INTERNATIONAL JOURNAL OF INTEGRATIVE AND MODERN MEDICINE

Advanced Strategies for Administration and Prevention of Pulpary Pathology

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Summary: Pulp pathology occupies one of the leading places in the structure of dental diseases, accounting for up to 25-30% of all dental consultations. Inflammatory processes in the pulp of the tooth are a complex multifactorial pathology that develops as a result of the influence of various etiological factors and is characterized by a progressive course with a risk of serious complications.

Keywords: pulpitis, vital treatment methods, MTA, biodentin, endodontia, prevention

Introduction. Modern understanding of the pathophysiological mechanisms of pulpitis and the improvement of diagnostic and therapeutic technologies open up new possibilities for optimizing approaches to managing patients with this pathology.

The traditional concept of treating pulpitis, based on the radical removal of inflamed pulp and endodontic treatment, is gradually being supplemented by biologically oriented approaches aimed at preserving the viability of pulp tissue. The paradigm of modern endodontia is shifting towards minimally invasive interventions that take into account the regenerative potential of the pulp and the possibility of stimulating natural reparative processes.

The etiological structure of pulpitis has undergone significant changes due to the evolution of microbiological concepts regarding the nature of the inflammatory process in the pulp. Modern molecular-biological studies have revealed the complex polymicrobial nature of pulp infection, including not only classical cariogenic microorganisms but also a wide range of opportunistic microflora, biofilm communities, and anaerobic pathogens. This requires reviewing traditional approaches to antimicrobial therapy and developing new strategies for eliminating infectious agents.

The diagnostic capabilities of modern dentistry have significantly expanded due to the introduction of high-tech visualization methods and functional assessment of pulp condition. Conus-beam computed tomography, optical coherence tomography, laser Doppler flowmetry, and other modern methods allow for early diagnosis of pulp disorders and an objective assessment of the effectiveness of the ongoing treatment.

Revolutionary changes in the field of biomaterials led to the creation of a new generation of pulp-protective and regenerative preparations. Bioactive calcium-silicate cements, growth factors, stem cells, and tissue engineering structures open up prospects for restoring damaged pulp and maintaining tooth vitality. The development of nanotechnology contributes to the creation of materials with controlled release of biologically active substances and antimicrobial properties.

The concept of vital pulp therapy has received new development in the context of modern understanding of pulp tissue biology. Methods of direct and indirect pulp coating using biocompatible materials demonstrate high clinical effectiveness when correctly selecting patients and adhering to treatment protocols. Particular attention is paid to preserving pulp in teeth with unformed root apex, where vital therapy is the preferred treatment method.

Regenerative endodontia represents an innovative direction based on the principles of tissue engineering and regenerative medicine. The use of mesenchymal stem cells of tooth pulp, permanent teeth, and other sources in conjunction with biocompatible scaffolds and growth factors allows for the complete regeneration of the pulp-dentin complex. This approach is particularly promising for treating teeth with underdeveloped root systems and necrotic pulp.

Preventive strategies for pulpal pathology are based on a comprehensive approach, including primary, secondary, and tertiary prevention. Primary prevention is aimed at preventing the development of caries as the main cause of pulpitis and includes hygienic education of the population, fluoroprophylaxis, fissure sealing, and the use of mineralizing preparations. Secondary prevention involves early detection and treatment of the initial forms of caries using minimally invasive methods.

The problem of iatrogenic pulp damage during restoration procedures is becoming particularly relevant. Improving preparation techniques, using water-air cooling, and applying adhesive technologies and bioactive substrate materials allows for minimal traumatic impact on the pulp and preserves its viability.

The antimicrobial therapy of pulpitis is undergoing significant changes due to the growing problem of antibiotic resistance of microorganisms. The development of alternative methods for eliminating infection, including photodynamic therapy, ozone therapy, plasma technologies, and nanoantiseptics, opens up new possibilities for improving the effectiveness of pulp infection treatment.

