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Original Article

Impact of Gingival Phenotype on the Periodontal Disease

Zdravka Pashova-Tasseva[1], Antoaneta Mlachkova[1], Ekaterina Tosheva[2]

[1] *Department of Periodontology, Faculty of Dental Medicine, Medical University of Sofia, Sofia, Bulgaria*
[2] *Faculty of Applied Informatics and Statistics, University of National and World Economy, Sofia, Bulgaria*

Corresponding author: Zdravka Pashova-Tasseva, Department of Periodontology, Faculty of Dental Medicine, Medical University of Sofia, Sofia, Bulgaria; Email: z.pashova@abv.bg; Tel.: +359 878 180 262

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Abstract

Aim: The aims of the present study were to explore the relations between the gingival phenotype (GP) and the periodontal health status and find the prevalence of a specific gingival phenotype in a small Bulgarian population.

Materials and methods: We recruited 50 patients attending our dental practice with different periodontal diagnoses. A detailed periodontal status was taken to assess the diagnosis of each participant. Several clinical methods for evaluation of the gingival thickness and keratinized tissue width, including the TRAN method, transgingival probing, and direct measurement, were used. The data were summarized and analyzed statistically.

Results: We found a significant prevalence of the thick gingival phenotype, in particular the thick flat type. The patients with periodontitis had a higher distribution of the thick gingival phenotype, while in those with gingivitis, the thin scalloped gingival phenotype was noted. In regards to the gingival thickness (GT), 36 participants were found to have GT >1 mm, and the remaining 14 had GT ≤1 mm. Statistically significant differences were found in the keratinized tissue width and the width of attached gingiva in the different gingival phenotypes. No significant differences were found in the age and sex of participants.

Conclusions: We found a significant prevalence of the thick (with a mild prevalence of thick flat to thick scalloped) versus thin gingival phenotype in the studied sample. The highest relative proportion of patients with periodontitis was among the subsample of individuals with thick flat gingival phenotype. Regarding gingivitis, the highest proportion was in the thin scalloped phenotype subsample – 42.9%. The highest prevalence of periodontal health was among the individuals with thick scalloped GP (50%), followed by the thin scalloped GP (35.7%).

Keywords

gingival phenotype, gingival thickness, keratinized tissue width, periodontal phenotype, width of attached gingiva

Abbreviations

KTW: keratinized tissue width	**CAL:** clinical attachment loss
GT: gingival thickness	**BL:** bone loss
BM: bone morphotype	**FMPS:** full mouth plaque score
KT: keratinized tissue	**FMBS:** full mouth bleeding score
PP: periodontal phenotype	**BOP:** bleeding on probing
WAG: width of attached gingiva	**PPD:** probing pocket depth
GP: gingival phenotype	**R:** recession

INTRODUCTION

A significant challenge in routine clinical practice is identifying a patient's individual anatomical characteristics. When a dental practitioner considers the most adequate treatment approach, they frequently are faced with the difficulty of recognizing the factors that might contribute to long-term success.[1] Between the constellation of reasons for clinical failure or success, a major impact has the periodontal phenotype. This anatomical factor determines the clinical outcome after restorative, prosthetic, orthodontic, surgical, and periodontal treatment. Three important categories can describe the periodontal phenotype – the keratinized tissue width (KTW), the gingival thickness (GT), and the bone morphotype (BM).[2]

A recent 2017 classification of periodontal and peri-implant diseases and conditions highlights the change of the term periodontal biotype to periodontal phenotype. Three types of periodontal phenotype have been introduced, classified by the specificity of the teeth, the mucogingival complex, and bone morphotype. The thin scalloped phenotype is described by slender triangular tooth crowns, subtle cervical convexity, interproximal contacts located closer to the incisal edge, a narrow zone of keratinized tissue (KT), delicate and thin gingiva, and relatively thin alveolar bone. The thick flat periodontal phenotype is characterized by a square-shaped tooth crowns, pronounced cervical convexity, large interproximal contact point located more apically, a wide zone of KT, thick, resilient, fibrotic gingival tissues, and a relatively thick alveolar bone plate. The description of the thick scalloped periodontal phenotype (PP) consists of a thick fibrotic gingiva, slender teeth, narrow zone of KT, and a pronounced gingival scalloping.[2] The clinical significance of the periodontal tissues and the search of different strategies to improve its quality leads to the development of a variety of clinical approaches for periodontal phenotype modification.[3,4]

