Journal of Clinical Periodontology
Official Journal of The European Federation of Periodontology
Founded by the British, Dutch, French, German, Scandinavian, and Swiss Societies of Periodontology

J Clin Periodontol 2009; 36: 958–963 doi: 10.1111/j.1600-051X.2009.01479.x

The gingival biotype assessed by experienced and inexperienced clinicians

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Eghbali A, De Rouck T, De Bruyn H, Cosyn J. The gingival biotype assessed by experienced and inexperienced clinicians. J Clin Periodontol 2009; 36: 958–963. doi: 10.1111/j.1600-051X.2009.01479.x.

Abstract

Aim: A recent cluster analysis has identified three gingival biotypes among 100 periodontally healthy subjects based on different combinations of morphometric data related to maxillary front teeth and surrounding soft tissues. Patients with a thin-scalloped biotype are considered at risk because they have been associated with a compromised soft tissue response following surgical and/or restorative therapy. Hence, an accurate identification of these high-risk patients is warranted. The purpose of the present study was to evaluate the precision of simple visual inspection as a method to identify the gingival biotype by experienced and inexperienced clinicians.

Material and Methods: Fifteen clinicians (five Restorative Dentists, five Periodontists and five Students) were invited to assess the gingival biotype (thin-scalloped, thick-flat, thick-scalloped) of 100 periodontally healthy subjects based on clinical slides. Cluster analysis on these subjects was used as the gold standard and the accuracy in identifying the gingival biotype was determined using percentile agreement and κ statistics. Intra- and inter-examiner reliability were also calculated.

Results: The gingival biotype was accurately identified only in about half of the cases irrespective of the clinician's experience. The thick-flat biotype was mostly recognized especially by experienced clinicians ($\geqslant$70% of the cases). Nearly half of the thin-scalloped cases were misclassified. The intra-examiner repeatability was fair to substantial (κ: 0.328–0.670) and the inter-examiner reproducibility was slight to moderate (κ: 0.127–0.547).

Conclusions: Simple visual inspection may not be considered a valuable method to identify the gingival biotype as nearly half of the high-risk patients are overlooked.

Key words: biotype; experience; gingival; visual inspection

Accepted for publication 23 August 2009

Several studies have been conducted using cluster analysis to identify groups of subjects with different combinations of morphometric data related to maxillary front teeth and surrounding soft tissues (Müller & Eger 1997, Müller et al. 2000, De Rouck et al. 2009). In these reports, two extreme so-called ''gingival biotypes'' could be recognized with a slightly scalloped gingival margin, short and wide teeth on the one hand and a thin, highly scalloped gingival margin with slender teeth on the other. Even though the remaining third group had basically one or more characteristics in common with these extreme biotypes, its specific morphometric features showed less resemblance among the studies.

In clinical practice, the identification of the gingival biotype is considered important because differences in gingival and osseous architecture have been shown to exhibit a significant impact on the outcome of restorative therapy. That is Pontoriero & Carnevale (2001) observed that natural teeth showed more soft tissue regain following crown lengthening procedures in patients with a thick gingiva than in those with a thin gingiva. This observation is in line with a higher prevalence of gingival recession in the latter as reported by Olsson & Lindhe (1991). The gingival biotype has also been described as one of the key elements decisive for success of implant restorations (Kois 2004). In particular, papilla

Conflict of interests and source of funding

The authors declare that they have no conflict of interests.
The study was supported by the dental department of the Free University of Brussels (VUB).

presence between immediate single-tooth implants and adjacent teeth was significantly correlated with a thick peri-implant mucosa (Romeo et al. 2008). A trend towards more gingival recession at immediate single-tooth implant restorations in patients with a thin peri-implant mucosa was also described (Evans & Chen 2008). Similarly, more gingival recession was found following regenerative surgery in patients with a thin gingiva (Anderegg et al. 1995, Baldi et al. 1999). These observations illustrate that disparities in aesthetic treatment outcome could arise as a result of variability in tissue response to surgical trauma. Especially patients with a thin-scalloped biotype seem at risk for aesthetic failure and therefore need to be accurately identified. Usually, simple visual inspection is used in clinical practice and even in research to lift out these high-risk patients. However, the precision of this method has never been documented. The purpose of this study was to evaluate this in 100 subjects using cluster analysis performed earlier on these subjects as the gold standard and to explore the impact of the clinician's experience. The research hypothesis was that the vast majority of the thin-scalloped biotype cases would be correctly identified by visual inspection.

