THE MECHANISMS OF PERIODONTAL PATHOLOGY IN YOUNG ADULTS

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Abstract
The clinical, radiological and morphological methods of research (n = 39) applied evidenced that the main manifestations of the pathology of alveolar bone depend on the imbalance between the intensity of resorption and the new formation processes, which usually are of prevalence. Also, they depend on the reduction of osteoplastic processes. A significant reduction of alveolar bone mineralization for mild and generalized periodontitis in young ages appears when reducing energy supply. Also evidenced was an expediency of using antioxidants and antihypoxants together with osteotropic therapy, which will help to improve the re-ossification process of a poor in minerals alveolar bone.

Keywords: periodontal disease, energy metabolism of gums, periodontal tissues, alveolar bone.

1. INTRODUCTION

A significant prevalence of periodontal disease in adult population all over the world necessitates further development of diagnostic criteria and treatment plans. In literature, all aspects of periodontal diseases (pathogenesis, diagnosis, clinical features, treatment and prevention) are highlighted mainly in 40-50 year-old individuals or even older ones, and feature their flow at young ages. Particularly the initial changes in the periodontal tissues remain poorly understood at the beginning of the pathogenetic chain [1,2].

Especially important is to consider the age of a patient in the metabolism and bone structure of the alveolar bone as, at young ages, the processes of bone formation dominate. In middle-aged people, formation and destruction of bone are balanced while, in old people – a resorption process prevails over the others. Bone mineralization of the alveolar bone reaches its maximum within 25-30 years [3-4].

The alveolar bone consists of inorganic and organic substances, among which collagen prevails. The bone cells - osteoblasts, osteoclasts, osteocytes - are involved in permanent processes of resorption and bone tissue osteogenesis. Normally, these processes are balanced, constituting the basis of the continuous reconstruction of the alveolar bone that characterizes plasticity and adaptation. The bone component of the alveolar bone of both jaws is in a constant state of renewal, due to permanent restructuring processes. As a result of these processes, the old bone is replaced by a new one.

Against the background of the development of pathological processes in the bone tissue, changes occur in the alveolar process, most important among them being osteoporosis - a systemic disease of metabolic osteopathy, based on the reduction of bone weight infraction of architectonics [5]. Therefore, to specify the mechanisms of periodontal diseases, it is logical to study the bone structure of the alveolar process, concomitantly with the energy metabolism of gums. As part of the periodontal complex, they reflect the state of redox processes that provide the functional activity of periodontal tissues in general. Until recently, specialists have had no doubt on the existence of a correlation between the morphological characteristics of inflammation in periodontal tissues and the severity of the clinical course of chronic catarrhal gingivitis (HKH) and generalized periodontitis (GP)

Based on these data, the aim of the study was the clinical, radiological and morphological manifestations of periodontal tissue damage...
concerning generalized periodontal diseases in young people.

2. MATERIALS AND METHODS

Clinical, radiological and histochemical investigations were conducted with 39 patients, divided into 3 main groups.

Group I - 9 patients with chronic catarrhal gingivitis, manifested for at least 3-5 years

Group II - 23 patients with early generalized periodontitis -- stage I;

Group III - 7 patients with no signs of pathology of periodontal tissues (control).

Morphological studies of the periodontal bone were conducted on archival material. Painting of histological sections of teeth blocks with hematoxylin and eosin (by the van Gisoni method) was made on materials from 9 dead persons who suffered from chronic catarrhal gingivitis and generalized periodontitis, early lesion-- stage I. Teeth blocks were decalcified in trichloroacetic acid and embedded in paraffin.

Histochemical studies on energetic metabolism were conducted on criostatic sections of incision albiophtaes of gums. We studied the activity of the complex of enzymes limiting tissue respiration, glycolysis, pentose cycle and terminal oxidation, succinate dehydrogenase (SDG) - by Nahlas et al., Malate dehydrogenase (MDH), lactate dehydrogenase (LDH), glucose-6-phosphate dehydrogenase (Ch-6f-DG) - by Hess, Skarpelli and Pierce; NAD+-P and NADPH dehydrogenase - by Farber. The histochemical methods were taken over from literature [6].

None of the patients, aged between 19-30 years, was hospitalized for the presence of somatic pathology.

