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ETIOLOGY, PATHOGENESIS AND MODERN METHODS OF TREATMENT OF PULPITIS

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Annotation. This article examines the etiology, clinical manifestations, and modern diagnostic approaches to pulpitis. In addition, it analyzes scientifically based and effective treatment methods tailored to the stages of disease progression. The role of early diagnosis and comprehensive strategies in preventing severe complications of pulpitis is emphasized. The article also discusses the effectiveness of preventive measures and the advantages of contemporary endodontic approaches in maintaining tooth vitality.
Keywords: pulpitis, diagnosis, clinical features, scientifically based effective treatment, prevention, endodontic therapy.

Introduction. Pulpitis is one of the most common diseases in dentistry, developing mainly as a result of deepening caries and the penetration of microorganisms into the pulp cavity through the dentin. It is characterized by pain syndrome, pulp inflammation, and later spread to the periapical tissues (1,3,7). Timely diagnosis and treatment of pulpitis is important not only for saving the tooth, but also for protecting the general health of the patient.

Recent studies have shown that the pathogenesis of pulpitis is a very complex process: in it, the microbiota, the immune system response, and the regenerative ability of pulp cells are closely interconnected (1,3,10). Therefore, modern approaches consider not only the elimination of inflammation, but also the possibility of preserving and restoring pulp tissue (2,4,8,9).

There have also been significant advances in diagnostics, with cone-beam computed tomography (CBCT), vitality tests, and biomarkers increasing the ability to detect disease at an early stage (5,6). This has enabled individualized treatment strategies and the introduction of minimally invasive techniques. Pulpitis is a problem in dentistry that has not only clinical but also socio-economic significance, and its effective prevention, early diagnosis, and treatment play an important role in improving the quality of dental care (3,6,9).

Etiology and pathogenesis. The main etiological cause of pulpitis is the penetration of microorganisms into the pulp cavity through the dentinal tubules during caries and the initiation of an inflammatory process. The bacterial biofilm associated with caries is formed mainly by Streptococcus mutans, Lactobacillus, and anaerobic microbes. They destroy the dentin structure and penetrate the pulp tissue, causing an inflammatory reaction in the pulp (1,3,10).

In addition, traumatic factors (tooth fracture, excessive dental procedures, thermal or chemical exposure) are also important etiological factors in the development of pulpitis (3,6).

From the point of view of pathogenesis, pulpitis is a complex inflammatory process in which the immune response of the host tissue plays a central role. In response to toxins and antigens released by microbes, inflammatory mediators - interleukins, tumor necrosis factor, and prostaglandins - are actively produced in the pulp (3,10). This process is accompanied by vasodilation, exudation, and edema. Since the pulp tissue is located in a closed chamber, pressure increases and pain syndrome increases (6,7).

Recent studies have also widely studied the regenerative capacity of the pulp. Pulp fibroblasts, odontoblasts, and stem cells in response to inflammation activate protective mechanisms and attempt to form dentin (1,4,9). However, if the infection persists or the immune response is too strong, pulp necrosis develops and periapical tissues are damaged (7,10).

In general, the pathogenesis of pulpitis is based on a complex interaction between the microbiota, the immune response and the biological properties of the pulp tissue. A thorough understanding of these mechanisms is of great importance for the development of modern treatment methods.

Classification and clinical manifestations. Pulpitis manifests itself in clinical practice in various forms. In the traditional classification, it is divided into acute and chronic forms. Acute pulpitis is usually characterized by severe pain that occurs suddenly. The pain often worsens at night, radiates to other teeth, and is aggravated by heat or cold. At this stage, a serous or purulent inflammatory process occurs in the pulp (3,7).

Chronic pulpitis develops gradually and is often painless or mildly uncomfortable. Clinical manifestations include granulating pulpitis, hypertrophic pulpitis, or fibrosing pulpitis (5,6). Chronic forms are often diagnosed late, as the patient does not feel pain and consults a doctor only because of discomfort (2,9).

Modern classifications also distinguish reversible and irreversible forms of pulpitis (1,4,10). In reversible pulpitis, the inflammatory process is reversible, and conservative treatment can restore pulp function. In irreversible pulpitis, the pulp is completely damaged and necrosis develops, which requires endodontic treatment.

The clinical significance of the classification is that it allows for the diagnosis, the determination of the treatment regimen, and the assessment of the prognosis. Therefore, the correct differentiation of pulpitis forms in dental practice is an important condition for effective disease management (7,8).

Diagnostic methods. In the diagnosis of pulpitis, clinical signs are of primary importance. In the acute form, severe and sudden pain is observed, especially at night. The reaction to hot and cold stimuli is also diagnostically important: in reversible pulpitis, the pain is short-lived, while in irreversible pulpitis it is long-lasting. Chronic pulpitis is often painless or manifests itself only with mild discomfort (2,6,7). The condition of the periodontal tissues is assessed using palpation and percussion tests performed by the doctor. An electric pulp test allows you to determine the vitality of the pulp, while in irreversible forms, high stimulation is required (3,5). Radiological examinations are also widely used in the diagnosis. Plain radiography determines the depth of caries, the border of the pulp chamber, and changes in the periapical tissues. In modern conditions, cone beam computed tomography (CBCT) has more advantages, facilitating diagnosis in complex cases by providing three-dimensional high-resolution images (5,9).