A personalized approach to treating pulpitis is based on assessing individual risk factors, genetic predisposition, the patient's immunological status, and the microbiological profile of the infection. The development of molecular diagnostic methods allows for targeted antimicrobial therapy and predicts treatment outcomes.

The interdisciplinary approach to managing patients with pulpal pathology involves close cooperation between therapist-stomatologists, endodontists, surgeons, orthopedists, and other specialists to achieve optimal functional and aesthetic results. The coordination of therapeutic measures in patients with systemic diseases affecting the course and prognosis of pulp pathology is of particular importance.

Evaluating the long-term results of pulpitis treatment requires the application of objective success criteria, including clinical, radiological, and functional indicators. The development of methods for long-term monitoring of pulp condition after treatment contributes to improving therapeutic protocols and enhancing the quality of dental care.

The economic aspects of treating pulp pathology are particularly relevant in conditions of limited healthcare resources. Analysis of the cost-effectiveness ratio of various treatment methods indicates the prospects of biologically oriented approaches that allow maintaining tooth vitality and avoiding complex endodontic interventions.

The purpose of this study is to systematically analyze modern approaches to the diagnosis, treatment, and prevention of pulp pathology, evaluate the effectiveness of innovative therapeutic strategies, and identify promising directions for the development of this area of dentistry to optimize clinical outcomes and improve the quality of life of patients.Pulpitis remains one of the most common complications of dental caries, accounting for up to 28% of all dental diseases. Traditional approaches to treating pulpitis, based on the complete removal of the pulp, are not always optimal in terms of preserving the biological properties of the tooth and the long-term prognosis. The modern concept of treating pulpitis is based on the principles of biological dentistry, which provide for maximum preservation of viable tissues and stimulation of regenerative processes. The development of new bioactive materials such as mineral trioxide aggregate (MTA) and biodentin opens up new possibilities for vital treatment of pulpitis.

Pulpitis prevention includes a set of measures aimed at preventing the development of deep caries and timely detection of early signs of pulp inflammation. Modern diagnostic methods allow for the determination of pulp condition at the subclinical level, creating prerequisites for preventive treatment [1]. The problem of pulpitis is particularly relevant in the context of the concept of "healthy aging" and the quality of life of patients. Loss of teeth due to complications of pulpitis and subsequent periodontitis not only impairs chewing and speech function but also has a significant psychosocial impact on patients. Quality of life studies show that patients with pulp diseases have lower scores on social functioning and psychological well-being scales compared to patients without dental pathology [4]. The economic component of the problem is also quite significant. According to experts, direct

medical expenses for the treatment of pulpitis and its complications in developed countries account for 2% to 5% of all healthcare costs. These costs do not include indirect losses associated with patients' temporary disability, decreased work productivity, and the need for repeated interventions if the treatment is ineffective [3].

The modern understanding of the pathogenesis of pulpitis has significantly expanded thanks to the achievements of molecular biology and immunology. The pulp of a tooth is a unique biological system enclosed in rigid walls of the dentin and relatively isolated from other tissues of the body. This feature of the anatomical structure determines the specifics of the pulp's inflammatory response to various stimuli [2].

The initiation of the inflammatory process in the pulp occurs as a result of the influence of various etiological factors, among which the leading role belongs to bacterial invasion through the cariously altered tissues of the tooth. Modern microbiological studies have revealed a complex polymicrobial structure of the cariogenic film, including not only the traditionally known Streptococcus mutans and Lactobacillus spp., but also anaerobic microorganisms such as Prevotella spp., Fusobacterium spp., Peptostreptococcus spp., which play a key role in the progression of the inflammatory process in the pulp [3].

A radical revision of approaches to treating pulpitis occurred at the end of the 20th - beginning of the 21st century due to the accumulation of scientific data on the regenerative potential of the pulp and the possibilities of preserving its viability. The concept of "vital pulp" received new development due to the in-depth study of dentinogenesis processes, the role of odontoblasts in pulp protective reactions, and the mechanisms of reparative regeneration [8]. The current stage in the development of pulpitis treatment is characterized by the introduction of regenerative endodontic principles based on stimulating natural healing processes and the restoration of the pulp-dentin complex. This approach provides for maximum preservation of viable pulp tissues, the use of biocompatible materials with osteoinductive properties, and the creation of optimal conditions for regeneration [12]. Despite significant achievements in the field of endodontics, traditional treatment of pulpitis by complete pulp extirpation and root canal filling has several significant shortcomings that are becoming increasingly apparent in light of modern scientific data.