Morphological studies were conducted in the laboratory of experimental studies (Head. - Dr. med., Professor Kolesov NA) at the Research Institute of Experimental and Clinical Medicine (Bogomolets National Medical University).

3. RESULTS AND DISCUSSION

The results of clinical and radiological studies of GP development — stage I and in young people without somatic pathology showed that clinical symptoms of GP are associated with disorders of the bone tissue in 1/3 of the height of the alveolar bone. It appears on X-ray results as an irregular cortical resorption on the tops of the interalveolar membranes, with a gradual spread of the spongyous substance (Fig. 1).

![Fig.1. Orthopantomogramme](image)

Diagnosis: generalized periodontitis, early lesion - stage I, chronic flow course

The activity of bone destructive changes is radiologically determined by the nature of resorption. Unclear contours of the osteoporosis foci on X-ray pictures indicate an exacerbation of GP, which is clinically combined with an increase of bleeding gums, purulent exudate character. Clinical and radiological signs of GP with a clear morphological basis are established, such as: the presence of chronic inflammation in remission or aggravation stages in the gums and periodontal bone (lympho-plasmocellular, macrophagous, tissue-basophilic infiltration of neutrophils in the presence of exacerbations, edema vessels of the walls of the hematocrit channel and perivascular connective tissue - Fig. 2). Osteoblastic bone resorption and the inflammatory destruction also occur. The flow of the pathological process is associated with bone resorption and with the alveolar bone that appears as an increase in the number of preosteoclasts and osteoclasts with high functional activity, which further alterate the bone. Microscopically, progression of the signs of destruction of bone tissue with the enlargement in diameter of the medullar bone space are detected, which becomes the basis of the radiographic signs of osteoporosis. The cells of the inflammatory infiltrates move from the gums and encourage the production of
proinflammatory cytokines and osteoporotic cytokines, enzymes, biologically active substances, which provoke, on one hand - activation of functional activity of osteoclasts and, on the other - reduction of pH with development of acidosis. Bone generation is slower, due to the decrease in the number of osteoblasts per unit area of histological sections, and to their degenerative and atrophic changes.

Patients with early GP stage suffer changes of metabolic profile of gum epithelium. At this stage of GP development, the correlation of tissue respiration and glycolysis processes occurring in the gums is changing in favor of the likely prevalence of the last one: 42.2 ± 2.01% and 57.8 ± 2.29% (r≤0.005), respectively. Such data, together with other parameters, indicates the development of periodontal tissue hypoxia. Tissue hypoxia is one of the triggers of reactions of lipid peroxidation, which leads to the development of periodontal alterationative processes and clinical manifestations of GP. During this process, histochemical studies revealed a likely decrease in the enzyme activity of tissue respiration (SDG, MDH), pentose cycle (Ch-6-F DG) and terminal oxidation (NAD-H and NADPH DG) in the epithelium and connective tissue cells, while increasing glycolysis enzymes activity (LDH).

Regarding chronic catarrhal gingivitis (CCG), the main feature evidenced by X-ray images is the «occultness» of the figure of spongy bone of interalveolar membrane, due to swelling and cell infiltration of gum tissues, especially during the exacerbation period of chronic inflammation (Fig. 3).

In parallels, we analyzed the state of metabolic pathways that provide the character of energy metabolism in periodontium. It was established that the percentage of normal processes of respiration and glycolysis in gums structures is of 54.3 ± 2.21% and 45.7 ± 2.11% (r≤0.005), respectively. These energy processes provide the normal physiological and clinical gums parameters (color, turgor, no bleeding and no periodontal pockets).

As for the intimate mechanisms of inflammatory alteration of the near-dental tissues, we support modern scientific views about the importance of some complex immunological, biochemical, structural and other pathological changes, including the importance of vitamin D in this process. The metabolites of vitamin D influence every stage of the appearance of a GP. Mainly, they influence the periodontopathogens by inducing the formation of antibacterial peptides, inflammation reaction of organism and periodontal tissues, by reducing the formation of pro-inflammatory cytokines and increasing the formation of anti-inflammatory cytokines through reduction of alveolar bone resorption [7].