Many methods for evaluation of the periodontal phenotype have been introduced in the last decades. The recent methods are based on different approaches – the transgingival probing, visual method, ultrasonic method and many others, but the most reliable and reproducible method is the periodontal probe transparency (TRAN). [5-9] The transgingival probing method is considered very accurate but invasive in order for the GT evaluation. This method consists of anaesthetized gingiva, which is pierced with periodontal probe or endodontic instrument until resistance of the bone is reached. After a firm contact with the underlying bone, the distance is measured with a ruler or a digital calliper.[10,11] A reliable method for the bone morphotype evaluation is the CBCT scanning. This method is considered very reliable but has some limitation in regards to the X-ray radiation exposure, which makes it unconventional when evaluating this parameter. In order to facilitate the exploration process, a number of less invasive but still highly accurate methods have been developed. [12] When applying the TRAN method and the periodontal probe is visible in the sulcus, the gingival phenotype is considered thin and the GT is ≤1 mm, while in thick gingival phenotype, the periodontal probe is not visible in the sulcus and the GT is assumed to be >1 mm. The KTW is established by direct measurement of the distance from the gingival margin to the mucogingival junction in millimeters, while the width of the attached gingiva (WAG) is measured from the bottom of the sulcus/pocket to the mucogingival junction. The fast clinical measurement of those parameters relies on direct measurement using the periodontal probe. Another method of evaluating these parameters is staining with Lugol's iodine solution, which demarcates the attached gingival tissues. In the present study, we assumed that the gingival morphology relied on the bone morphology, that is why we determine the GT and the KTW. Although the KTW is considered an essential parameter when discussing the prerequisites for periodontal health in natural teeth and in restorative treated teeth, the authors consider the importance of the attached gingiva since the quality of the gingival tissue by itself without been firmly attached to the underlying periodontal structures provokes poor resistance.[13]

The periodontal phenotype varies from one individual to another and in the areas of the individual's dentition. It has been noted that in some populations there is a significant dominance of certain periodontal phenotype. Since the specifics of the PP can influence the periodontal health and the future treatment of patients with no regards of it being non-surgical, surgical, orthodontic or restorative, it is crucial to evaluate it before planning and executing any treatment strategies. In this study, we aimed at identifying the dominant PP in a Bulgarian population and relating it to the inflammatory changes in the periodontal tissues.

AIM

The aim of this study was to evaluate the presence of dominant type periodontal phenotype in a small Bulgarian population and its relationship to the presence or absence of periodontal pathology/inflammation.

MATERIALS AND METHODS

Fifty randomly selected patients were included in the study. The selected participants had a diagnosis of periodontal health (17 participants), plaque-induced gingivitis (on intact periodontium) (15 patients), and periodontitis stage I and II with mild or moderate rate of progression (Grade A and B) (16 patients). Nineteen male and 31 female participants were recruited. The age of the participants was in the range of 23 to 72 years. They all met the inclusion criteria and signed an informed consent form. The inclusion criteria for periodontal health and plaque- induced gingivitis among the tested individuals was the absence of clinical attachment loss (CAL) and bone loss (BL). For periodon-

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tal health we have included individuals with pocket depths ≤3 mm and <10% bleeding sites. In order to confirm the diagnosis of gingivitis, the patients periodontal status was clarified based on the presence of pocket depths ≤3 mm and ≥10% bleeding on probing. For all patients diagnosed as periodontitis CAL and BL were detected. The patients with stage I periodontitis have presented interdental site of greatest CAL 1-2 mm, radiographic bone loss <15%, no teeth lost due to periodontitis, maximum probing depth ≤4 mm and mostly horizontal bone loss. The stage II periodontitis patients demonstrated CAL of 3-4 mm, radiographic bone loss <15%, no teeth lost due to periodontal disease, maximum probing depth ≤5 mm and mostly horizontal bone loss. The patients were recruited from the private practice of the investigator. All selected patients had complains in regards to their periodontal status – functional and aesthetic demands. The specific tasks were defined:

1. Full periodontal status evaluation – the hygiene and gingival status were registered by the full mouth plaque score (FMPS) and the full mouth bleeding score (FMBS) and detailed periodontal status was registered by the probing pocket depth, clinical attachment loss, bleeding on probing, furcational involvement, mobillity, and recessions. The diagnosis of periodontitis was clarified by orthopantomography and periapical x-rays;

2. Evaluation of the prevalent periodontal phenotype in the selected individuals;

3. Exploring relations between the periodontal phenotype and the presence/absence of inflammation;

4. Conducting statistical analysis of the presented clinical data.

All participants met the following inclusion criteria: individuals with diagnosis of periodontal health, dental plaque induced gingivitis, periodontitis stage I and II; systemically healthy individuals. The exclusion criteria referred to patients with diagnosis of periodontitis stage III and IV, pregnant and lactating women, patients with allergy, patients with oromucosal and gingival lesions, and patients with hyperplastic gingival inflammation or any medication intake that results in gingival enlargement. Several clinical methods for evaluation of the gingival phenotype around the maxillary frontal teeth were used. The TRAN method was performed by inserting a UNC 15 (Hu Friedy) periodontal probe in the sulcus/pocket and observing the visibility of the periodontal probe in it. A transgingival probing for gingival thickness evaluation by the means of endodontic instrument under topical anesthesia with lidocaine spray 10% 38 g was performed. The method was used in the midfacial surface of all frontal teeth. An endodontic spreader No. 20 was inserted at the distance between the bottom of the sulcus/pocket and the most coronal part of the alveolar crest established by transgingival probing. When a contact is made with the bone, a silicone stopper is placed at the gingiva. The distance is measured with endodontic ruler to the nearest millimeter. The KTW was measured by measuring the distance from the gingival margin to the mucogingival junction in millimeters. Evaluation of the WAG was also performed by measuring the distance from the bottom of the pocket to the mucogingival junction with UNC 15 (Hu Friedy) periodontal probe. A detailed periodontal status was taken of all participants and the following scores/indices were performed:

- Hygiene status registered with FMPS and gingival status registered with FMBS;
- Bleeding on probing (BOP);
- Periodontal pocket depth (PPD)* – measured circumferential around each tooth and registered in six sites;
- Clinical attachment loss (CAL) – measured circumferential around each tooth and registered in six sites;
- Gingival recession – depth and width – (R);
- Methods for evaluation of gingival phenotype – described above.

*The measurements are given in mm and entered into a periodontal chart. All measurements were performed by a single periodontist with UNC-15 periodontal probe (Hu Friedy). All measurements were made circumferential around each periodontal unit and registered at 6 sites (mesiobuccal, midbuccal, distobuccal, mesiolingual, midlingual, and distolingual).

A radiographic method to confirm the diagnosis of periodontitis or periodontal health was used. The following diagnostic X-rays were made:

1) orthopantomography;

2) intraoral retroalveolar x-ray.

Data processing was analyzed using SPSS – IBM SPSS Statistics Version 22. The following analyses were used:

1. Descriptive analysis – the frequency distribution of the tested parameters is presented in tables by subgroups.

2. Variation analysis – measures of central tendency and variability.

3. Student *t*-test – for hypothesis testing for two independent sample means. The basic level of significance in the hypothesis testing was 0.05.

RESULTS

There was a considerable prevalence of women in the participants (62% of all participants). Most of the participants were non-smokers (80%). They were distributed almost equally by diagnosis – periodontal health, gingivitis, and periodontitis. In regards to the gingival phenotype and the gingival thickness of the explored periodontal parameters, we established prevalence of the thick gingival phenotype and respectively of the gingival thickness >1 mm. The main characteristics of the study sample are presented in **Table 1**. Comparing male and female subsamples by health status, it was noted that 47.4% of men had periodontitis versus 29% of women. 26% of the men had gingivitis versus 32.3% of women.