In recent years, special attention has been paid to the use of biological markers in pulp diagnostics. Inflammatory mediators such as cytokines and matrix metalloproteinases have been detected in the pulp fluid and peri-dental exudate, and their levels serve as additional criteria for determining the early stage of the disease process (7,10). This approach, complementing classical clinical and radiological methods, allows for more accurate diagnosis.

Thus, pulp diagnostics is a multifaceted process, in which the most effective method is the complex use of clinical observations, instrumental examinations and modern biomarker analysis. The correct diagnosis is a decisive factor in choosing a treatment strategy and is of great importance in saving the patient's tooth (2,6,9).

Modern methods of treatment. The main goal of pulpitis treatment is to eliminate inflammation, preserve the viability of the pulp tissue as much as possible, and restore the functional significance of the tooth. Treatment approaches are usually determined depending on the clinical form of the disease, the reversible or irreversible state of the pulp.

Conservative methods are the priority in reversible pulpitis. In this case, caries is completely removed, treated with antiseptic drugs, and protective coating materials are used on the pulp surface. In recent years, calcium hydroxide-based preparations have been replaced by bioceramic

materials, including mineral trioxide aggregate (MTA) and bioceramic cements, which have been shown to be effective in stimulating the regeneration of pulp cells (1,4,8).

Endodontic treatment, i.e., removal of infected pulp tissue inside the canal, remains the main approach in irreversible pulpitis. Modern endodontics uses nickel-titanium instruments for mechanical treatment, and solutions such as sodium hypochlorite, EDTA, and chlorhexidine for irrigation (2,6). However, it has been proven that enhanced irrigation with ultrasound and laser can effectively remove biofilm inside the canal (5,9).

In addition, new methods aimed at preserving pulp vitality are widely developed in modern dentistry. Pulp regenerative therapy aims to restore pulp tissue using stem cells, growth factors and biomaterials. Experience shows that these methods may become an alternative direction for endodontic treatment in the future (3,7,10).

The combined use of conservative, endodontic and regenerative approaches in the treatment of pulpitis increases its effectiveness. In each clinical case, an individual treatment plan should be selected, taking into account the patient's age, general health and pulp condition.

Prevention and social significance. Prevention of pulpitis is primarily related to the prevention of caries. Reducing the formation of biofilm on the tooth surface, implementing regular hygiene measures and properly organizing the diet significantly reduce the risk of pulpitis. Fluoridated toothpastes and professional hygiene procedures are effective in controlling the development of caries, reducing the main etiological factors of pulpitis (2,6).

Preventive measures carried out at the community level are also of particular importance. Public education on oral hygiene, regular dental examinations of school-age children and the introduction of protective procedures reduce the prevalence of pulpitis (4,7). Also, the practice of doctors aimed at early diagnosis and treatment prevents the transition of pulpitis to complex forms (1,8).

The social significance of pulpitis is that it is a widespread disease that affects a large part of the population. Due to severe pain syndrome, the quality of life of patients deteriorates, negatively affects work activity and creates an additional economic burden for the health system (3,5,9). Therefore, effective prevention programs are important not only for protecting individual health, but also for ensuring economic sustainability in the general health system (10).

For effective control of pulpitis, hygienic, clinical and social preventive measures must be carried out in a coordinated manner. In this way, it is possible to prevent the disease at an early stage, which will reduce the complexity of treatment and economic losses.

Practical solutions. An integrated approach is necessary to effectively solve the problem of pulpitis. First of all, preventive measures should be strengthened, since the main etiological factor of the disease is caries. Regular oral hygiene, the use of fluoride products, and the introduction of periodic dental examinations significantly reduce the prevalence of pulpitis. Special attention should also be paid to early diagnosis. By combining clinical observations, radiological examinations, and biomarker analyses, the chances of timely detection and treatment of reversible pulpitis increase.

The use of modern materials in the treatment process is important. With the help of bioceramic coatings and preparations based on MTA, it is possible to preserve the vitality of the pulp and restore the functional value of the tooth for a long time. In cases of irreversible pulpitis, the use of mechanized endodontic instruments, effective irrigation solutions, laser and ultrasound technologies increases the effectiveness of treatment. In the future, regenerative endodontics is seen as a particularly promising direction. Approaches based on stem cells, biomaterials and growth factors can provide an opportunity to restore pulp tissue and open a new era in dentistry. At the same time, increasing the dental literacy of the population through social and health programs will help reduce the social and economic consequences of pulpitis.

Conclusion. Pulpitis is a common and complex clinical disease in dentistry, the development of which is a multifactorial process. Although the main etiological cause is caries and microbiological factors, traumatic and iatrogenic influences also play an important role. The pathogenesis is based on a complex interaction between inflammatory mediators, immunological response and the regenerative capacity of pulp tissue. Improvements in diagnostic methods and new treatment approaches are expanding the possibilities for early detection and effective treatment of the disease.

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