Material and Methods

Clinicians

Fifteen clinicians of the Free University in Brussels (VUB) were asked to identify the gingival biotype in 100 subjects. Among them, five men (mean age: 33 years) were specialists in Restorative Dentistry (R) involved in the theoretical and clinical training programme of graduate and postgraduate students. These clinicians had experience in prosthetic treatment strategies including tooth-supported and implant-supported restorations. Another five experienced clinicians (three men, two women; mean age: 38 years) had been trained in periodontology and oral implantology (P). These specialists were also involved in the theoretical and clinical training programme of graduate and postgraduate students. In addition, they showed expertise in the surgical part of implant therapy. Finally, five inexperienced clinicians (three men, two women; mean age: 24 years) (S) in the final year of the graduate programme in dentistry participated.

Cases

Clinical slides of 100 subjects were used to evaluate the accuracy in identifying the gingival biotype by the 15 clinicians. A slide per subject with cheek retractors was taken of the anterior teeth and surrounding tissues in optimal occlusion. Slides were taken by the same investigator (A. E.) 1 week following oral hygiene instructions and thorough dental prophylaxis. All subjects were medical students at the Free University in Brussels (VUB) with all maxillary incisors present. Exclusion criteria were as follows:

(i) subjects with crown restorations or fillings involving the incisal edge on the anterior maxillary teeth,
(ii) pregnant or lactating female volunteers,
(iii) subjects taking medication with any known effect on the periodontal soft tissues,
(iv) volunteers with clinical signs of periodontal disease defined as having pockets exceeding 3 mm.

The gingival biotype for each of these subjects was determined on the basis of a cluster analysis (k-means clustering) categorizing them into three groups, with different combinations of morphometric data related to central maxillary incisors and surrounding soft tissues. Four morphometric parameters recorded by the same clinician (A. E.) were included in this analysis: crown width/crown length ratio, gingival width, papilla height and gingival thickness based on the transparency of the periodontal probe through the gingival margin while probing the buccal sulcus. A clear thin gingiva was found in about one-third of the sample in mainly female subjects with slender teeth, a narrow zone of keratinized tissue and a highly scalloped gingival margin corresponding to the features of the thin-scalloped biotype (Fig. 1). A clear thick gingiva was found in about two-thirds of the sample in mainly male subjects. About half of them showed quadratic teeth, a broad zone of keratinized tissue and a flat gingival margin corresponding to the features of the thick-flat biotype (Fig. 2). The other half could not be classified as such. These subjects showed a clear thick gingiva with slender teeth, a narrow zone of keratinized tissue and a high gingival scallop. This group could be defined as the thick-

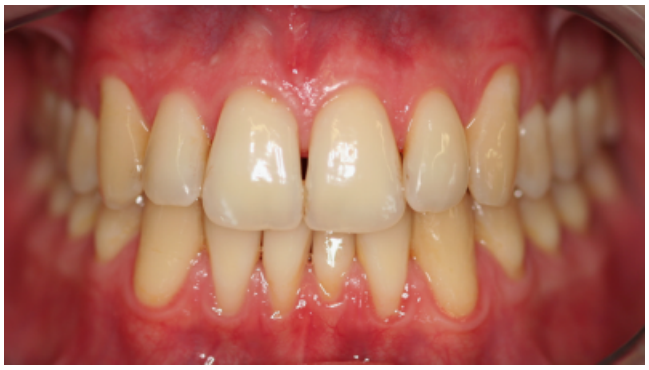

Fig. 1. Clinical example of a subject with a thin-scalloped gingival biotype.

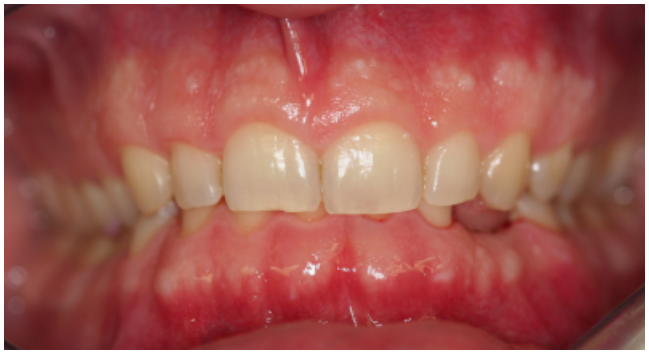

Fig. 2. Clinical example of a subject with a thick-flat gingival biotype.

scalloped biotype (Fig. 3). Detailed information on the results of this partitioning method can be found in a recent publication (De Rouck et al. 2009). The cluster analysis was used as the gold standard in the present study.