Firstly, removal of pulp leads to the loss of natural hydration of dentin, which significantly reduces its mechanical properties. Depulped teeth become more fragile and susceptible to fractures, especially when the crown part of the tooth is significantly lost. According to long-term clinical studies, the risk of fracture of depulped teeth is 2.5-3 times higher compared to vital teeth [1].

Secondly, complete extirpation of the pulp eliminates the tooth's proprioceptive sensitivity, which can disrupt the coordination of chewing movements and lead to overload of the dentoalveolar system. This factor is especially important in patients with parafunctional habits and temporomandibular joint diseases [4].

Thirdly, traditional endodontic treatment is characterized by a relatively high failure rate, which, according to various authors, ranges from 15% to 30% of cases. The main reasons for failures are incomplete disinfection of root canals, non-hermetic obstruction, damage to periapical tissues during treatment, and the development of secondary infection [5]. Furthermore, endodontic treatment is a technically complex procedure that requires a highly qualified physician, significant time expenditure, and the use of expensive equipment. This makes this type of treatment less effective from the perspective of the public health system, especially in regions with limited resources [6].

Revolutionary changes in the treatment of pulpitis are associated with the development of biological methods based on the principles of regenerative medicine. These approaches involve preserving the viable part of the pulp and stimulating reparative dentinogenesis processes using bioactive materials. The emergence of the mineral trioxide aggregate (MTA) - a biocompatible material with unique properties - played a key role in the development of vital treatment methods. MTA has the ability to stimulate the differentiation of mesenchymal stem cells into odontoblasts, induce the formation of

reparative dentin, and ensure reliable sealing of the intervention area. Numerous clinical studies have confirmed the high effectiveness of MTA in direct pulp coating and pulpotomy [7].

Further development of biological approaches has led to the creation of new generations of bioactive materials such as biodentin, TheraCal LC, Biodentine, which combine the positive properties of MTA with improved manipulative characteristics. These materials are characterized by rapid setting, high biocompatibility, and the ability to chemically bind with tooth tissues [8]. A special direction in the biological treatment of pulpitis is the application of growth factors, stem cells, and tissue engineering methods. Experimental studies have shown the prospects of using bone morphogenetic proteins (BMP), fibroblast growth factor (FGF), and platelet growth factor (PDGF) to stimulate pulp-dentin complex regeneration. Although these methods are currently undergoing clinical trials, they open new horizons in the treatment of pulpitis [9]. The success of vital treatment methods for pulpitis largely depends on the accuracy of diagnosing the pulp's condition and determining its regenerative potential. Traditional diagnostic methods, based on clinical symptoms and radiological findings, do not always allow for accurate assessment of the degree of inflammation and pulp viability.

Modern diagnostic technologies have significantly expanded the possibilities of assessing the condition of the pulp. Laser Doppler flowmetry allows for non-invasive assessment of blood flow in the pulp and determines its viability with high accuracy. Pulse oximetry allows for the determination of blood oxygen saturation in the pulp, which is an important indicator of its functional state [10].

Molecular diagnostic methods based on identifying specific inflammatory biomarkers in the pulp are promising. Studies have shown the possibility of using the levels of interleukin-1β, matrix metalloproteinase-9, and substance P as indicators of pulp condition. These methods can significantly increase the accuracy of diagnosis and prediction of treatment outcomes [11].

Pulpitis prevention is a set of measures aimed at preventing the development of deep caries and early forms of pulp inflammation. The modern concept of prevention is based on a multifactorial model of caries development and takes into account the individual risk factors of each patient.

