

State of Regional Blood Flow in Patients with Varying Degrees of Anatomical and Functional Disorders of Periodontal Tissues

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Abstract

Background: The aim of this research was to determine the functional state of regional blood flow in young people with varying degrees of anatomical and functional disorders of periodontal tissues.

Methods and Results: One hundred and thirty-five young patients with varying degrees of anatomical and functional disorders of periodontal tissues (AFDP) and 52 controls with intact periodontium were examined. All patients with AFDP were divided into three groups: Group 1 included 33 patients in the compensation stage (low degree of periodontal risk, intact periodontium, no clinical symptoms, pale pink gums, no bleeding on probing, dentogingival attachment is not disturbed); Group 2 included 38 patients in the sub-compensation stage (average degree of periodontal risk, disorders of the mucogingival complex, without clinical symptoms); and 64 patients in the decompensation stage (high degree of periodontal risk, disorders of the mucogingival complex, the presence of clinical symptoms, individual or combined signs of periodontal pathology, gingival recession (Class I and II according to Miller's classification). The regional blood flow of periodontal tissues was assessed by an ultrasound Doppler graph in a non-invasive way. The parameters of linear (PSV, peak systolic velocity) and volumetric (Qs, maximum systolic volume velocity) velocities of blood flow, as well as the parameters of the wall vascularization (PI, pulsation index; RI, resistance index). The PSV increased statistically significantly with a load compared to rest in the control and sub-compensation groups and decreased in the decompensation group with a load, compared to the rest condition. The PSV increased relative to the control in the subcompensation and decompensation groups in rest and under load. The Qs indicator showed a similar trend in the groups. Qs significantly increased under load, compared to the rest condition in the control, compensation, and subcompensation groups, and decreased in the decompensation group. The Qs values, in comparison with the control, increased in the subcompensation and decompensation groups in the rest condition and under load. The PI increased with the load relative to the rest condition in the control, compensation, and decompensation group. At the same time, PI decreased under the load, compared to the rest condition, in the subcompensation group. In comparison with the control, the PI values decreased in the subcompensation and decompensation groups in the rest condition and under load. The RI significantly changed only in the subcompensation group under load, compared to the rest condition. Only RI values decreased significantly in the subcompensation group under load, compared to the control.

Conclusion: The velocity characteristics (linear and volumetric velocities) of blood flow are important diagnostic indicators, allowing the most rapid and reliable assessment of the degree of anatomical and functional disorders of periodontal tissues. (International Journal of Biomedicine. 2023;13(2):277-280.)

Keywords: periodontium • regional blood flow • blood flow velocity • resistance index • pulsation index

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Introduction

Inflammatory periodontal diseases constitute an urgent, unsolved problem of modern healthcare due to the continuing high prevalence among the population of different ages.^(1,2) There is a sharp increase in young people with severe destructive and atrophic periodontal diseases, the most common cause of tooth loss in adults.^(3,4) It has been established that the vascular bed of periodontal tissues, which includes a complex of tissues having genetic and functional commonality (periodontium, bone of the alveoli of the jaw, gum with periosteum, and tooth tissue), is represented by small arteries, arterioles, pre-capillaries, and capillaries.⁽⁵⁾ Due to the abundant vascularization of tissues and a thinner vascular surface, this area seems to be a particularly good research object.⁽⁶⁾ It has been established that changes in the functioning of the microcirculatory bed of the periodontium are the most sensitive indicators (predictors), which are the first to react to pathogenic factors even before the appearance of clinical symptoms.⁽⁷⁾ With prolonged overload and constant traumatization of periodontal tissues, the processes of local metabolism in tissues are disrupted, collagen structures are destroyed, and the level of mineralization of bone tissue is significantly reduced, ultimately leading to resorption.⁽⁸⁾

To prevent severe destructive lesions, it is relevant to study local changes in the hemodynamics of periodontal tissues for a further informed and differentiated approach to the treatment and prevention of this pathology.

The aim of this research was to determine the functional state of regional blood flow in young people with varying degrees of anatomical and functional disorders of periodontal tissues.

Materials and Methods

One hundred and thirty-five young patients (49% men and 51% women) (mean age of 30.3 ± 0.5 years) with varying degrees of anatomical and functional disorders of periodontal tissues (AFDP) and 52 controls (mean age of 28.2 ± 0.6 years) with intact periodontium were examined. All patients with AFDP were divided into three groups: Group 1 included 33 patients in the compensation stage (low degree of periodontal risk, intact periodontium, no clinical symptoms, pale pink gums, no bleeding on probing, dentogingival attachment is not disturbed);⁽⁹⁾ Group 2 included 38 patients in the sub-compensation stage (average degree of periodontal risk, disorders of the mucogingival complex, without clinical symptoms); and 64 patients in the decompensation stage (high degree of periodontal risk, disorders of the mucogingival complex, the presence of clinical symptoms, individual or combined signs of periodontal pathology, gingival recession (Class I and II according to Miller's classification)).⁽¹⁰⁾

The study was conducted in the Department of Therapeutic Dentistry at the Altai State Medical University (Barnaul, Russia).