The distribution of the GP among patients with periodontitis, gingivitis, and periodontal health shows that the highest proportion of thick flat gingival phenotype was found in the periodontitis subgroup, while the thick scalloped gingival phenotype had highest prevalence among

Table 1. General characteristics of all participants

Characteristic		n	Relative proportion
Total number of patients	50		
Sex	Male	19	38%
	Female	31	62%
Age	Up to 39 yrs	14	28%
	40-54 yrs	22	44%
	Over 55 yrs	14	28%
Smoking	Yes	10	20%
	No	40	80%
Gingival phenotype (GP)	Thick scalloped	14	28%
	Thick flat	22	44%
	Thin scalloped	14	28%
Gingival thickness (GT)	<1	14	28%
	>1	36	72%
Periodontal status	Periodontitis	18	36%
	Gingivitis	15	30%
	Periodontal health	17	34%

the participants with periodontal health. In regards to gingivitis, we have established a prevalence of thin gingival tissue among the tested subgroup **(Fig. 1)**.

In all of the investigated subgroups, we summarized the basic data about hygiene status, inflammation activity, and some anatomical factors such as keratinized and attached gingiva in order to find any correlation between the presence of inflammation in regards to genetically determined components as the above mentioned ones **(Table 2)**. In the three subgroups, we found statistically significant differences in the mean values of all of the tested parameters.

The analysis of KTW and WAG as well as the dental plaque distribution (FMPS) and the inflammation in both thick and thin GP shows some statistically significant differences in KTW and WAG **(Table 3)**.

We found that in the thin GP individuals, the gingival recessions appeared in three fourths of the cases and confirmed that the thin gingival tissues were more likely to develop gingival recession compared to patients with thick GP **(Table 4)**.

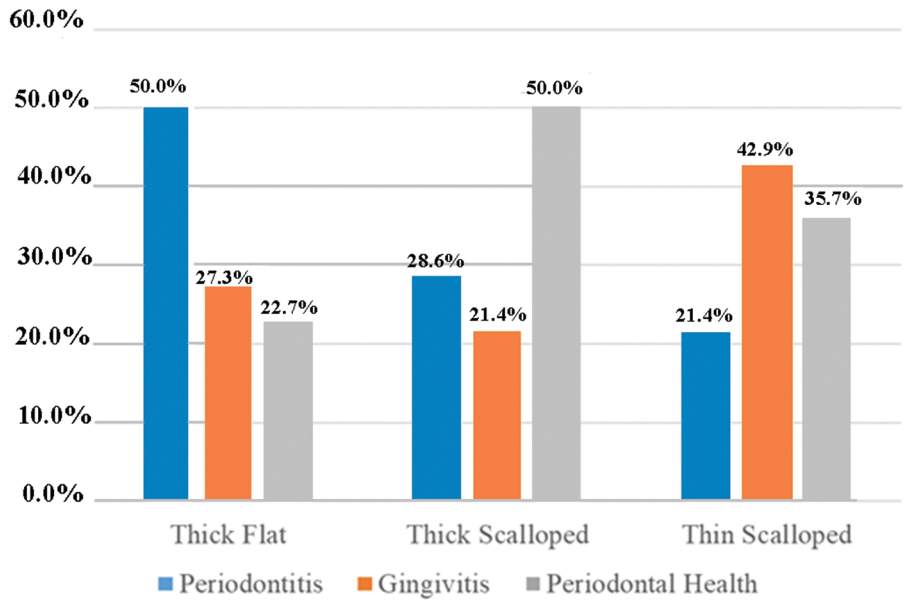

Figure 1. Distribution of health status among gingival phenotype subgroups.

Table 2. Clinical parameters by periodontal health status

Tested parameter	Arithmetic mean	Median	SD	Min. value	Max. value
Patients with periodontitis (n=18)					
FMPS (%)	84.39**	90.5	16.77	48	100
FMBS (%)	75.94**	80.5	25.12	28	100
BOP (%)	80.83**	88	22.24	32	100
KTW	5.46	5.75	1.02	2.8	6.5
WAG	2.35*	2.4	1.02	0	3.5
Patients with gingivitis (n=15)					
FMPS (%)	68.13**	72	26.37	24	100
FMBS (%)	55.87**	56	31.22	10	100
BOP (%)	54.00**	44	32.47	12	100
KTW	4.75	5.7	1.81	1	6.3
WAG	3.16**	3.8	1.39	0.5	5
Healthy patients (n=17)					
FMPS (%)	40.88	44	13.63	18	66
FMBS (%)	7.29	8	2.23	2	10
BOP (%)	7.29	8	2.23	2	10
KTW	5.34	5.9	1.42	2.5	6.8
WAG	3.16	3.8	1.39	0.5	5

