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CLINICAL AND PATHOGENETIC FEATURES OF POST-VACCINATION COMPLICATIONS IN CHILDREN AND IMPROVEMENT OF DIAGNOSTIC AND THERAPEUTIC METHODS (LITERURE REVIEW)

Djurayeva Dilrabo Narzullayevna,
Sanoyeva Matlyuba Jakhonkulovna
Bukhara State Medical Institute Named After Abu Ali Ibn Sino

Abstract
Most post-vaccination reactions have a benign and transient course, however, in some cases, neurological, allergic and systemic complications may develop that require timely diagnosis and comprehensive treatment. The article examines modern ideas about the pathogenesis, clinical and neurological manifestations of post-vaccination complications in children, highlights the methods of laboratory and instrumental diagnostics, and presents the principles of a differentiated approach to patient therapy and rehabilitation. The development of post-vaccination complications is associated with a complex interaction of immunological, inflammatory and neurometabolic processes.

Keywords: Post-vaccination complications, young children, neurological disorders, diagnosis, treatment.

Introduction

Vaccination is one of the most significant achievements of modern medicine, which has significantly reduced the incidence and mortality of infectious diseases among the child population[1,6-9]. Despite the proven efficacy and safety of most vaccines, post-vaccination reactions and complications of significant scientific and social interest are periodically reported in clinical practice. This problem is particularly relevant in pediatric neurology, since the child's nervous system is characterized by functional immaturity, high sensitivity to immunological and toxic effects, as well as limited compensatory capabilities[4,17-20].

Post-vaccination complications are pathological conditions that occur after the introduction of a vaccine preparation and go beyond the limits of physiological post-vaccination reactions[2]. They may be caused by individual characteristics of the immune response, a genetic predisposition, concomitant diseases, a violation of vaccination techniques, or the composition of the vaccine preparation. In most cases, complications are short-term, but some neurological forms may be accompanied by severe functional disorders of the central and peripheral nervous system[6, 13].

Etiopathogenetic mechanisms of post-vaccination complications

The development of post-vaccination complications is associated with a complex interaction of immunological, inflammatory and neurometabolic processes. After the introduction of the vaccine,

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the mechanisms of innate and acquired immunity are activated, accompanied by the synthesis of cytokines, interleukins, and inflammatory mediators. In children with increased immunological reactivity or immaturity of the immune system, an excessive inflammatory response is possible, contributing to the development of pathological changes in various organs and systems[10-14].

Neurological complications may be associated with autoimmune mechanisms in which the immune system begins to produce antibodies to components of the nervous tissue. Disorders of the blood-brain barrier play an essential role, leading to the penetration of inflammatory mediators into the central nervous system. In some cases, genetic factors predisposing to the development of seizures, demyelinating processes, and encephalopathies are of some importance[18].

In young children, the risk of neurological complications increases due to the anatomical and physiological features of the nervous system, high hydrophilicity of brain tissue, instability of neurotransmitter processes and insufficient maturity of the mechanisms of neuroimmune regulation[3]. Additional risk factors are perinatal damage to the central nervous system, hypoxic-ischemic encephalopathy, hereditary burden of epilepsy and the presence of chronic somatic diseases[1,12].

Clinical features of post-vaccination complications

The clinical picture of post-vaccination complications is characterized by significant polymorphism and depends on the age of the child, the type of vaccine, the immunological status of the body and the nature of damage to organs and systems. Most often, children experience general and local reactions, including hyperthermia, hyperemia and infiltration at the injection site, weakness, irritability and decreased appetite. These manifestations are usually physiological and do not require special treatment[4,16].

Pathological post-vaccination complications include severe allergic reactions, toxic-allergic conditions, generalized seizures, encephalic reactions, encephalitis, meningeal syndromes and peripheral neurological disorders. One of the most common neurological complications in children is febrile seizures that occur on the background of hyperthermia after vaccination. In most cases, they have a benign course, but require differential diagnosis with the onset of epilepsy and organic lesions of the central nervous system[12-15].

Post-vaccination encephalopathy is characterized by impaired consciousness, convulsive syndrome, muscular hypotension or hypertension, focal neurological symptoms and signs of intracranial hypertension. Some patients may develop ataxia, paresis, impaired coordination of movements and cognitive disorders. Severe forms may be accompanied by persistent neurological deficits[1,9,20].