Criteria for inclusion in the groups of patients with AFDP were reproductive age (18-44 years old) and absence of concomitant somatic pathology. Criteria for inclusion in the

controls group were the absence of acute or exacerbation of chronic diseases and pathological changes in the Ent-organs.

Clinical examination of patients was carried out according to the generally accepted method of examination of patients with mucogingival pathology.⁽¹¹⁾ In the control group, a cone-beam computed tomography was performed for a complete diagnosis of the condition of the dental system, according to the results of which no changes in the bone tissue were detected.

The regional blood flow of periodontal tissues was assessed by an ultrasound Doppler graph in a non-invasive way using Minimax-Doppler-K (MM-D-K), model NB ("Minimax SP"), and a sensor with a frequency of 20 MHz. The parameters of linear (PSV, peak systolic velocity) and volumetric (Qs, maximum systolic volume velocity) velocities of blood flow, as well as the parameters of the wall vascularization (PI, pulsation index [the Gosling index]; RI, resistance index [the Pourcelot index]). The indicators were measured at the border between the attached gum and the transitional fold since all the links of the microcirculation system are represented here.⁽¹²⁾ Blood flow parameters were studied in dynamics after functional load (standard tension of the soft tissues of the upper and lower lip and cheeks).

Statistical analysis was performed using STATISTICA 10.0 software package (Stat-Soft Inc, USA). Inter-group comparisons were performed using Student's t-test. A probability value of $P < 0.05$ was considered statistically significant.

The study was conducted in accordance with ethical principles of the WMA Declaration of Helsinki (1964, ed. 2013) and approved by the Ethics Committee at the Altai State Medical University (Barnaul, Russia). Written informed consent was obtained from all participants.

Results

The PSV increased statistically significantly with a load compared to rest in the control ($P < 0.001$) and sub-compensation groups ($P < 0.001$) and decreased in the decompensation group with a load, compared to the rest condition ($P < 0.001$). The PSV increased relative to the control in the subcompensation and decompensation groups in rest and under load ($P < 0.001$ in both cases) (Figure 1). The Qs indicator showed a similar trend in the groups. Qs significantly increased under load, compared to the rest condition in the control, compensation, and subcompensation groups, and decreased in the decompensation group ($P < 0.001$ in all cases). The Qs values, in comparison with the control, increased in the subcompensation and decompensation groups in the rest condition and under load ($P < 0.001$ in all cases) (Figure 2).

The PI increased with the load relative to the rest condition in the control, compensation, and decompensation group ($P < 0.001$ in all cases). At the same time, PI decreased under the load, compared to the rest condition, in the subcompensation group ($P < 0.001$). In comparison with the control, the PI values decreased in the subcompensation and decompensation groups in the rest condition and under load ($P < 0.001$ in all cases) (Figure 3).

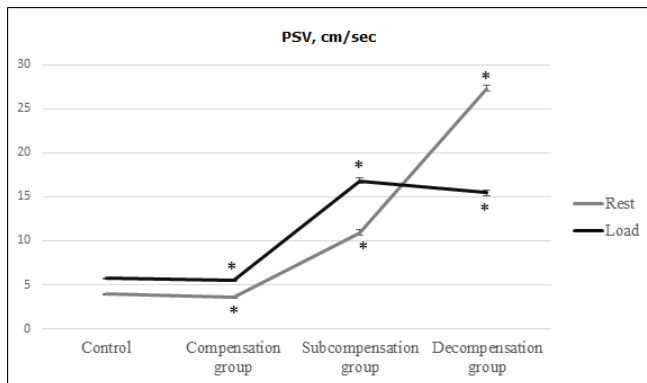


Fig. 1. PSV (cm/sec) level change in patients with different degrees of anatomical and functional disorders of periodontal tissues (* - statistically significant differences with the control group).

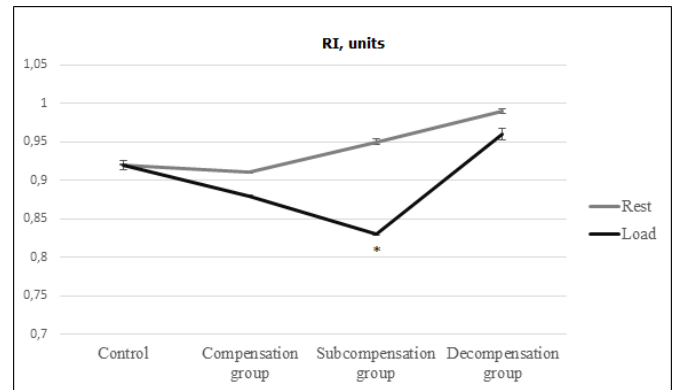


Fig. 4. RI (units) level change in patients with different degrees of anatomical and functional disorders of periodontal tissues (* - statistically significant differences with the control group).