Scoring

All clinicians were invited in a conference room for a 1-h update on gingival biotypes. Essentially, the results of the cluster analysis (De Rouck et al. 2009) were discussed in detail focusing on the specific features of each biotype using unambiguous clinical pictures as shown in Figs 1–3. Borderline cases were not included in this discussion. Thereupon, clinicians were asked to assign one of the three biotypes (thin-scalloped, thick-flat, thick-scalloped) to each case. This was carried out by showing the clinical slide of each subject on a large screen in a dark room. An image was projected for 20 s. After having scored the cases, all 100 were scored a second time in a randomized order. None of the clinicians had been informed of this double scoring.

Statistical analysis

For each clinician, the accuracy in identifying the gingival biotype was assessed using percentile agreement and κ statistics. Disparities between the three groups of clinicians (R, P, S) were evaluated on the basis of κ values using the Kruskal–Wallis test. Precision in scoring when considering the positive cases for each of the three gingival biotypes was evaluated using percentile agreement. Intra-examiner repeatability and inter-examiner reproducibility were examined using percentile agreement and κ statistics. The level of significance was set at 5%.

Results

Accuracy in identifying the gingival biotype

Table 1 shows in how many cases each clinician correctly identified the gingival biotype. Only about half of them were accurately scored with clinician P4 scoring worst (42%) and clinician P3 best (64%). The corresponding κ values ranging from 0.144 (P4) to 0.457 (P3) were indicative of a slight to fair precision as defined by Landis & Koch (1977). Figure 4 illustrates this for Restorative Dentists, Periodontists and Students.

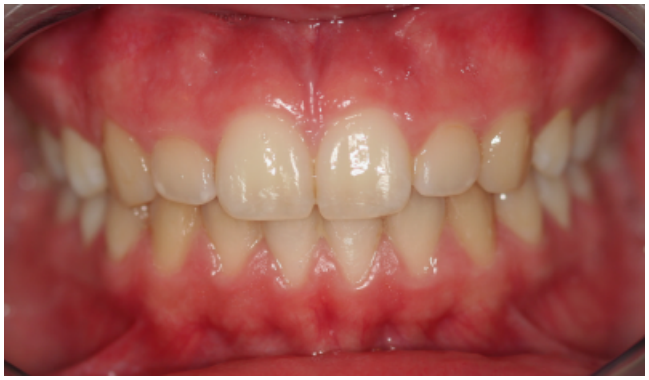

Fig. 3. Clinical example of a subject with a thick-scalloped gingival biotype.

Table 1. Accuracy in identifying the gingival biotype

Clinician	Percentage of cases correctly identified	κ (p-value)
R1	51	0.268 (0.000)
R2	48	0.259 (0.000)
R3	53	0.278 (0.000)
R4	56	0.347 (0.000)
R5	57	0.366 (0.000)
P1	52	0.298 (0.000)
P2	47	0.212 (0.002)
P3	64	0.457 (0.000)
P4	42	0.144 (0.029)
P5	49	0.245 (0.000)
S1	50	0.247 (0.000)
S2	47	0.205 (0.003)
S3	49	0.235 (0.000)
S4	54	0.223 (0.002)
S5	58	0.373 (0.000)

R, Restorative Dentist; P, Periodontist; S, Student.

There were no significant differences between the three groups of clinicians ($p = 0.326$).

Table 2 presents the precision in scoring when considering the positive cases for each of the three gingival biotypes. On average, 52% of the thin-scalloped cases were accurately identified by the Restorative Dentists. The equivalent proportion was 61% for Periodontists and 57% for Students, respectively.

By and large, the thick-flat biotype seemed most frequently recognized especially by experienced clinicians. On average 73% and 70% of these cases were accurately identified by Restorative Dentists and Periodontists, respectively. This was 51% for Students.

The thick-scalloped biotype was seldom recognized. On average 45% of the thick-scalloped cases were accurately identified by Restorative Dentists. For Periodontists, this was only 26% and for Students 43%.