Special attention is paid to demyelinating lesions of the nervous system, including acute multiple encephalomyelitis and Guillain–Barre syndrome. These conditions are characterized by autoimmune damage to the myelin sheaths of nerve fibers and can manifest as progressive muscle weakness, impaired sensitivity, hyporeflexia, and motor disorders[10].

Neurological manifestations of post-vaccination complications

Neurological symptoms occupy one of the leading places in the structure of severe post-vaccination complications in children. The most common manifestations include seizures, headache, sleep

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disorders, emotional lability, hyperesthesia, muscular hypotension, and focal neurological symptoms[5].

Infants often experience monotonous crying, bulging of a large fontanel, refusal to feed and increased excitability. At an older age, dizziness, ataxia, cognitive impairment, and behavioral changes may occur. In some cases, neurological complications are manifested by transient ischemic disorders and dyscirculatory disorders of cerebral hemodynamics[8].

Convulsive syndrome can occur in the form of generalized tonic-clonic seizures, short-term absences, or focal paroxysms. It is important to assess the duration of seizures, the presence of the post-ictal period and changes in the electroencephalogram. In severe cases, the formation of epileptic activity and the development of symptomatic epilepsy is possible[6].

Diagnostic features

Diagnosis of post-vaccination complications in children requires a comprehensive interdisciplinary approach involving pediatricians, neurologists, immunologists, and infectious diseases specialists. The main importance is a thorough history collection with the establishment of a temporary link between vaccination and the appearance of clinical symptoms[17]. In this case, it is necessary to take into account the type of vaccine, the timing of symptoms, the presence of concomitant diseases, and the features of the perinatal period[16].

Laboratory diagnostics includes general and biochemical blood analysis, determination of the level of inflammatory markers, immunological examination, cytokine profile assessment and serological tests. If an infectious lesion of the central nervous system is suspected, the cerebrospinal fluid is examined[15].

Neuroimaging techniques play an important role. Magnetic resonance imaging can detect foci of demyelination, signs of inflammatory changes and structural disorders of the brain. Computed tomography is mainly used in acute conditions to exclude volumetric processes and intracranial hemorrhages[4].

Electroencephalography is used to assess the functional state of the brain and detect epileptiform activity. Electroneuromyography and nerve conduction studies are used in children with peripheral neurological disorders. Consultations of related specialists and assessment of the child's neuropsychiatric status in dynamics are of additional importance[1].

A differentiated approach to treatment

Treatment of post-vaccination complications in children should be individualized and depend on the severity of clinical manifestations, the nature of neurological disorders and the age of the patient. In case of mild post-vaccination reactions, symptomatic therapy is sufficient, including antipyretic drugs, adequate hydration and monitoring of the child's condition[3].

Antihistamines, glucocorticosteroids, and infusion therapy are used for allergic complications. In cases of anaphylactic reactions, emergency measures using adrenaline and intensive therapy are required.

Treatment of neurological complications includes anticonvulsants, dehydration therapy, neuroprotectors, drugs to improve cerebral hemodynamics and metabolic support of nervous tissue.

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In autoimmune demyelinating processes, glucocorticosteroids, intravenous immunoglobulins, and plasmapheresis are used [7, 10].

Early rehabilitation of children with neurological disorders is of particular importance. The complex of rehabilitation measures includes physical therapy, physiotherapy, massage, neuropsychological correction and speech therapy. Long-term dynamic monitoring allows timely detection of residual neurological disorders and correction of therapeutic tactics[20].

Conclusion

Post-vaccination complications in children are a complex interdisciplinary problem requiring timely diagnosis, comprehensive assessment of neurological status and an individualized approach to treatment. Despite the relative rarity of severe complications, their possible impact on the state of the child's nervous system determines the need for early detection of pathological changes and adequate therapy.

Modern methods of laboratory and instrumental diagnostics can significantly improve the accuracy of verification of neurological complications and perform differential diagnosis with infectious, hereditary and metabolic diseases of the central nervous system. A differentiated approach to treatment and rehabilitation helps to reduce the risk of developing persistent neurological deficits and improve the quality of life of children.

At the same time, it should be emphasized that the benefits of vaccination significantly exceed the risk of post-vaccination complications, and improving vaccine production technologies and the safety monitoring system for immunobiological drugs remains one of the priorities of modern medicine.

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