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Fig. 2. Histological section of the dento-alveolar unit
Diagnosis: generalized periodontitis, early lesion — stage I, chronic flow course
Painted with hematoxylin and eosin. Coll. Ab. 10 Ok.10.

Fig. 3. Orthopantomogramme
Diagnosis: chronic catarrhal gingivitis

Morphologically, CCG manifests itself by the presence of cell infiltration in gum tissue, where small and medium lymphocytes, plasma cells dominate; less common are tissue macrophages and basophils. The blood vessel walls of the hemo-microcirculatory channel are swollen,
gaps are unevenly widened, especially in the capacitive (venous) part. Perivascular connective tissue is swelling, especially during the exacerbation of CCG. In this period, the number of neutrophilic granulocytes is increasing in infiltrates. The energetic supply of the functional activity of periodontal tissues has the tendency to decrease, due to the decrease of enzyme activity of breathing (SDG) up to 51.2 ± 2.02%, while the activity of enzymes of glycolysis (LDH) increases to 48.8 ± 1.86% (r≤ 0.005).

Inflammatory processes in the CCG are distributed mainly on the papillary layer of connective tissue and epithelium of gums and epithelium, not leading to a direct contact of cell infiltrates and oedematous fluid with the alveolar bone tissue, whose structure suffers no unidirectional pathological changes (Fig. 4). It is only rarely (usually at intervals of several years) that swelling and infiltration spread on a reticular layer of connective tissue of gums and on the non-bone basis of alveolar bone and periodontium.

![Histological section of the dento-alveolar unit](image)

**Fig. 4.** Histological section of the dento-alveolar unit
Diagnosis: chronic catarrhal gingivitis
Painted with hematoxylin and eosin. Coll. Ab. 10 Ok.10.

The obtained data allow us to conclude that the pathogenesis of CCG and GP in young adults is associated with the development of inflammation, first in the gum tissues and then in the alveolar bone tissue and periodontium, which agrees with literature providing information about the method of densitometry [7]. Thus, according to photodensitometric investigations with X-ray photos about CCH, there is no reliable data about the decreases of optical density of the alveolar bone tissue (HC ranges from 0.96 ± 0.002 to 0.99 ± 0.021 units). According to GP, this figure was significantly reduced to 0.84 ± 0.023 – 0.92 ± 0.032, which is an early diagnosis criterion on GP development.

The clinical, radiological and structural changes in periodontal tissues are established in CCG, developing especially during the GP, against the background of reducing the energy sufficient for their functional activity. It is manifested by signs of tissue hypoxia with decreased activity of the enzymes of tissue respiration and increased glycolysis.

4. CONCLUSIONS

The development of periodontal tissue diseases in young persons with no somatic pathology is associated mainly with a slowly progressive chronic inflammatory process with periodic, slowly progressive exacerbations and transitions of pathological process from gums (while CCG) to the alveolar bone, tooth circular ligament and periodontium (during GP).

It is established that the «occultness» of alveolar bone issue evidenced on X-ray photos in patients with CCG is mainly due to oedema and cellular infiltration of gums, especially during exacerbations of inflammation, not depending on the development of bone resorption during this pathology processes, which agrees with the literature about the detection of alveolar bone mineral density by the photodensitometric method of X-ray photos.

The basis of the development of stage I of GP in young people is a contact switch of gum chronic inflammation to the alveolar bone tissue with a distribution of cell infiltration on it (lymphocytes, plasma cells, macrophages, tissue basophils, neutrophil granulocytes) and oedema, causing accumulation of biologically active substances (inflammatory cytokines, osteoporotic cytokines, enzymes, etc.), which activate the functional activity of osteoclasts, lead to pH decrease and to the development of acidosis. Together, they determine the prevalence of alveolar bone resorption over the bone tumor and also the clinical symptoms for the
development of generalized periodontitis. This may be detected by radiological symptoms of GP of early stage I and is reflected by a significant decrease of the optical density of the alveolar bone tissue, up to 0.84 – 0.92 units.

A significant reduction of mineralization of the alveolar bone tissue in stage I of GP at people of young age develops in the reduction of the energy supply and shows the expediency of using antioxidants and antihypoxants together with osteotropic therapy in complex treatments. Their use will lead to the ossification of the impoverished with mineral components of the alveolar bone of both jaws.

References


