noticed in the peri-implant mucosa. In addition, this gingival biotype is often associated with the presence of a thin lamellar bone around the teeth, together with the presence of fenestration and dehiscence, which can be a significant limiting factor in terms of possible immediate implant procedures. From dental implantology point of view, it is important to emphasize that the frequency of gingival recession, around the implant, after the replacement of one lost tooth, increases with the reduction of gingival thickness. In addition, Hwang et al. concluded, in their histological study, that a thin gingival biotype, at the implantation site, is more likely to have angulated bone defects, in contrast to a thick biotype where greater stability of the cortical bone is noticed. Finally, the success of numerous periodontal procedures for the coverage of gingival recessions is significantly lower in patients with a thin gingival genotype. Having in mind all the mentioned data concerning a significance of gingival biotype, numerous methods have been developed to evaluate the thickness of the gingival tissue.

The visual method of gingival biotype identification represents the simplest and one of the most commonly used methods. However, its biggest deficiency is the lack of standardization among accurate clinical parameters, so the method itself is often based on the subjective evaluation and experience of the dentist himself. This is the main reason why the precision of this method is insufficient, compared to the others available to the
 clinician's. According to the results of this study, when using the visual method in gingival
biotype detection, a thin gingival biotype was noticed in only 24.2% of cases, which is
markedly different compared to the direct method, taken as a reference, where the
percentage was 51.5%. This discrepancy is smaller within other examined methods.
Concerning identification of the thick biotype, the diagnostic accuracy of this method
showed its sensitivity of 41.2%, while its overall accuracy was 66.7%, and specificity
93.8%, and, unlike the previous parameters, it does not differ from other examined
methods, which indicates that the possibility of erroneous identification of a thin biotype by
this method was far greater than that of a thick one.

According to different authors, a much more suitable method for determining
gingival biotype, is periodontal probing. The procedure is quite simple, with precise
clinical parameters, which reduces possibility of subjective assessments in contrast to the
visual method. On the other hand, it is less invasive compared to the trans-gingival and
direct method. The trans-gingival method requires application of anesthesia in an examined
area, while the direct method can be used only during surgical intervention and cannot be
used to determine the gingival biotype in order to plan and predict the success of the future
treatment. The results of this study show that the concordance of the measurements of
periodontal method and the direct one, in determining the thin biotype, is higher than when
using the visual method. Statistical analysis showed that its sensitivity value was higher
compared to the visual method, although still lower compared to trans-gingival method.
Similarly, the value of the overall accuracy was 78.8% and it is higher compared to the
visual method, which gives an advantage to this method for determining the gingival
biotype. On the other hand, it is lower compared to much more invasive trans-gingival
method. For this reason, the method of periodontal probing can be recommended as a
method of choice in everyday routine practice.

The sensitivity of the trans-gingival method, as well as the overall accuracy, is the
highest of all examined methods -100% and 97% respectively, and therefore almost
coincides with the direct method. During the study, a slightly larger deviation in the values
of gingival thickness was observed, compared to the direct method in the thick biotype (> 1
mm), which is explained by incomplete insertion of a needle into the thickened gingival
tissue. However, these discrepancies do not affect the overall results of this study.
Therefore, although invasive, and in the need of local anesthesia of the examined area,
which is considered as a shortcoming of this method, compared to the method of periodontal sounding, it is still more precise, almost at the level of the direct method. In addition, it can also be used for preoperative evaluations.

Conclusion

The periodontal probing can be recommended for gingival biotype determination as a routine method, due to the fact that its sensitivity and overall accuracy (in relation to direct measurement) is higher compared to the visual method, and it is less invasive compared to the trans-gingival method, although not as accurate.
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Table 1. Frequency of different gingival biotypes determined by visual method

| Frequency | Percent | Valid Percent | Cumulative % |
|-----------|---------|---------------|--------------|
| Biotype       | Frequency | Percent  | Valid Percent | Cumulative Percent |
|--------------|-----------|----------|---------------|--------------------|
| Thin biotype | 12        | 36,4     | 36,4          | 36,4               |
| Thick biotype| 21        | 63,6     | 63,6          | 100,0              |
| Total        | 33        | 100,0    | 100,0         |                    |

Table 2. Frequency of different gingival biotypes determined by periodontal probing

| Biotype       | Frequency | Percent  | Valid Percent | Cumulative Percent |
|--------------|-----------|----------|---------------|--------------------|
| Thin biotype | 18        | 54,5     | 54,5          | 54,5               |
| Thick biotype| 15        | 45,5     | 45,5          | 100,0              |
| Total        | 33        | 100,0    | 100,0         |                    |

Table 3. Frequency of different gingival biotypes determined by trans-gingival method

| Biotype       | Frequency | Percent  | Valid Percent | Cumulative Percent |
|--------------|-----------|----------|---------------|--------------------|
| Thin biotype | 17        | 51,5     | 51,5          | 51,5               |

Table 4. Frequency of different gingival biotypes determined by direct method
Table 5. Compatibility of results: Visual method relative to direct method

| Direct nominal | Thin biotype | Thick biotype | Total |
|----------------|--------------|---------------|-------|
| Visual method  |              |               |       |
| Thin biotype   | 7            | 1             | 8     |
| Thick biotype  | 10           | 15            | 25    |
| Total          | 17           | 16            | 33    |

Table 6. Compatibility of results: Periodontal probing relative to direct method

| Direct nominal | Thin biotype | Thick biotype | Total |
|----------------|--------------|---------------|-------|
| Periodontal probing |            |               |       |
| Thin biotype   | 11           | 1             | 12    |
| Thick biotype  | 6            | 15            | 21    |
| Total          | 17           | 16            | 33    |

Table 7. Compatibility of results: Trans-gingival method relative to direct method

|            | Thick biotype | 48,5 | 48,5 | 100,0 |
|------------|---------------|------|------|-------|
| Thick biotype | 16            | 48,5 | 48,5 | 100,0 |
| Total       | 33            | 100,0| 100,0|       |
| Direct nominal | Thin biotype | Thick biotype | Total |
|----------------|-------------|---------------|-------|
| Trans-gingival method | Thin biotype | 17 | 1 | 18 |
| | Thick biotype | 0 | 15 | 15 |
| | Total | 17 | 16 | 33 |

Table 8. Diagnostic accuracy measures of the tested methods in relation to direct method

| Diagnostic accuracy measures | Visual % (95% CI) | Periodontal % (95% CI) | Trans-gingival % (95% CI) |
|-----------------------------|-------------------|--------------------------|---------------------------|
| Sensitivity (Se)            | 41,2 (18,4-67,1)  | 64,7 (38,3-85,8)         | 100,0 (72,7-100,0)        |
| Specificity (Sp)            | 93,8 (69,8-99,8)  | 93,8 (69,8-99,8)         | 93,8 (69,8-99,8)          |
| Overall accuracy            | 66,7 (48,2-82,0)  | 78,8 (61,1-91,0)         | 97,0 (84,2-99,9)          |
Figure 4.

Figure 5.
Figure 6.

Figure 1. Thick gingival biotype.

Figure 2. Thin gingival biotype. Note the gingival recessions on teeth 11, 21 and 22 – a common clinical finding associated with the thin gingival biotype.

Figure 3. Periodontal examination of gingiva thickness.

Figure 4. Trans-mucosal probing

Figure 5. Direct measurement.
Figure 6. Graphical presentation of the overall accuracy of the tested methods.