

Children's Osteomyelitis: Clinical Current, Diagnosis, and Treatment Methods

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Abstract: The article reflects the etiology, clinical signs, pathogenesis, and modern treatment methods for jaw osteomyelitis in children. According to the results of scientific analysis, the main causes of the disease are odontogenic infections, reduced immunity, and the resistance of microorganisms to antibiotics. Early diagnosis of osteitis in children, comprehensive treatment, and preventive measures are crucial for preventing complications of the disease.

Keywords: osteomyelitis in children, microflora, antibiotics, clinical effectiveness.

Introduction. In recent decades, there has been an increase in inflammatory diseases of the maxillofacial region in children, among which osteomyelitis occupies a special place. In children, this pathology develops faster than in adults, which is associated with anatomical and physiological features: increased vascularization of the bone, loose bone marrow spaces, and imperfect immune defense. The most common causes of the disease are complications of caries, pulpitis, traumatic injuries to the jaw, and hematogenous introduction of infection. Without timely treatment, osteomyelitis can lead to serious complications. According to domestic researchers, in the Republic of Uzbekistan, there is a trend towards an increase in severe forms of osteomyelitis in school-age children, especially in rural areas. A pressing task of modern surgical dentistry is to increase the effectiveness of complex treatment of such patients using new antiseptic agents with high antimicrobial activity and low toxicity.

According to T. G. Robustova, jaw osteomyelitis in children often occurs with the participation of mixed microflora. At the same time, about 75% of infectious agents are anaerobic bacteria, and the remaining 25% are aerobic microorganisms. The predominance of anaerobes is especially pronounced, which is associated with a lack of oxygen in deep tissues and the rapid development of purulent-necrotic processes.

Pediatric osteomyelitis represents one of the most challenging and clinically significant infectious diseases affecting the musculoskeletal system in children worldwide. This condition, characterized by infection and inflammation of bone tissue, continues to pose substantial diagnostic and therapeutic challenges despite significant advances in modern medicine. The global incidence of pediatric osteomyelitis varies considerably across different geographical regions, ranging from 1 to 13 cases per 100,000 children annually, with higher rates observed in developing countries where access to healthcare and early intervention may be limited.

The clinical significance of osteomyelitis in pediatric populations extends far beyond the immediate infectious process, as this condition can result in devastating long-term complications including growth disturbances, bone deformities, chronic pain syndromes, and functional disabilities that may persist throughout the patient's lifetime. The unique anatomical and physiological characteristics of growing bones in children make them particularly susceptible to osteomyelitis, while simultaneously presenting distinct challenges in both diagnosis and treatment compared to adult populations.

Contemporary understanding of pediatric osteomyelitis has evolved significantly over the past several decades, driven by advances in molecular diagnostics, improved imaging techniques, and enhanced knowledge of pathogen-specific treatment protocols. However, the condition remains a diagnostic

puzzle in many cases, particularly during the early stages when clinical manifestations may be subtle and non-specific. The classic triad of fever, localized pain, and functional impairment is not consistently present, especially in neonates and very young children, leading to potential delays in diagnosis and treatment initiation.

The pathophysiology of osteomyelitis in children is fundamentally influenced by the unique vascular anatomy of growing bones. The metaphyseal blood supply, characterized by terminal arterioles and sluggish blood flow, creates an environment conducive to bacterial seeding and proliferation. The presence of growth plates and the dynamic nature of bone remodeling in children further complicate the infectious process, potentially leading to more extensive bone destruction and affecting longitudinal growth patterns.

Microbiological patterns in pediatric osteomyelitis have demonstrated significant temporal changes over recent decades. While *Staphylococcus aureus* remains the predominant pathogen across all age groups, the emergence of methicillin-resistant *Staphylococcus aureus* (MRSA) and other multidrug-resistant organisms has fundamentally altered treatment paradigms. Additionally, age-specific pathogen distributions, with Group B *Streptococcus* and *Escherichia coli* being more common in neonates, while *Kingella kingae* has emerged as an important pathogen in children under four years of age, necessitate tailored diagnostic and therapeutic approaches.