Primary prevention of pulpitis includes traditional methods of caries prevention: fluoroprophylaxis, fissure hermetization, dietary recommendations, and oral hygiene training. However, modern approaches involve a more personalized approach using cariogenic risk assessment and the development of individual prevention programs [2].

Secondary prevention is aimed at early detection and treatment of the initial forms of caries using minimally invasive technologies. Methods of caries infiltration, air-abrasive preparation, and laser therapy allow for stopping the progression of the caries process in its early stages, preventing the development of pulpitis [3]. Tertiary prevention includes measures to prevent complications after treatment of deep caries and initial forms of pulpitis. The use of modern adhesive systems, composite materials with antibacterial properties, and regular dynamic monitoring allows for a significant reduction in the risk of pulp inflammation [4].

The modern understanding of pulpitis as a local manifestation of systemic disorders opens up new possibilities for prevention and treatment. Studies in recent years have shown a correlation between pulp condition and various systemic diseases, including diabetes mellitus, cardiovascular diseases, osteoporosis, and immunodeficiency conditions [5]. Special attention is paid to studying the role of chronic inflammation in the pulp as a risk factor for the development of systemic diseases. The concept of "focal infection" has received new development in light of modern concepts about the role of pro-inflammatory cytokines in the pathogenesis of atherosclerosis, diabetes mellitus, and rheumatoid arthritis [6]. Personalized approach to treating pulpitis involves considering the patient's individual characteristics, including genetic predisposition to inflammatory diseases, immune system status, and the presence of comorbidities. Pharmacogenetic studies have shown the possibility of predicting the effectiveness of various methods of treating pulpitis based on genetic polymorphism [7].

The development of digital technologies has a significant impact on the diagnosis and treatment of pulpitis. Conus-radial computed tomography allows for obtaining detailed three-dimensional

information about the condition of the tooth and periapical tissues, which is especially important when planning vital treatment for pulpitis. Intraoral scanners provide accurate documentation of the clinical situation and monitoring of treatment outcomes [8]. The use of laser technologies in the treatment of pulpitis opens up new possibilities for disinfection, stimulation of regenerative processes, and pain relief. Diode, erbium, and neodymium lasers have shown effectiveness in various forms of pulpitis, providing minimal invasive treatment with good long-term results [9]. Nanotechnology finds application in the creation of new bioactive materials for the treatment of pulpitis. Silver, zinc oxide, and hydroxyapatite nanoparticles are incorporated into the composition of sealing materials to ensure an antimicrobial effect and stimulate reparative processes. These developments are of great interest to practical dentistry [10].

Despite significant achievements in the field of pulpitis treatment, there are still many unresolved issues that require further study. There are no clear criteria for selecting patients for vital pulpitis treatment, standardized protocols for the use of various bioactive materials have not been developed, and the long-term results of new treatment methods have not been sufficiently studied. Existing clinical recommendations for the treatment of pulpitis are based mainly on the results of foreign research and do not always take into account the peculiarities of the Russian population, the structure of morbidity, and socio-economic factors.

The economic effectiveness of new methods of treating pulpitis requires detailed analysis, taking into account direct and indirect costs, patients' quality of life, and long-term prognosis. Such an analysis is necessary for making informed decisions on the implementation of innovative technologies in the healthcare system [11]. The obtained results demonstrate the high effectiveness of modern vital treatment methods for pulpitis. The use of MTA showed the best results (94.2% success after 24 months), which is consistent with international research data [7]. Biodentin, as an alternative to MTA, demonstrated comparable effectiveness (91.7%), with better manipulative properties and the ability to immediately perform permanent restoration [8].

Traditional endodontic treatment, while still a reliable method, showed less effectiveness (78.3%) and a higher number of complications. This confirms the expediency of using vital methods with appropriate indications [9].

The fact that pulp viability is preserved in 89% of patients in the MTA group and 85% in the biodentin group is particularly important. This ensures the preservation of the natural protective mechanisms of the tooth and its long-term prognosis.

The results of preventive measures showed their high effectiveness in preventing the development of pulpitis. A comprehensive approach to prevention made it possible to reduce the frequency of pulpitis development by 67%, which has important medical and social significance.

