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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 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 the reliability of accurate gingival biotype determination with the use of the visual method, periodontal, and trans-gingival probing compared to the direct measurement method. **Methods.** This prospective study involved 33 patients indicated for apical root resection in the intercanine sector of the upper jaw. Gingival biotype identification was performed in all patients using the following techniques: 1) visual method; 2) periodontal probe technique; 3) trans-gingival probing; and 4) direct measurement after flap elevation. 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 the visual method, 78.8% for periodontal probing, and 97.0% for trans-mucosal probing. **Conclusion.** The periodontal probing method can be recommended for gingival biotype determination as a routine method since its sensitivity and overall accuracy are 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 the periodontal probing method, and it has to be conducted in local anesthesia.

Key words:
evaluation study; gingiva; methods; periodontium; phenotype; surgery, oral.

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 rada bio je da se proceni pouzdanost određivanja biotipa gingive primenom vizuelne metode i metoda parodontalnog i transgingivalnog sondiranja u odnosu na direktnu metodu merenja. **Metode.** Prospektivnom studijom obuhvaćena su 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 parodontalnog sondiranja; 3) tehnike transgingivalnog sondiranja i 4) direktnog merenja nakon odizanja režnja. Statistička analiza dobijenih podataka izvršena je radi procene dijagnostičke tačnosti vizuelne metode, parodontalnog 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%; parodontalno sondiranje – 78,8%; transmukozno sondiranje – 97,0%. **Zaključak.** Parodontalna metoda

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sondiranja može se preporučiti za određivanje biotipa gingive kao rutinska metoda, s obzirom da je njena senzitivnost i ukupna tačnost veća u odnosu na vizuelnu metodu. U pogledu senzitivnosti i sveobuhvatne tačnosti, transgingivalna metoda se gotovo u potpunosti poklapa sa direktnom metodom, ali je invazivnija u poređenju sa metodom parodontalnog sondiranja i mora se sprovesti uz prethodnu primenu lokalne anestezije.

Ključne reči:
procena, istraživanja; gingiva; metodi; periodoncijum; fenotip; hirurgija, oralna.

Introduction

In recent years, the characteristics of the oral mucosa, especially gingival thickness, have 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 [1–3]. The first analysis of gingival anatomy in this sense was given in 1969 by Ochsenbein and Ross [4], who described two main types of gingival morphology: flat and thick, and thin and scalloped gingiva. They have indicated a connection between the gingival contour and the contour of the underlying alveolar bone. Based on this classification, Seibert and Lindhe [5] later introduced the term "periodontal biotype", which further categorized gingiva into thick-flat and thin-scalloped biotypes.

After observing different variations of keratinized tissue and with the increasing use of dental implants, in 1997, Müller and Eger [6] joined the term gingival and periodontal biotype into a soft tissue biotype, which includes both tooth tissue and tissue around implants.

In general, it can be said that a gingival thickness of ≤ 1 mm is defined as a thin biotype and a gingival thickness of ≥ 1 mm as a thick biotype [7]. A 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, is more resistant to trauma and thus to recessions, and is much easier to be manipulated during surgical procedures. 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. It is usually characterized by bone defects, such as dehiscence and fenestration underneath, and is less resistant to inflammation and trauma [8, 9].

Numerous studies [8, 10–14] have shown that gingival biotype can have a significant impact on the outcome of the therapeutic procedures and the predictability of the aesthetic outcome. There is a strong correlation between gingival biotype and possible gingival recession after restorative, periodontal, and implant surgical procedures. Therefore, accurate identification of gingival biotype before initiating these procedures is one of the essential predictive factors for their success. In that sense, there is a number of methods for determining the gingival biotype: the visual method [2, 10], biotype identification method with the use of periodontal probe [11], direct measurement of the gingival thickness [15], trans-gingival probing [16], ultrasonic measurement and cone-beam computed tomography (CBCT) radiographic examination [17–21].

The aim of this study was to evaluate the reliability of the gingival biotype determination by using the 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 Priština/Kosovska Mitrovica, Kosovska Mitrovica, Serbia, and the private dental practice "Radix" in Kruševac, 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 were previously indicated for apical surgery in the intercanine sector of the upper jaw due to chronic periapical lesions that could not be treated endodontically. In addition, an important parameter was the existing indication for the use of a 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, such as soft tissue augmentation, treatment for gingival recessions, or esthetic extension of the clinical tooth crowns. Patients with fixed prosthetic works, marginal gingiva inflammation, systemic diseases, and bad habits that could compromise the results, such as smoking, alcoholism, or oral breathing due to airway obstruction, were excluded from the study. Systemic therapy with medications that might affect 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, the central in 11 patients, and the canine in 5 patients. The evaluation was performed first by visual method and then by periodontal probing. After administrating infiltration anesthesia to perform oral surgery, gingival biotype identification was performed using trans-gingival probing. In the end, immediately after the full-thickness mucoperiosteal flap elevation, a direct measurement of gingival thickness was performed using a modified caliper. The entire testing procedure was performed by the same researcher.