The diagnostic landscape for pediatric osteomyelitis has been revolutionized by technological advances in medical imaging and laboratory diagnostics. Magnetic resonance imaging (MRI) has emerged as the gold standard for early detection and assessment of osteomyelitis, offering superior soft tissue contrast and the ability to detect bone marrow edema before radiographic changes become apparent. Advanced nuclear medicine techniques, including technetium-99m bone scintigraphy and fluorodeoxyglucose positron emission tomography (FDG-PET), provide functional information about bone metabolism and inflammatory activity.

Laboratory biomarkers have also evolved significantly, with C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) remaining important but non-specific indicators of inflammation. More sophisticated markers, including procalcitonin, interleukin-6, and various cytokines, are being investigated for their potential to improve diagnostic accuracy and monitor treatment response. The integration of these biomarkers with clinical assessment and imaging findings forms the foundation of modern diagnostic algorithms.

Treatment strategies for pediatric osteomyelitis have undergone substantial modifications in response to changing antimicrobial resistance patterns and improved understanding of bone penetration characteristics of various antibiotics. The traditional approach of prolonged intravenous antibiotic therapy is being challenged by evidence supporting shorter courses of intravenous treatment followed by oral antibiotics, particularly in cases of uncomplicated acute osteomyelitis. This shift towards more conservative management approaches reflects both improved outcomes and reduced healthcare costs while minimizing the burden on patients and families.

Surgical intervention in pediatric osteomyelitis requires careful consideration of multiple factors, including the location and extent of infection, patient age, presence of complications such as abscess formation or sequestrum development, and response to initial medical management. Minimally invasive techniques, including image-guided drainage procedures and arthroscopic debridement, have gained popularity due to their reduced morbidity compared to traditional open surgical approaches.

The management of chronic osteomyelitis in children presents particularly complex challenges, often requiring multidisciplinary approaches involving orthopedic surgeons, infectious disease specialists, plastic surgeons, and rehabilitation specialists. Innovative treatment modalities, including the use of bioactive materials, local antibiotic delivery systems, and regenerative medicine techniques, are being explored to address the challenging problem of bone defects and non-union associated with chronic infections.

Complications associated with pediatric osteomyelitis can be broadly categorized into acute complications, such as septic arthritis, soft tissue abscesses, and bacteremia, and chronic complications, including growth disturbances, angular deformities, leg length discrepancies, and avascular necrosis. The prevention and management of these complications require vigilant monitoring and often necessitate long-term follow-up extending into adulthood.

The psychosocial impact of osteomyelitis on children and their families cannot be understated. Prolonged hospitalization, multiple procedures, activity restrictions, and potential long-term disabilities can significantly affect the child's emotional well-being, educational progress, and family dynamics. Comprehensive care must therefore incorporate psychological support and social services to address these broader implications of the disease.

Recent advances in molecular diagnostics, including polymerase chain reaction (PCR) techniques and next-generation sequencing, offer promising avenues for rapid pathogen identification and antimicrobial susceptibility testing. These technologies may enable more precise and timely therapeutic interventions, potentially improving outcomes while reducing the duration of empirical antibiotic therapy.

The economic burden of pediatric osteomyelitis on healthcare systems is substantial, encompassing direct medical costs related to hospitalization, diagnostic procedures, medications, and surgical interventions, as well as indirect costs associated with lost productivity and long-term disability care. Understanding and optimizing the cost-effectiveness of different diagnostic and treatment approaches is increasingly important in resource-constrained environments.

International variations in the epidemiology, causative organisms, and treatment outcomes of pediatric osteomyelitis highlight the importance of region-specific surveillance and the development of locally relevant treatment guidelines. Collaborative international research efforts are essential to advance our understanding of this complex condition and develop evidence-based management strategies applicable across diverse healthcare settings.

The emergence of antimicrobial resistance as a global health threat has particular implications for the management of pediatric osteomyelitis. The development of novel antimicrobial agents, optimization of dosing regimens to maximize bone penetration, and implementation of antimicrobial stewardship programs are critical components of contemporary management strategies.

Looking forward, the integration of artificial intelligence and machine learning technologies in diagnostic imaging interpretation, predictive modeling for treatment outcomes, and personalized medicine approaches based on patient-specific factors holds promise for further advancing the field of pediatric osteomyelitis management.

