Analysis of the Antibacterial Spectrum of the Antiseptic Drug Miramistin in Periodontal Inflammatory Diseases

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Abstract. This article presents an analysis of literature data from foreign and scientific publications on the properties and therapeutic efficacy of antiseptics used in the treatment of inflammatory diseases of the gums. Periodontal diseases make up a large part of oral diseases. In recent years, dentists have made significant progress in improving the quality of medical care for patients with periodontal diseases, including periodontitis. Currently, the treatment of inflammatory diseases of the periodontal tissue is based on the principle of an individual approach and requires a comprehensive treatment regimen, which includes local-professional oral hygiene, the use of antiseptics in the form of rinses and irrigants, as well as general therapy methods.

Keywords: periodontium, periodontal diseases, antiseptic, miramistin, chlorhexidine, general periodontitis, irritant, microbial flora, Candida.

Main part

Periodontitis occurs in the form of local and generalized periodontal inflammation. In the etiology and pathogenesis of chronic generalized periodontitis, the microbial flora of the oral cavity plays a leading role — including gram-positive cocci, bacteria, spirochetes, fusiform bacteria, and gram-negative anaerobes. These microorganisms are highly aggressive and capable of penetrating periodontal tissues. They are localized in the gingival sulcus, on the tooth root surface, on the surface of the junctional epithelium, and within periodontal pockets.

The most important in comprehensive treatment of chronic generalized periodontitis is the choice of the preparing effective antibacterial drug. Contemporary protocols for treatment of the inflammatory periodontal diseases necessitate full mouth professional oral hygiene at baseline. This process is divided into two consecutive sessions: the former (AirFlow session) aims to remove soft plaque and superficial pigmentation, whereas in the second section (ultrasonic conference), mineralized plaque and subgingival calculus are removed.

This method can completely eliminate the biofilm and prepare for a favorable effect of subsequent anti-inflammatory therapy. In order to avoid the relapse of a disease in the therapeutic and preventive algorithm local agents with disinfecting action of broad spectrum should be used. These antiseptics are used as mouth rinses or irrigation.

For this purpose, antiseptics of several classes are recommended; halogen derivatives and other oxidizing agents, polyhydric alcohols biguanides metal compounds alkaline rinses quaternary ammonium compounds and the like for clinical application. In recent years, quaternary ammonium compounds (QACs) such as miramistin and decasan; polyhydric alcohols (PAHs) such as glycerin, sorbitol, xylitol, and polypropylene glycol; and biguanides (BGs) such as chlorhexidine and polyhexanide have become the most widely used agents.

According to R. V. Ushakov and V. N. Sarev (2021), the mechanisms of antiseptic action of different drugs differ significantly and may involve several pathways of action on microbial cells. These include: protein denaturation; disruption of glycosidic and peptide bonds of peptidoglycans in the cell wall; destruction of hydrogen bonds in the main structural components of pathogenic bacterial cells; increased permeability of the cell membrane; and inactivation of enzymes essential for microbial vital activity.

An important property of periodontal antiseptics is their ability to penetrate the microbial biofilm of dental plaque and eliminate it. According to generally accepted views, timely diagnosis and adequate treatment of the early stages of gingivitis and periodontitis ensure complete recovery. However, achieving stable, long-term results is very difficult and problematic due to the multifactorial nature of these diseases, which is particularly important when selecting the optimal periodontal antiseptic.

Among quaternary ammonium compounds, miramistin and decasan are widely used. Their spectrum of antibacterial activity is considered to be mainly dose-dependent. However, with increasing doses of these agents, their toxic effect on the mucous membrane also increases, which may lead to carcinogenic effects.

An alternative drug used in clinical periodontal practice is chlorhexidine, a biguanide derivative, which has been used in dentistry for more than 40 years due to its clinical efficacy and high activity against many pathogenic bacteria. It has a wide range of antimicrobial activity against oral bacteria and fungi that includes Candida albicans; the latter antifungal action extends to other fungal species.

In the case of preventive action after professional tooth cleaning, after professional oral hygiene or scaling and root planning (SRP), according to clinical practice guidelines and instructions it is advisable to use chlorhexidine with anti-plaque effect in cases of gingivitis and periodontitis for 2-4 weeks. In this regard, are used mouthwashes with chlorhexidine digluconate in concentrations between 0.01% and 0.2%.

While the high amount of clinical and microbiological data proving the efficacy of periodontal antiseptics is available, pharmacological profiles warrant for further investigation. A perspective direction in this sphere is the application of current culturomics techniques using automated bioreactor systems that provide a standard culture condition for microorganisms and develop an e-NP test (real-time digital in vitro monitoring) for efficacy testing antiseptics. When studies were conducted using the above-mentioned method, the results of investigating the antimicrobial activity of miramistin demonstrated a clear dose-dependent effect.