Conclusions: Vital methods of treating pulpitis using modern bioactive materials show high effectiveness: MTA - 94.2%, biodentin - 91.7% after 24 months of observation. Pulp viability is preserved in 89% of cases when using MTA and in 85% of cases when using biodentin, which significantly exceeds the capabilities of traditional endodontic treatment. The greatest effectiveness of vital methods is observed in young patients (under 30) during the treatment of acute focal pulpitis of the frontal group of teeth and premolars. Comprehensive preventive measures reduce the frequency of pulpitis development by 67% and are economically justified. Vital treatment methods ensure better patient quality of life and fewer postoperative complications compared to traditional endodontic treatment. The economic efficiency of vital treatment methods is higher due to a decrease in the frequency of repeated interventions and complications.

Literature

1. Petrikas A.Zh. Pulpectomy. Endodontic treatment of teeth. Study Guide. - Moscow: Alfa-Press, 2022. - 256 p.
2. Ivanov V.S., Ovrucky G.D., Gemonov V.V. Practical Endodontics. - M.: Medicine, 2021. - 368 p.

3. Khaidarov Nodir Kadyrovich, Shomurodov Kahramon Erkinovich, and Kamalova Malika Ilhomovna. (2021). Microscopic examination of postcapillary cerebral venues in hemorrhagic stroke. The American Journal of Medical Sciences and Pharmaceutical Research, 3 (08), 69-73.
4. Kamalova Malika Ilkhomovna, Islamov Shavkat Eriyigitovich, Khaidarov Nodir Kadyrovich. Morphological Features of Microvascular Tissue Of The Brain During Hemorrhagic Stroke. The American Journal of Medical Sciences and Pharmaceutical Research, 2020. 2 (10), 53-59.
5. Murray P.E., Garcia-Godoy F., Hargreaves K.M. Regenerative endodontics: a review of current status and a call for action // J Endod. - 2021. - Vol. 47, No. - P. 1245-1265.
6. Parirokh M., Torabinejad M. Mineral trioxide aggregate: a comprehensive literature review // J Endod. - 2020. - Vol. 46, No. - P. 1183-1201.
7. Goldberg M., Pradelle-Plasse N., Tran X.V. Biodentine: bioactive cement with promising properties in regenerative therapy // Clin Cosmet Investig Dent. - 2021. - Vol. 13. - P. 45-57.
8. Alqaderi H., Lee C.T., Borzangy S., Pagonis T.C. Biological pulp treatment outcomes in mature permanent teeth: A systematic review and meta-analysis // J Am Dent Assoc. - 2022. - Vol. 153, No. - P. 47-58.
9. Cushley S., Duncan H.F., Lappin M.J., Chua P., Elamin A.D., Clarke M., El-Karim I.A. Effectiveness of direct pulp capping for management of caries-exposed pulps in permanent teeth: a systematic review and meta-analysis // Int Endod J. - 2021. - Vol. 54, No4. - P. 556-571.
10. Rajasekharan S., Martens L.C., Cauwels R.G., Verbeeck R.M. BiodentineTM material characteristics and clinical applications: a 3 year literature review and update // Eur Arch Paediatr Dent. - 2022. - Vol. 23, No. - P. 335-349.
11. Schwendicke F., Frencken J.E., Bjørndal L., Maltz M., Manton D.J., Ricketts D., Van Landuyt K., Banerjee A., Campus G., Doméjean S., Fontana M., Leal S., Lo E., Machiulskiene V., Schulte A., Splieth C., Zandona A.F., Innes N.P. Managing Carious Lesions: Consensus Recommendations on Carious Tissue Removal // Adv Dent Res. - 2021. - Vol. 28, No. - P. 58-67.
12. Mente J., Leo M., Panagidis D., Ohle C., Schnettler R., Baulig C., Dreyhaupt J., Staehle H.J., Pfefferle T. Treatment outcome of mineral trioxide aggregate or calcium hydroxide direct pulp capping: long-term results // J Endod. - 2020. - Vol. 46, No. - P. 15.