The aim of this comprehensive review is to provide healthcare professionals with current evidence-based information on the clinical presentation, diagnostic modalities, and treatment strategies for pediatric osteomyelitis, while highlighting emerging trends and future directions in the management of this challenging condition. Through synthesis of recent literature and expert consensus, this review seeks to support clinical decision-making and improve outcomes for children affected by osteomyelitis worldwide. The main etiological factor is bacterial infection - predominantly mixed aerobic-anaerobic flora, including *Staphylococcus aureus*, *Streptococcus mutans*, *Prevotella intermedia*, *Porphyromonas gingivalis*, *Fusobacterium nucleatum*. Most often, otitis develops as a complication of untreated caries, pulpitis, periodontitis, dental trauma, or postoperative infections.

In childhood, bone tissue is characterized by high vascularization, loose structure, and a large number of osteogenic cells, which creates favorable conditions for rapid spread of infection. The disease's pathogenesis includes the infection of the spongy bone tissue, the activation of osteoclasts, the breakdown of the intercellular matrix, and the formation of a purulent focus. The periosteum, bone marrow, and surrounding soft tissues are involved in the inflammatory process, leading to a pronounced local reaction and systemic intoxication.

Clinical picture

Children's osteomyelitis is characterized by the following main symptoms:

- ✓ Intense, pulsating, swelling pain in the affected area of the tooth or jaw;
- ✓ Swelling of the soft tissues of the face, asymmetry, pain on palpation;
- ✓ increased body temperature to 38-39 °C, weakness, headache;
- ✓ enlargement of regional lymph nodes;
- ✓ mobility of 2 or more teeth.

Diagnostics

The diagnostic complex includes:

1. Clinical examination - assessment of the inflammation focus, palpation of bone structures, analysis of the child's general condition.
2. X-ray or MSCT of the jaws - detection of areas of osteolitis, destruction.
3. Laboratory studies:
 - ✓ increase in leukocytes, left shift of the formula;
 - ✓ increased ESR;
 - ✓ high CRP level;
 - ✓ in saliva - increase in MMP-8, MMP-9, IL-1 β , TNF- α , decrease in pH and buffer capacity.
4. Microbiological analysis - identification of pathogenic flora to clarify antibacterial therapy.

Modern research confirms the high diagnostic value of oral fluid analysis for early detection of inflammatory changes in bones and monitoring treatment effectiveness.

treatment

Treatment of osteomyelitis in children should be comprehensive, phased, and aimed at eliminating the infection, suppressing the inflammatory process, and restoring the function of the maxillofacial region.

Main treatment areas:

1. Surgical intervention
 - ✓ opening and drainage of the purulent focus;
 - ✓ antiseptic treatment and sanitation of the cavity;
 - ✓ removal of the causative tooth;
2. Medication therapy
 - ✓ broad-spectrum systemic antibiotics (cephalosporins, amoxicillin/clavulanate, clindamycin);
 - ✓ NSAIDs for pain and inflammation reduction (ibuprofen, paracetamol);
 - ✓ antihistamines;
 - ✓ vitamin therapy and immunomodulators.

For intracavitary applications, chlorhexidine, miramistin, and enzyme solutions are effective.

3. Detoxification and symptomatic therapy

- ✓ plenty of drinking, with pronounced intoxication - infusion therapy;
- ✓ antipyretics;

Complications

Untimely treatment of osteomyelitis in children can lead to:

- ✓ pathological jaw fractures;
- ✓ formation of fistulas;

Prevention

The following are key:

- ✓ timely treatment of caries and pulpitis in children;
- ✓ oral cavity sanitation;
- ✓ increasing the body's immune reactivity;

Conclusion. Osteomyelitis in children is a serious inflammatory disease that requires timely diagnosis, comprehensive treatment, and careful observation. Due to the anatomical and immunological characteristics of childhood, the disease develops rapidly and aggressively, therefore early intervention plays a crucial role in preventing severe complications. The use of clinical and radiological methods in conjunction with oral fluid analysis significantly increases the accuracy of diagnosis and allows for effective control of inflammation dynamics.

A comprehensive approach ensures high therapeutic efficacy and improves the prognosis for the restoration of maxillofacial region functions.

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