**statistically significant difference between the arithmetic means in the subgroup of patients with periodontitis (gingivitis) and healthy patients at 0.05 level of significance; * statistically significant difference between the arithmetic means in the subgroup of patients with periodontitis (gingivitis) and healthy patients at 0.10 level of significance

Table 3. Clinical parameters by gingival phenotype

Tested parameter	Arithmetic mean	Median	SD	Min. value	Max. value
Patients with thick gingival phenotype (n=36)					
FMPS (%)	66.72	68	25.02	22	100
FMBS (%)	48.19	55	37.44	2	100
BOP (%)	49.17	43	38.95	2	100
KTW	6.00**	6	0.38	5.4	6.8
WAG	3.37**	3.5	0.82	1.8	5
Patients with thin gingival phenotype (n=14)					
FMPS (%)	59.57	55	30.2	18	100
FMBS (%)	42.43	29.5	37.32	4	100
BOP (%)	44.21	31.5	37.22	4	100
KTW	3.16**	3	1.04	1	5.2
WAG	0.93**	1	0.74	0	2.2

**statistically significant difference between the arithmetic means in the subgroup of patients with thick and thin gingival phenotype at 0.05 level of significance

DISCUSSION

The scientific interest in the periodontal phenotype, in particular the gingival phenotype, is guided by the abundance of literature evidence about the significance of the individual's anatomy for the outcomes of clinical features such as tissue response to trauma or healing. The evaluation of the periodontal phenotype in modern dental practice is a crucial factor in the treatment planning and long-term clinical success. The high esthetic demands in both clinicians and patients increase the need for planning each step from the treatment. The abundant data about the clinical outcomes

Table 4. Gingival recession and gingival phenotype

Gingival phenotype	Gingival recession			
	No		Yes	
	Number	Proportion	Number	Proportion
Thick GP	34	81%	2	25%
Thin GP	8	19%	6	75%
Total	42	100%	8	100%

in different procedures in patients with thick and thin PP contribute to the understanding of necessity to improve the anatomical status in order to achieve thick and resilient periodontal tissues. The importance of the soft tissue quality especially, but not only in an aesthetic area, but also when planning orthodontic, periodontal, restorative and implant therapy is emphasized.

In this study, a small sample of individuals with different diagnoses was included. The gingival phenotype of the patients was evaluated on the maxillary frontal teeth (central and lateral incisors and canines). The results demonstrated significant prevalence of the thick GP, whereas the thick flat GP was more observe in comparison to thick scalloped GP. The distribution of the three gingival phenotypes varies between the individuals and within the specific periodontal diagnoses – periodontal health, plaque induced gingivitis and periodontitis. When studying the gingival phenotypes, the results show that despite the relatively small sample size, it seems that individuals with thick flat phenotype have developed periodontitis. The fact that the periodontal pocket is a significant clinical sign of periodontitis and the evidence in the literature that the inflammatory changes in patients with thick PP result in pocketing confirm our results. On the other hand, the thick periodontal tissues in absence of inflammatory burden are associated with health. The participants with periodontitis were found to have insufficient oral hygiene and thick gingival biotype that potentially is associated with occurrence of periodontal disease. We have established a significant dominance of the thick GP explored in the maxillary frontal teeth of all participants using the TRAN method, direct measurement of the gingival thickness, and measurements of width of attached gingiva and keratinized tissue width. The results from the study show statistically significant differences between KTW and WAG in periodontal health and periodontal pathology (gingivitis and periodontitis). This highlights the importance of the periodontal tissues being attached to the underlying tissues in order to secure the adequate pocket seal and to maintain the integrity of the healthy sulcus. Our results demonstrated no relation between the gingival phenotype and the age or sex of the studied individuals. In regards to the sex, our results differ from some literature data.[14,15] Further investigations with a larger sample of individuals are needed in order to provide more conclusive results. The gingival phenotype is ethnicity and individual specific.[1] When analyzing the demographical data in regards to the gingival phenotype, we were aiming to identify the prevalence of a certain type of gingival phenotype and to relate it to the presence or absence of any periodontal pathology. The periodontal phenotype assessment is important as a periodontal parameter that should be assessed for each patient. The specific characteristics are responding differently to inflammation, trauma, treatment and healing.[16] The literature data show differences in the gingival tissues in different populations. Liu et al. conducted a cohort study in order to evaluate the specifics of the PP in Chinese subjects with healthy periodontium and periodontitis. They found thicker gingival tissues in healthy subjects and thinner tissues associated with recessions in previously treated periodontal patients.[17] In a study among Saudi Arabian subjects, there was a relative equilibrium between the thick and thin PP with 53% dominance of the thick PP and 47% of the population presented with thin periodontal tissues.[18] When exploring the tissue characteristics in Dravidian and mongoloid population by testing 100 study subjects, Venkatesh et al. found that compared to a Caucasian population, both studied ethnical groups are presented by thick gingival tissues.[19] Alhajj et al. explored a variety of clinical parameters in order to describe the periodontal phenotype in Yemeni population.[20] Different characteristics of the tooth crown width and length and soft tissue characteristics such as KTW, papilla height, and GT were considered. The author concluded that the examined subjects had a sufficient level of KTW. In regards to GT, the female participants were found to have thin GT.[21]

