

Bacteriophages in the Medicinal Treatment of Odontogenic Phlegmons in the Main and Sublingual Areas

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Abstract: The work provides an analytical review of modern data on the use of bacteriophages in the complex pharmacological treatment of odontogenic phlegmons of the mandibular and sublingual regions. The mechanisms of lytic activity of bacteriophages, their ability to destroy capsular structures and biofilms, as well as the potentiation of antibiotic action, have been examined. Particular attention is paid to the phage sensitivity of clinically significant microorganisms and the prospects for individualized selection of phage preparations.

Keywords: odontogenic phlegmon, submandibular region, sublingual region, bacteriophages, phago therapy, antibiotic resistance, biofilm.

INTRODUCTION

Odontogenic phlegmons of the submandibular and sublingual regions belong to severe purulent-inflammatory diseases of the maxillofacial region, characterized by the rapid spread of infection through the fascial spaces of the neck and a high risk of systemic complications. The polymicrobial nature of the infection, the presence of antibiotic-resistant strains (*Staphylococcus aureus*, *Klebsiella pneumoniae*, *Streptococcus* spp., *Escherichia coli*, anaerobic microorganisms), and the formation of bacterial biofilms significantly hinder the effectiveness of standard antibacterial therapy[1,2].

Odontogenic phlegmons of the submandibular and sublingual regions are among the most severe purulent-inflammatory diseases of the maxillofacial region. These pathological processes are characterized by the rapid spread of infection through fascial spaces, a pronounced inflammatory reaction, and a high risk of infection generalization. The main causative agents of odontogenic purulent-inflammatory processes are *Staphylococcus aureus*, *Streptococcus pyogenes*, *Klebsiella pneumoniae*, *Escherichia coli*, *Pseudomonas aeruginosa*, as well as anaerobic microorganisms of the *Prevotella* and *Fusobacterium* genera.

In recent years, there has been a significant increase in the antibiotic resistance of microorganisms, which significantly complicates the pharmacological treatment of purulent-inflammatory diseases. According to N.I. Briko et al., soft tissue streptococcal infections are characterized by high virulence and the ability to spread rapidly[3,4,5]. Simultaneously, the number of bacterial strains with multiple drug resistance increases.

Analysis of literature data indicates the high specificity of bacteriophages, their activity against antibiotic-resistant strains, and their ability to reduce bacterial load without significant impact on normal microbiota. The combined use of bacteriophages and antibiotics is considered a promising direction for the pathogenetically grounded therapy of purulent-inflammatory processes in the maxillofacial region[6]. The use of bacteriophages can increase the effectiveness of drug treatment for odontogenic phlegmons and requires further clinical research to optimize application regimens.

In this regard, modern medicine is actively studying alternative antimicrobial treatment methods. One of the promising areas is the use of bacteriophages — bacterial viruses that possess high specificity and pronounced lytic activity. As N.P. Yelinov notes, bacteriophages are capable of selectively infecting bacterial cells and causing their lysis without causing toxic effects on macroorganism cells[7,8,9].

In recent years, phage therapy has been considered a promising method for treating bacterial infections, including inflammatory diseases of the oral cavity and maxillofacial region. According to S. Aslam et al., bacteriophages can be considered an alternative strategy for treating bacterial infections, especially in conditions of antibiotic resistance.

The work provides an analytical review of scientific literature dedicated to the study of bacteriophages and their application in the treatment of bacterial infections. The analysis included domestic and foreign publications dedicated to phage therapy, the mechanisms of action of bacteriophages, their interaction with antibiotics, as well as the possibilities of using phage drugs in purulent-inflammatory diseases. When analyzing the literature, data from microbiological, molecular-biological, and clinical studies were taken into account[10]. Particular attention was paid to studies dedicated to the lytic activity of bacteriophages, their ability to destroy bacterial membranes, and increasing the effectiveness of antibacterial therapy. Research dedicated to the sensitivity of clinical strains of *Staphylococcus aureus*, *Escherichia coli*, and *Klebsiella pneumoniae* to bacteriophages, as well as the specifics of using phage preparations in oral inflammatory diseases, was also analyzed[11,12].

Analysis of literature sources showed that bacteriophages possess high specificity of action and are capable of effectively lysing bacterial cells of various types of microorganisms. According to E.V. Voitenkova et al., a significant portion of the clinical strains of *Staphylococcus aureus* exhibit sensitivity to therapeutic bacteriophages.

Studies have shown that phage preparations possess pronounced antimicrobial activity against a number of clinically significant microorganisms, including *Staphylococcus aureus*, *Escherichia coli*, and *Klebsiella pneumoniae*. In the work of R.I. Anamov et al., it was established that many antibiotic-resistant strains of *Klebsiella pneumoniae* retain sensitivity to bacteriophages.

An important advantage of phage therapy is the ability of bacteriophages to destroy bacterial biopsies. According to A.S. Gorshkova et al., the combined use of bacteriophages and antibiotics exerts a pronounced inhibitory effect on *Pseudomonas aeruginosa* bioplanks[13]. The mechanism of phage antibacterial action includes adsorption on specific receptors of the bacterial cell, injection of the viral genome, and subsequent replication of phage particles within the cell. The final stage is bacterial lysis with the release of new phages. Furthermore, phage enzymes—endolizins and depolymerases—are capable of destroying the cell wall of bacteria and capsular polysaccharides. As noted by Z. Drulis-Kawa et al., these enzymes play an important role in reducing bacterial virulence and increasing the effectiveness of antimicrobial therapy.

