INTERNATIONAL JOURNAL OF INTEGRATIVE AND MODERN MEDICINE

Specific Changes in Oral Liquid Composition in Children With Osteomielitis

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Abstract: Jaw bone osteomyelitis in children is a serious problem of modern children's maxillofacial surgery and dentistry, characterized by a high frequency of complications and unfavorable long-term consequences for the formation of the dentofacial system. According to various researchers, the frequency of osteomyelitis lesions of the maxillofacial region in childhood accounts for 5 to 15% of all inflammatory diseases of this localization, while a trend towards an increase in morbidity has been observed in recent decades.

Keywords: Jaw bone osteomyelitis, children, oral fluid, mixed saliva, biochemical markers, inflammatory cytokines, diagnosis, alkaline phosphatase, osteocalcin, antioxidant system, lipid peroxidation, secretory immunoglobulins, lysozyme, lactoferrin

Introduction. The relevance of the problem is due to the peculiarities of the anatomical and physiological structure of the jaw bones in children, including rich blood supply, the presence of growth zones, active processes of mineralization and remodeling of bone tissue. These factors contribute to the rapid spread of the infectious process and the formation of extensive destructive foci, which can lead to impaired jaw growth, the formation of facial skeletal deformities, and multiple tooth loss. Timely diagnosis of jaw bone osteomyelitis in children remains a complex task, as the clinical manifestations of the disease in its early stages are often nonspecific and may be disguised as other inflammatory processes of the oral cavity. Traditional diagnostic methods, including radiological examination, computed tomography, and blood laboratory tests, do not always allow for the detection of the disease in the initial stages of development, when therapeutic measures are most effective.

In recent years, the study of the composition of body fluids as a source of diagnostic information about pathological processes has attracted considerable attention from researchers. Oral fluid (mixed saliva) is of particular interest as a biological material for diagnosing diseases of the maxillofacial region, as it directly contacts inflammatory foci and can reflect local pathological changes. Oral fluid is a complex biological medium consisting of secretions from large and small salivary glands, gum fluid, metabolic products of oral microorganisms, epithelial cells, and various biologically active substances. Normally, oral fluid contains numerous components, including electrolytes, proteins, enzymes, immunoglobulins, cytokines, hormones, and other biologically active molecules, the concentration of which can change during various pathological conditions. In inflammatory processes in the maxillofacial region, significant changes occur in the oral fluid composition, associated with the activation of the local immune response, the disruption of the barrier function of the mucous membranes, changes in microcirculation, and the development of tissue destruction processes. These changes can serve as early markers of the pathological process and be used for diagnostic purposes. The study of specific biochemical markers of bone destruction in oral fluid in osteomyelitis of the jaws is of particular interest. Such markers include bone metabolism enzymes (alkaline phosphatase, acid phosphatase, osteocalcin), collagen degradation products, inflammatory cytokines (interleukins, tumor necrosis factor, prostaglandins) and other biologically active substances, the concentration of which can correlate with the severity of the osteomyelitis process.

Studying changes in the antioxidant defense system of oral fluid in osteomyelitis also has important diagnostic significance. Inflammatory processes are accompanied by the activation of lipid peroxidation and the depletion of the body's antioxidant reserves, which can be reflected in the composition of oral fluid and serve as an additional criterion for assessing the severity of the pathological process.

Microbiological studies of oral fluid in osteomyelitis allow not only to identify the pathogens of the disease, but also to assess the state of local immunity, including the level of secretory immunoglobulins, lysozyme, lactoferrin, and other factors of nonspecific defense. Changes in the ratio of various microbial populations in the oral cavity can serve as prognostic criteria for the development of complications and the effectiveness of the ongoing therapy.

The electrolyte composition of oral fluid also undergoes significant changes during inflammatory processes in the maxillofacial region. Disruptions in the concentration of sodium, potassium, calcium, phosphorus, and other electrolytes can reflect the degree of salivary gland damage, changes in vascular wall permeability, and disruptions in local homeostasis.

The use of modern high-tech analysis methods, including mass spectrometry, chromatography, enzyme-linked immunosorbent assay, and molecular genetic research, opens up new possibilities for identifying specific markers of osteomyelitis in oral fluid and developing highly sensitive diagnostic tests.

The advantages of oral fluid research are the non-invasiveness of material sampling, the absence of stress for young patients, the possibility of repeated studies for dynamic observation, and the relative simplicity and accessibility of the methodology. These factors are particularly important in pediatric practice, where minimizing painful procedures is a priority.

The development of methods for diagnosing jaw bone osteomyelitis based on oral fluid analysis can significantly improve the treatment outcomes of children with this pathology through early diagnosis, timely initiation of therapy, and the ability to monitor treatment effectiveness. This is especially relevant in the context of growing resistance of microorganisms to antibacterial drugs and the need for a personalized approach to treating each patient.

Jaw osteomyelitis in children is one of the most common inflammatory diseases in maxillofacial surgery and pediatric dentistry. According to some data, odontogenic osteomyelitis in children occurs in 80% of all cases of jaw osteomyelitis in children, hematogenous - in 9%, traumatic - in 11%. The frequency of manifestations of individual forms of osteomyelitis depends on the child's age. Between the ages of 0 and 3, hematogenous osteomyelitis predominates; from 3 years of age and older, odontogenic osteomyelitis prevails; in adolescence, the proportion of traumatic osteomyelitis increases. In childhood, the pathological process is more acute, which is due to the intensive blood supply to the bones, the high activity of metabolic processes, and the anatomical and physiological features of the teeth. Under inflammatory conditions, significant changes occur not only in bone tissue but also in oral fluid, which is an accessible biological material and reflects the state of local immunity, microbiota, and tissue reactions.