CONCLUSIONS

Within the limitations of the present study, we found a dominance of the thick flat gingival phenotype and related it to periodontitis, but only in the presence of inflammation. Since the small group of investigated individuals cannot provide definitive conclusions neither for the dominant gingival phenotype in the explored population nor for the definitive relation between the phenotype and the presence of periodontal disease, further research is needed in order to obtain solid results in the explored area. Nevertheless, the results from our study show a relation between the gingival phenotype and the presence of periodontal disease in the studied population.

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Competing Interests

The authors have declared that no competing interests exist.

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Влияние фенотипа десен на пародонтоз

Здравка Пашова-Тасева[1], Антоанета Млачкова[1], Екатерина Тошева[2]

[1] *Кафедра пародонтологии, Факультет дентальной медицины, Медицинский университет – София, София, Болгария*

[2] *Факультет прикладной информатики и статистики, Университет национальной и мировой экономики, София, Болгария*

Адрес для корреспонденции: Здравка Пашова-Тасева, Кафедра пародонтологии, Факультет дентальной медицины, Медицинский университет – София, София, Болгария; E-mail: z.pashova@abv.bg; тел.: +359 878 180 262

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Резюме

Цель: Целью настоящего исследования было изучение взаимосвязи между фенотипом десны (GP) и состоянием здоровья пародонта, а также выявление распространённости определённого фенотипа десны у небольшой болгарской популяции.

Материалы и методы: Мы набрали 50 пациентов, посещающих нашу стоматологическую практику, с различными пародонтальными диагнозами. Детальный пародонтальный статус был взят для оценки диагноза каждого участника. Было использовано несколько клинических методов оценки толщины десны и ширины ороговевшей ткани, включая метод TRAN, трансгингивальное зондирование и прямое измерение. Данные были обобщены и проанализированы статистически.

Результаты: Мы обнаружили значительную распространённость фенотипа толстой десны, в частности толстого плоского фенотипа. У пациентов с пародонтитом было более высокое распространение фенотипа толстой десны, в то время как у пациентов с гингивитом отмечался фенотип тонкой фестончатой десны. Что касается толщины десны (GT), у 36 участников было обнаружено, что GT > 1 mm, а у остальных 14 – GT ≤ 1 mm. Статистически значимые различия были обнаружены в ширине кератинизированной ткани и ширине прикреплённой десны при различных фенотипах десны. Достоверных различий в возрасте и поле участников выявлено не было.

Заключение: Мы обнаружили значительное преобладание фенотипа толстой (с умеренным преобладанием толстой плоской до толстой фестончатой) над фенотипом тонкой десны в исследуемом образце. Самая высокая относительная доля пациентов с пародонтитом приходится на подвыборку лиц с фенотипом толстой плоской десны. Что касается гингивита, самая высокая доля была в подвыборке тонкого фестончатого фенотипа – 42.9%. Самая высокая распространённость заболеваний пародонта была среди лиц с толстым фестончатым GP (50%), за которым следовал тонкий фестончатыЙ GP (35.7%).

Ключевые слова

фенотип десны, толщина десны, ширина ороговевшей ткани, пародонтальный фенотип, ширина прикреплённой десны