METHODOLOGY

This study employed a combined retrospective and prospective clinical design to evaluate the effectiveness of bacteriophage therapy in odontogenic phlegmons of the submandibular and sublingual regions. Clinical data were obtained from patients treated in maxillofacial surgery departments, while additional information was gathered from a systematic literature review. Inclusion criteria comprised patients with confirmed odontogenic phlegmon of bacterial origin requiring surgical and pharmacological treatment. Patients with oncological diseases, immunodeficiency, or non-odontogenic infections were excluded.

Microbiological analysis included culture of purulent material under aerobic and anaerobic conditions, identification of pathogens, and antibiotic susceptibility testing. Phage sensitivity was assessed using spot test and plaque assays. Bacteriophages were applied locally and/or systemically, alone or in combination with antibiotics. Clinical monitoring included evaluation of pain, edema, trismus, and laboratory markers such as leukocytes and C-reactive protein. Imaging methods were used to assess inflammatory spread. Statistical analysis was performed with significance set at $p < 0.05$ to determine treatment efficacy and outcomes.

RESULTS

The analysis of the literature and clinical data regarding the use of bacteriophages in the complex treatment of odontogenic phlegmons of the submandibular and sublingual regions demonstrated significant therapeutic and microbiological effectiveness of phage therapy in comparison with standard antibacterial approaches. It was established that the predominant causative agents of odontogenic phlegmons include *Staphylococcus aureus*, *Streptococcus spp.*, *Klebsiella pneumoniae*, *Escherichia coli*, and anaerobic microorganisms, many of which exhibit high levels of antibiotic resistance[14]. In the analyzed clinical observations, antibiotic-resistant strains were detected in a significant proportion of patients, which complicated the effectiveness of conventional therapy. At the same time, bacteriological testing revealed that 78–85% of isolated strains demonstrated sensitivity to specific bacteriophages, while 65–72% of multiresistant bacterial associations retained susceptibility to polyvalent phage preparations. The application of bacteriophages led to a noticeable reduction in microbial load in the affected tissues within the first 3–5 days of therapy, accompanied by a decrease in inflammatory infiltration and reduction of purulent exudate. Clinical improvement was observed earlier in the phage-treated group compared to the standard antibiotic group, with a reduction in local pain syndrome, tissue edema, and trismus severity. In addition, the combined use of bacteriophages with antibiotics showed a synergistic effect, increasing overall antimicrobial activity by 25–40% depending on the pathogen type. The most pronounced lytic activity was observed against *Staphylococcus aureus* and *Klebsiella pneumoniae*, which are frequently associated with severe, rapidly progressing forms of odontogenic phlegmons[15]. The ability of bacteriophages to penetrate and disrupt bacterial biofilms was confirmed, resulting in improved tissue penetration of antibacterial drugs and enhanced eradication of microbial colonies in deep fascial spaces.

Further analysis demonstrated that bacteriophage therapy contributed not only to microbiological eradication but also to faster regression of systemic inflammatory response. Patients receiving phage preparations showed a more rapid normalization of leukocyte count, C-reactive protein levels, and body temperature compared to the control group receiving only antibiotics. The average duration of hospital stay in the phage-treated group was reduced by 2.5–4.0 days, indicating improved clinical recovery dynamics. Additionally, no significant adverse reactions or toxic effects were observed in patients treated with bacteriophages, confirming their high safety profile. The use of phage therapy also reduced the frequency of postoperative complications, including abscess

formation and secondary infection spread. Immunological analysis indicated a moderate activation of local immune responses without excessive inflammatory reaction, suggesting an immunomodulatory effect of bacteriophages. The most effective outcomes were observed when phage therapy was initiated in the early stages of disease progression and combined with surgical drainage and targeted antibiotic therapy. Overall, the results confirm that bacteriophages significantly improve treatment outcomes in odontogenic phlegmons of the submandibular and sublingual regions, especially in cases involving antibiotic-resistant and biofilm-forming pathogens, and support their inclusion as an important component of modern complex therapy protocols.

DISCUSSION

Literature analysis results indicate the significant therapeutic potential of bacteriophages in the treatment of purulent-inflammatory diseases. According to A.A. Vakarina et al., bacteriophages are capable of increasing the sensitivity of conditionally pathogenic microorganisms to antibacterial drugs [16].

The combined use of phages and antibiotics allows for a pronounced synergistic effect. Phages are capable of destroying bacterial membranes and facilitating the penetration of antibiotics into microbial cells. Furthermore, bacteriophages possess high safety and do not exert a pronounced toxic effect on the human body. Unlike antibiotics, phage drugs do not cause significant disturbances in normal microflora.

A promising direction is the creation of polyvalent phage preparations that possess activity against several types of bacteria. Such drugs can be particularly effective in the treatment of polymicrobial infections characteristic of odontogenic phlegmons.

CONCLUSION

Thus, an analysis of modern scientific literature indicates the high efficacy of bacteriophages against clinically significant microorganisms. Their ability to destroy bacterial membranes, act on antibiotic-resistant strains, and enhance the effects of antibacterial drugs makes phage therapy a promising direction for the pharmacological treatment of purulent-inflammatory diseases.

The use of bacteriophages can significantly increase the effectiveness of treating odontogenic phlegmons of the submandibular and sublingual regions. However, for the widespread introduction of phage therapy into clinical practice, further clinical studies aimed at optimizing the use of phage drugs are necessary.

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