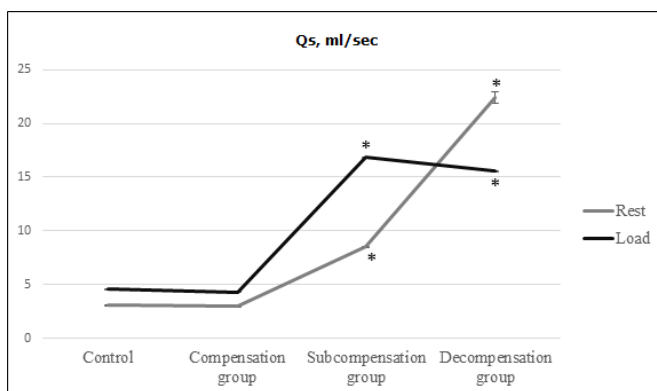


Fig. 2. Qs (ml/sec) level in patients with different degrees of anatomical and functional disorders of periodontal tissues (* - statistically significant differences with the control group).

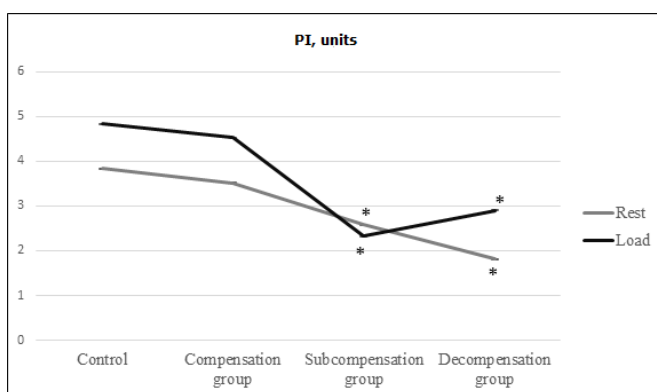


Fig. 3. PI (units) level change in patients with different degrees of anatomical and functional disorders of periodontal tissues (* - statistically significant differences with the control group).

The RI significantly changed only in the subcompensation group under load, compared to the rest condition ($P < 0.001$). Only RI values decreased significantly in the subcompensation group under load, compared to the control ($P < 0.001$) (Figure 4).

Discussion

Since the progression of pathology occurs with functional loads (lip tension and frenulum tension, eating, articulation, chewing), it is relevant to study local hemodynamics not only at rest, but also with functional load. The results showed that the reaction of periodontal tissue vessels both at rest and in a state of functional load with varying degrees of anatomical and functional disorders has its characteristics. The differences consisted of a significant change in the indicators of local hemodynamics in the study area. One of the most important indicators of the state of blood flow is its velocity, which is based on the determination of quantitative parameters of blood flow—linear (PSV) and volumetric (Qs) velocities. RI (resistance index) reflects the resistance to blood flow distal to the measurement site due to vascular occlusion. PI (pulsation index) reflects the elastic-elastic properties of the arteries.⁽⁷⁾ In the control group at rest and under functional load, the indicators' changes were normative. In the patients of the compensation group and subcompensation group (without clinical symptoms), similar changes in PSV and Qs were observed in the upward direction. However, if in the compensation group, the changes in PSV and Qs were close to the indicators of the control group, then in the subcompensation group, the values of PSV and Qs increased by more than two times. It can be said that these changes occur due to the inclusion of local mechanisms of regulation and compensation to maintain the necessary level of circulation in periodontal tissues in conditions of initial disorders.⁽¹³⁾ The decompensation group was distinguished by clinical symptoms of the disease, among which there was a positive symptom of bleeding and a symptom of the departure of the interdental papilla. In this regard, there was a decrease in the PSV velocity along the curve of the maximum velocity and the Qs velocity along the curve of the maximum volumetric velocity during the functional test. A decrease in blood flow rates in patients may be associated with arteriole spasms, stagnation in the microcirculatory bed, and pronounced rheological disorders.⁽¹⁴⁾ We also analyzed the values of the RI and PI in our study. Similar changes

were noted in compensation group patients, as in the control group. However, in the subcompensation group, the PI values decreased significantly at rest and under load. This means that in the study area, the elastic properties of the vessels are less pronounced, which confirms a decrease in compensatory mechanisms to maintain the necessary circulation level in this area. The changes in the RI value were insignificant and were noted only in the subcompensation group under load, which indicated a drop in peripheral resistance during the functional test.

Conclusion

The use of Doppler ultrasonography in assessing the state of regional blood flow of periodontal tissues is a highly informative and non-invasive method. The velocity characteristics (linear and volumetric velocities) of blood flow are important diagnostic indicators, allowing the most rapid and reliable assessment of the degree of anatomical and functional disorders of periodontal tissues.

Competing Interests

The authors declare that they have no competing interests.

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