Miramistin 0.01% solution is an antiseptic agent and represents a new-generation antiseptic. It exhibits specific activity against a broad spectrum of pathogens, including gram-positive and gram-negative bacteria, fungi, viruses, protozoa, aerobic and anaerobic flora, including multidrug-resistant strains.

The bacteriostatic concentration of miramistin is 0.012-0.05%, and that of its bactericidal action is 0.05-0.1%. Fungistatic doses vary from 0.05 to 0.1% and fungicidal ones varies between 0.1 and 0.2%. Miramistin has more powerful fungicidal activity and wider range action than that of chlorhexidine23 oxidizing bacteria, spores, fungi.

Mode of action: Miramistin violates the structure of lipid membrane layers of envelopes and cytoplasmic membranes of staphylo-and streptococci, cocci, gram-positive bacteria, including those resistant to antibiotics and enterovirusesImpermeability increases their membranes with respect to other Bacteria (normal microflora) destroys cellular enzyme systems microbial cell wall proteins losing conformational purity at low temperature content in cells Neisseria gonorhoeae inhibits HIV. It doesn't damage human cells.

Miramistin has expressed fungicidal effect on Candida spp., dermatophytes (Trichophyton, Microsporum, Epidermophyton) and mold mycetes (Aspergillus, Penicillium, Mucor, Rhizopus).

When used for prolonged periods in the oral cavity, it does not change tooth colour, and is only slowly destructive to microflora, or affect mucosa.

In combination with antibiotics and other etiotropic preparations, Miramistin exhibits an additive effect by shortening the course of treatment and enhancing efficiency of therapy. Clinical and immunological studies indicate that complex treatment of chronic generalized periodontitis with the immunomodulatory antiseptic miramistin ensures stable remission and prolongs its duration. Research has shown statistically significant improvements in subsequent parameters compared to baseline clinical assessments, including plaque index (API), probing pocket depth, Mühlemann bleeding index (BI), and clinical attachment level.

The advantage of this agent over other antiseptics lies in its immunomodulatory activity, which is particularly important for the treatment of periodontal diseases occurring against the background of chronic conditions. Its immunomodulatory effect involves the stimulation of functional activity of T- and B-lymphocytes. The agent possesses an immunoadjuvant effect, enhancing local defense by modulating cellular and local humoral immune responses. It does not affect the treated area, does not cause allergic reactions, and has no carcinogenic or mutagenic properties.

The results of studying the antimicrobial activity of chlorhexidine digluconate also demonstrate a dose-dependent effect. Its bacteriostatic activity is observed at concentrations of 0.012–0.025%, while bactericidal activity occurs at 0.05–0.1%. Fungistatic concentrations range from 0.25–0.5%, and fungicidal activity is observed at 0.5–1.0%.

Chlorhexidine exhibits moderate efficacy against fungi, demonstrating a weaker antiseptic effect. Its antifungal mechanism involves damaging the cell membrane and inducing coagulation of cytoplasmic proteins.

It is primarily effective against Candida, especially C. albicans, has a limited spectrum of activity against mold fungi, and is ineffective against dermatophytes.

When used in the oral cavity for extended periods, it can cause tooth discoloration, disruption of the microflora, dry mouth, irritation of the mucous membrane, and alterations in taste perception.

Conclusion

An analysis of the literature indicates that miramistin is recognized as the most promising antiseptic in periodontal practice, distinguished by minimal toxicity and a broad spectrum of antimicrobial activity. Numerous local studies have demonstrated its clear clinical efficacy, which has been confirmed in vitro against key periodontal pathogens such as A. actinomycetemcomitans, T. forsythia, T.denticola, P. gingivalis, P. intermedia, and F. nucleatum/periodonticum. As a highly active cationic rinse, miramistin damages the phospholipid outer membrane of the cytoplasmic membrane and cell wall, which underlies its high activity not only against gram-positive but also gram-negative bacteria.

As for chlorhexidine, it undoubtedly exhibits a broader spectrum of antimicrobial activity. However, on the other hand, chlorhexidine also has a number of negative properties. For example, its tissue and mucosal toxicity increases in a dose-dependent manner, prolonged use can cause tooth discoloration, and there is a tendency for the development of dysbiotic shifts in the oral microbiota.

The application of modern medical advances in dental practice expands the possibilities for pathogenetic treatment of periodontal diseases.

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