Visual method

A 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 also by observing 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 (Figure 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 (Figure 2).

Fig. 1 – Thick gingival biotype.

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

Periodontal probing

Periodontal assessment of gingival biotype was performed using a 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 (Figure 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 [11].

Fig. 3 – Periodontal examination of gingiva thickness.

Trans-gingival probing

Gingival biotype assessment, using trans-gingival (mucosal) probing, was done by measuring its thickness with a root canal instrument number 25 with a rubber stopper (K-file Maillefer, Dentsply). After applying 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 (Figure 4). After that, the distance from the tip of the needle to the rubber stopper was measured with a millimeter ruler, based on 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 [22].

Fig. 4 – Trans-gingival probing.

Direct measurement

The modified caliper with a millimeter ruler (Wax caliper, Odontomed), with tips blunted to minimize the pressure and trauma to the soft tissue, was used for the direct measurement of the gingival thickness (Figure 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, based on which the gingival biotype was classified, namely: thick biotype – gingival thickness was > 1 mm; thin biotype – gingival thickness was < 1mm [7].

Fig. 5 – Direct measurement.

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, 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-gingival probing methods for discrimination of gingival thickness biotype (thin to thick), measures of sensitivity, specificity, and overall accuracy, in relation to direct measurement, were applied.

Although invasive, the direct method of measurement 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). For this reason, we can agree that a borderline value between the gingival thickness for thin and thick gingival biotypes could be considered 1 mm.

By examining the gingival biotype in 33 patients with 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 most and a thick one in the least number of respondents (Table1). Direct measurements of the gingival thickness, however, resulted in a thin biotype in 51.5% of respondents and a thick one in 48.5% (Table 1).

When examining the diagnostic accuracy of different methods for identifying a thin biotype, the compatibility of results between visual and direct methods 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 hand, the accuracy of this method in identifying the thick biotype was noticed in 15 out of 16 cases identified using the direct method, which indicates a specificity value of 93.8%. Based on the presented results, the calculated overall accuracy value was 66.7% (Tables 2 and 3).

Table 1

Frequency of different gingival biotypes determined by visual method, periodontal probing, trans-gingival method and direct methods

Method	Frequency	Percent	Valid percent	Cumulative percent
Visual				
thin biotype	8	24.2	24.2	24.2
thick biotype	25	75.8	75.8	100.0
Total	33	100.0	100.0	
Periodontal probing				
thin biotype	12	36.4	36.4	36.4
thick biotype	21	63.6	63.6	100.0
Total	33	100.0	100.0	
Trans-gingival				
thin biotype	18	54.5	54.5	54.5
thick biotype	15	45.5	45.5	100.0
Total	33	100.0	100.0	
Direct				
thin biotype	17	51.5	51.5	51.5
thick biotype	16	48.5	48.5	100.0
Total	33	100.0	100.0	

Table 2

Compatibility of results: visual method, periodontal probing, and trans-gingival probing in relation to the direct method

Method	Direct nominal		Total
	thin biotype	thick biotype	
Visual			
thin biotype	7	1	8
thick biotype	10	15	25
Total	17	16	33
Periodontal probing			
thin biotype	11	1	12
thick biotype	6	15	21
Total	17	16	33
Trans-gingival probing			
thin biotype	17	1	18
thick biotype	0	15	15
Total	17	16	33

Table 3

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

Diagnostic accuracy measures	Visual method	Periodontal probing	Trans-gingival probing
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)

Results are given as mean (95% confidence interval).

With the use of the periodontal probing method, a thin gingival biotype was diagnosed in 11 out of 17 cases determined by 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 2 and 3).

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 2 and 3).

Discussion

Gingival biotype is an important clinical parameter that can affect not only the success but also the 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 [6, 22, 23]. A similar phenomenon has also been noticed in the peri-implant mucosa [24]. 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 a 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 [25]. In addition, Hwang and Wang [26] 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 [27]. Finally, the success of numerous periodontal procedures for the coverage of gingival recessions is significantly lower in patients with a thin gingival genotype [27, 28]. Bearing in mind all the mentioned data concerning the significance of the 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 alone. This is the main reason why the precision of this method is insufficient compared to the others available to clinicians [9]. 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 in other examined methods. Concerning the 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%. In addition, 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 [6, 7]. The procedure is quite simple, with precise clinical parameters, which reduces the 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 methods. The trans-gingival method requires the application of anesthesia in an examined area, while the direct method can be used only during the 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 the periodontal and the direct method 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 the 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 the 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 the 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 need of local anesthesia of the examined area, which is considered a shortcoming of this method, compared to the method of periodontal probing, it is still more precise, almost at the level of the direct method. In addition, it can be used for preoperative evaluations.

This almost coincides with the findings of Kan et al. [7], who found the average gingival thickness of 1.06 mm.

Conclusion

The periodontal probing can be recommended for gingival biotype determination as a routine method because its sensitivity and overall accuracy (in relation to direct measurement) are 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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