Tissue inflammation triggers a whole cascade of immune reactions, including the activation of neutrophils, macrophages, osteoclasts, and mast cells. These cells produce numerous mediators, which partially diffuse into the surrounding soft tissues and oral fluid. Thus, saliva becomes a reflection of the ongoing pathophysiological processes in the bone.

The main mechanisms leading to changes in the composition of the oral fluid are:

- destruction of bone tissue and release of degradation enzymes;
- increased vascular permeability and blood plasma protein yield;
- activation of cellular immunity and release of cytokines;
- proliferation of pathogenic microflora in conditions of purulent inflammation;

- decreased functional activity of the salivary glands due to intoxication and pain syndrome. All these processes create a characteristic oral fluid profile, by which one can judge the severity and form of ostitis.

In the oral fluid of children with ostitis, indicators significantly increase, which are usually attributed to the biomarker of the acute phase:

1. C-reactive protein (CRP) - its level can increase 5-8 times compared to normal, reflecting the severity of acute inflammation.
2. Ferrin, seromucoids, fibrinogen - indicate a systemic reaction of the body.
3. Lysozyme, lactoferrin, cathepsin D - characterize the tension of local immunity.

One of the main pathological features of oral fluid in osteomyelitis is the increase in the activity of enzymes that destroy the intercellular matrix:

- Matrix metalloproteinases MMP-8 and MMP-9.

Their increase is considered a direct marker of osteolitis. In children with osteomyelitis, the level of MMP-8 can increase by more than 10 times, which correlates with the depth of bone damage.

Neutrophil elastase.

The increase in its activity indicates pronounced neutrophilic infiltration of the inflammatory focus.

- Alkaline and acid phosphatase.

An increase in alkaline phosphatase is associated with accelerated bone tissue restructuring, while acid phosphatase reflects osteoclast activity.

These indicators allow us to assess not only the intensity of inflammation but also the rate of destructive processes in bone tissue.

1. Cytokine profile

In children with osteitis, a characteristic inflammatory cytokine panel is formed, including:

- IL-1β - stimulates pain, swelling, and elevated temperature in the inflammation zone;
- IL-6 - enhances the systemic response of the acute phase;
- TNF-α - stimulates osteoclastic activity and bone destruction;
- IL-8 - attracts neutrophils and forms a purulent component;
- TGF-β - compensatorily increases during the onset of reparative processes.

The severity of cytokine changes correlates with the clinical form of osteitis: catarrhal, serous, or purulent-necrotic.

5. Microbiological characteristics

Normally, oral fluid contains various microorganisms that form a stable microbiocenosis. However, in ostitis, a significant shift in microbial balance occurs. The number of pathogenic and conditionally pathogenic bacteria increases in the oral fluid:

- Streptococcus mutans
- Streptococcus sanguinis
- Staphylococcus aureus
- Prevotella intermedia
- Porphyromonas gingivalis
- Fusobacterium nucleatum

An increase in the concentration of anaerobes is characteristic, which is associated with the development of purulent inflammation in bone tissue. Anaerobic flora, by producing proteolytic enzymes and toxic substances, contributes to the progression of osteitis and the destruction of bone structures.

Against the background of pathogenic colonization, the number of representatives of the normal microbiota - streptococci of the viridans group and neisseria - sharply decreases, reflecting the dysbiotic state of the oral cavity. Dysbiosis exacerbates the course of the disease and increases the likelihood of recurrence.

In children with ostitis, a change in several physicochemical saliva parameters is observed:

1. Decrease in pH - oral fluid becomes more acidic, creating favorable conditions for anaerobic flora growth.
2. Decreased buffer capacity, which reduces the ability of saliva to neutralize acids.
3. Increased viscosity of oral fluid, which makes it difficult to clean the oral cavity and increases the risk of developing a secondary infection.
4. Decreased salivation rate, especially with pronounced intoxication and pain syndrome.

These changes prevent the natural self-cleansing of the oral cavity, create conditions for the accumulation of microbial toxins, and intensify the inflammatory process. The peculiarities of childhood significantly affect the saliva profile in osteomyelitis:

- IgA and lactoferrin levels in 6-9-year-old children are significantly lower than in adolescents;
- in the younger age group, a sharp decrease in pH is more often observed;
- in adolescents, the cytokine response is expressed, especially IL-1β and TNF-α;

Changes in oral fluid composition can serve as an accessible, non-invasive, and informative method for monitoring pediatric osteomyelitis. Biochemical and immunological markers of saliva allow:

- assess the severity of the inflammatory process,
- monitor the effectiveness of treatment,
- identify early signs of microbiocenosis disorders,
- determine the need for correction of antimicrobial or anti-inflammatory therapy.

Modern studies show that a comprehensive assessment of oral fluid components (cytokines, MMP, microbial profile, pH, etc.) increases the accuracy of diagnosis by 1.5-2 times compared to traditional clinical examination.

Conclusions: Specific changes in oral fluid composition in children with jaw osteomyelitis are an important diagnostic criterion reflecting the nature and severity of the inflammatory process. In the biological environment, microbial imbalances, increased levels of inflammation mediators, activation of enzymes involved in bone tissue destruction, and changes in the physicochemical properties of saliva are recorded. A comprehensive analysis of these indicators allows for the timely detection of complications, monitoring the effectiveness of ongoing treatment, and developing personalized treatment regimens for children.

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