Intra-examiner repeatability

Tables 3 and 4 present the intra-examiner repeatability data. Agreement between the first and second scoring ranged from 57% (P2) to 78% (R5). The corresponding κ values ranging from 0.328 (P2) to 0.670 (R5) were indicative of fair to substantial agreement as defined by Landis & Koch (1977).

Inter-examiner reproducibility

Tables 3 and 4 present the inter-examiner reproducibility data. The lowest agreement was found between R2 and S4 (34%) and between P4 and S4 (34%). As the corresponding κ values (0.094 and 0.070, respectively) were not significant ($p = 0.061$, 0.248, respectively), the agreement between these clinicians was inflicted by chance.

R5–S5 and P5–S3 showed the highest percentile agreement (72%). The highest κ value was found for R4–R5 (0.547); the lowest for R2–R3 (0.127). This range was indicative of a slight to moderate agreement as defined by Landis & Koch (1977).

Discussion

The gingival biotype is gaining considerable attention as one of the key elements influencing aesthetic treatment outcome. Patients with a thick gingiva have been shown to be relatively resistant to gingival recession following surgical and/or restorative therapy (Anderegg et al. 1995, Baldi et al. 1999, Pontoriero & Carnevale 2001, Evans & Chen 2008). A thick peri-implant mucosa also appeared decisive for papilla presence between immediate single-tooth implants and adjacent teeth (Romeo et al. 2008). However, a thick biotype was never sub-classified. This

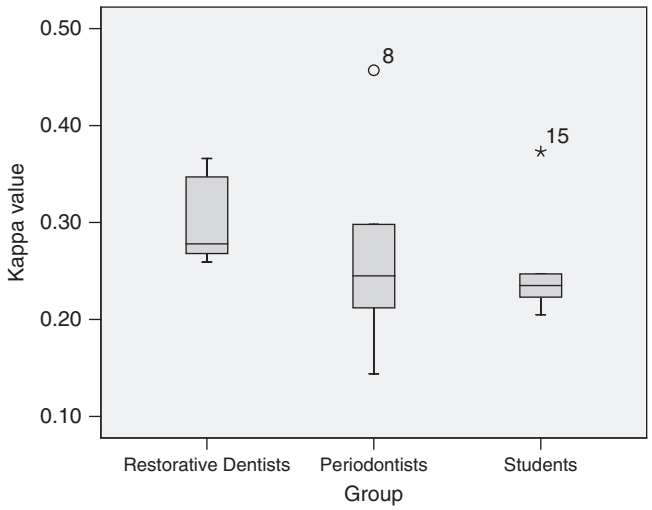

Fig. 4. Boxplot illustrating precision in identifying the gingival biotype by experienced clinicians (Restorative Dentists and Periodontists) and inexperienced clinicians (Students). Note one outlier in the group of Periodontists (P3) and one in the group of Students (S5).

Table 2. Accuracy in scoring when considering the positive cases for each gingival biotype

Clinician	Percentage of thin-scalloped biotype cases correctly identified	Percentage of thick-flat biotype cases correctly identified	Percentage of thick-scalloped biotype cases correctly identified
R1	44	66	46
R2	62	93	35
R3	62	41	54
R4	44	80	49
R5	47	86	43
P1	50	76	35
P2	53	62	30
P3	80	66	49
P4	44	76	8
P5	76	69	8
S1	50	55	46
S2	50	52	41
S3	65	52	32
S4	59	28	49
S5	59	69	49

R, Restorative Dentist; P, Periodontist; S, Student.

Table 3. Intra-examiner and inter-examiner agreement (percentages)

	R1	R2	R3	R4	R5	P1	P2	P3	P4	P5	S1	S2	S3	S4	S5
R1	*59*	37	56	61	60	59	47	53	40	48	56	54	55	45	55
R2		*74*	40	56	61	54	50	47	58	64	44	46	49	34	55
R3			*64*	52	53	49	48	61	46	49	60	54	62	55	54
R4				*73*	71	60	53	60	51	54	55	54	57	47	70
R5					*78*	63	56	53	58	54	48	67	50	44	72
P1						*65*	57	57	49	57	56	57	52	41	62
P2							*57*	58	49	60	54	47	67	48	60
P3								*72*	50	61	62	53	60	62	64
P4									*63*	58	47	48	47	34	47
P5										*77*	49	56	72	50	60
S1											*62*	51	57	49	62
S2												*70*	51	55	54
S3													*72*	59	67
S4														*65*	54
S5															*74*

R, Restorative Dentist; P, Periodontist; S, Student.

could become important because a recent study has shown that a thick gingiva essentially comes with low or high gingival scalloping (De Rouck et al. 2009). In this respect, patients with a thick-flat biotype demonstrate short papillae whereas those with a thick-scalloped biotype show long papillae. Such morphometric disparity could potentially result in more papilla loss in the latter. Evidently, the actual impact of the two traits–tissue thickness and gingival scalloping–on treatment outcome specifically with reference to papillae, needs to be elucidated in future studies in which the gingival biotype is properly identified and classified.

In contrast to patients with a clear thick gingiva, those with a thin-scalloped biotype are considered at risk as they have been associated with a compromised soft tissue response following surgical and/or restorative treatment (Olsson & Lindhe 1991, Anderegg et al. 1995, Baldi et al. 1999, Pontoriero & Carnevale 2001, Kois 2004, Evans & Chen 2008, Romeo et al. 2008). In this regard, an accurate identification of these high-risk patients is warranted. The purpose of the present study was to evaluate the precision of simple visual inspection as a method to identify the gingival biotype by experienced and inexperienced clinicians.

In only about half of the cases, the gingival biotype was recognized with no significant difference between experienced and inexperienced clinicians. This is surprising given the probability for pointing the correct biotype would be one in three by chance alone. Insight on why our findings only fairly surpassed this probability was gained by scrutinizing the data on the positive cases for each biotype. This analysis showed that the thick-flat biotype was most easily recognized. At least 70% of these cases were accurately identified by experienced clinicians. Students only recognized half of them, suggesting a possible impact of the clinician's experience. When considering the thin-scalloped and thick-scalloped cases lower precision was found pointing to 52–61% and 26–45%, respectively. More misclassifications were expected for the latter because the thick-scalloped biotype has features in common with both other, more extreme biotypes. Crucial are the results on the thin-scalloped cases, which can be considered problematic because only about half of these actual high-risk patients were correctly noticed. As a result, our research

Table 4. Intra-examiner and inter-examiner agreement (κ statistics)

	R1	R2	R3	R4	R5	P1	P2	P3	P4	P5	S1	S2	S3	S4	S5
R1	*0.388 (0.000)*	0.197 (0.003)	0.342 (0.000)	0.409 (0.000)	0.391 (0.000)	0.387 (0.000)	0.195 (0.006)	0.292 (0.000)	0.206 (0.003)	0.199 (0.002)	0.304 (0.000)	0.306 (0.000)	0.316 (0.000)	0.231 (0.001)	0.319 (0.000)
R2		*0.560 (0.000)*	0.127 (0.026)	0.306 (0.000)	0.367 (0.000)	0.267 (0.000)	0.183 (0.015)	0.179 (0.006)	0.289 (0.000)	0.339 (0.000)	0.178 (0.004)	0.166 (0.014)	0.158 (0.029)	0.094 (0.061)	0.292 (0.000)
R3			*0.408 (0.000)*	0.294 (0.000)	0.324 (0.000)	0.254 (0.000)	0.215 (0.001)	0.370 (0.000)	0.189 (0.000)	0.183 (0.003)	0.382 (0.000)	0.290 (0.000)	0.387 (0.000)	0.314 (0.000)	0.302 (0.000)
R4				*0.571 (0.000)*	0.547 (0.000)	0.391 (0.000)	0.276 (0.000)	0.402 (0.000)	0.234 (0.001)	0.279 (0.000)	0.330 (0.000)	0.306 (0.000)	0.347 (0.000)	0.282 (0.000)	0.543 (0.000)
R5					*0.670 (0.000)*	0.429 (0.000)	0.316 (0.000)	0.320 (0.000)	0.330 (0.000)	0.276 (0.000)	0.233 (0.000)	0.504 (0.000)	0.248 (0.000)	0.214 (0.000)	0.418 (0.000)
P1						*0.459 (0.000)*	0.339 (0.000)	0.358 (0.000)	0.198 (0.007)	0.312 (0.000)	0.352 (0.000)	0.356 (0.000)	0.264 (0.000)	0.192 (0.002)	0.426 (0.000)
P2							*0.328 (0.000)*	0.349 (0.000)	0.191 (0.009)	0.336 (0.000)	0.307 (0.000)	0.171 (0.000)	0.476 (0.000)	0.264 (0.000)	0.382 (0.000)
P3								*0.538 (0.000)*	0.232 (0.001)	0.335 (0.000)	0.411 (0.000)	0.264 (0.000)	0.332 (0.000)	0.433 (0.000)	0.443 (0.000)
P4									*0.397 (0.000)*	0.289 (0.000)	0.206 (0.002)	0.201 (0.004)	0.158 (0.024)	0.070 (0.248)	0.174 (0.015)
P5										*0.570 (0.000)*	0.210 (0.001)	0.290 (0.000)	0.492 (0.000)	0.252 (0.000)	0.351 (0.000)
S1											*0.406 (0.000)*	0.255 (0.000)	0.333 (0.000)	0.245 (0.001)	0.426 (0.000)
S2												*0.539 (0.000)*	0.256 (0.000)	0.291 (0.000)	0.312 (0.000)
S3													*0.523 (0.000)*	0.395 (0.000)	0.481 (0.000)
S4														*0.503 (0.000)*	0.357 (0.000)
S5															*0.597 (0.000)*

R, Restorative Dentist; P, Periodontist; S, Student; κ (p-value).

hypothesis was rejected hereby concluding that simple clinical inspection cannot be considered an appropriate method for identifying the gingival biotype. This is further substantiated by the fair intra-examiner agreement of some clinicians and the overall slight to moderate inter-examiner agreement when considering κ values. Clearly, the assessment of the gingival biotype should include some method to discriminate a thin from thick gingiva as numerous high-risk patients may otherwise be overlooked. An ultrasonic device could be used for this purpose. Although this non-invasive method proved to be reproducible (Eger et al. 1996), drawbacks include difficulties in maintaining the directionality of the transducer (Daly & Wheeler 1971), unavailability of the device (Vandana & Savitha 2005) and high costs. An easy and reproducible alternative which may be particularly interesting in clinical practice is based on the transparency of a periodontal probe through the gingival margin (De Rouck et al. 2009).

Visual inspection is a part of clinical examination. As it would be impossible to examine 100 subjects by 15 clinicians, clinical slides were used to simulate visual inspection in this study. We acknowledge this as a drawback as slides only provide a two-dimensional view. This could have negatively influenced our findings on the precision of clinical inspection as a method to identify the gingival biotype. Apart from the assessment of gingival thickness, however, the evaluation of the crown form, gingival width and papilla height could not have been affected by this. This highlights once again that it is fairly impossible to recognize the gingival biotype without information on gingival thickness, except for obvious thick-flat cases.

Another issue relates to possible confounding bias as the biotypes were not equally distributed among the genders. However, because all cases had been scored without details on demographics, we believe gender may not have been a relevant confounder.

A final limitation relates to the cluster analysis, which was considered the gold standard in this study. Evidently, the use of such a gold standard is necessary when the precision of a new method is evaluated. An ideal gold standard would identify the true gingival biotype for each case; however, it is uncertain whether a cluster analysis fits this description as it is only considered an exploratory method for grouping data of

similar kind into respective categories. Other methods besides cluster analysis have not been used in research to classify gingival biotypes.

In conclusion, 15 clinicians were asked to identify the gingival biotype of 100 periodontally healthy subjects based on clinical slides. The biotype was only in about half of the cases accurately identified irrespective of the clinician's experience. The thick-flat biotype was mostly recognized especially by experienced clinicians. Nearly half of the thin-scalloped cases were misclassified, which is problematic as these include the actual subjects at risk for aesthetic complications following surgical and/or restorative therapy. As a result, simple visual inspection may not be considered a valuable method to identify the gingival biotype. The results suggest that some other method is to be used to discriminate a thin from thick gingiva. Given the outcome of this study, details on the determination of the gingival biotype should be reported in scientific papers.

Acknowledgements

We wish to thank all clinicians for scoring the cases included in this study.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Supporting information in accordance with the CONSORT Statement 2001 checklist used in reporting randomized trials.

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Clinical Relevance

Scientific rationale: The gingival biotype is usually assessed by means of simple visual inspection. However, the precision of this method has never been documented.

Principal findings: In only about half of the cases, the biotype was accurately identified by a panel of 15 experienced and inexperienced clinicians. The thick-flat biotype was mostly recognized especially by experienced clinicians, whereas nearly half of the thin-scalloped cases were misclassified.

Practical implications: The results suggest that some other method is to be used to discriminate a thin from thick gingiva. Details on the determination of the gingival biotype should be reported in scientific papers.