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Editorial

Pediatric orthopedics and traumatology: The future begins today

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ABSTRACT

Advances in pediatric orthopedics and traumatology have certain patterns that originate in fundamental research and continue in the latest technologies. This article presents the views of the authors on the development of the most promising strategic trends in pediatric orthopedics and labels the main directions, starting from classical pediatric orthopedics and continuing with the latest achievements in pediatric neuroorthopedics and genetics. It also describes some of the advances in the treatment of genetic diseases and points to new challenges that pediatric orthopedists face in connection with the invention of life-changing methods of targeted therapy. Without claiming to be complete, the article outlines the trends for the possible joining of the efforts of scientists, practitioners, and researchers of related specialties, which will accelerate the introduction of the best practice for the current generation of pediatric traumatologists and orthopedists.

Keywords: pediatric orthopaedics; prospective development; new directions.

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Редакционная статья

Детская ортопедия и травматология: будущее начинается сегодня

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АННОТАЦИЯ

Развитие детской ортопедии и травматологии характеризуется определенными закономерностями, берущими свое начало в фундаментальных исследованиях, и продолжается благодаря новейшим технологиям. В данной статье представлен взгляд авторов на наиболее значимые перспективные пути развития детской ортопедии с точки зрения стратегических тенденций. В публикации рассмотрены основные направления развития классической детской ортопедии, а также последние достижения детской нейроортопедии. Описаны также некоторые достижения в области лечения генетических заболеваний и обозначены новые вызовы, стоящие перед детскими ортопедами в связи с появлением методов таргетной терапии. Не претендуя на полноту, статья обозначает траектории движения для возможного объединения усилий ученых, практикующих врачей, исследователей смежных специальностей, что позволит ускорить достижение поставленных перед нынешним поколением детских травматологов и ортопедов целей.

Ключевые слова: детская ортопедия; перспективы развития, новые направления.

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Pediatric orthopedics and traumatology is an intensively developing discipline that has passed historical evolution [1]. The development of this specialty is characterized by certain patterns reflected in the fundamental research that laid the foundation of this discipline and logically continues toward modern trends in improving medical science in general and pediatric traumatology and orthopedics in particular. Naturally, an understanding of the most relevant vectors of this movement should be considered a necessary contributor to optimal development. This paper presents our vision of the most significant promising vectors for the development of pediatric orthopedics from the point of view of strategic trends. This paper does not pretend to be a complete presentation of both promising directions for improving pediatric traumatology and orthopedics in general and scientific achievements and technologies in particular. Nevertheless, these trajectories of movement must be identified for the possible subsequent unification of the efforts of scientists, practicing physicians, and researchers of related specialties, which will accelerate the achievement of the goals for the current generation of pediatric traumatologists and orthopedists.

GENERAL DEVELOPMENT WAYS OF PEDIATRIC ORTHOPEDICS

Trends in diagnostics and treatment of "classical" orthopedic diseases, such as congenital hip dislocation, congenital clubfoot, platypodia, and scoliosis, have developed in recent decades. By summarizing the view on these problems, the general trends may include early diagnostics and a standardized algorithmic approach to the treatment of these diseases while maintaining the possibility of personalization if necessary [2]. In addition, the main trends in the treatment of these conditions include mandatory consideration of social and psychological factors that determine the quality of life of children and the psychological and social well-being of patients' families, which are inevitably disrupted not only by the disease but also by the need for long-term treatment [3]. In recent decades, the general trend in the development of pediatric orthopedics is the concentration on conservative treatment methods. Moreover, significant emphasis is placed on research that determines the effect of the treatment on the psychological status of the patient. Even familiar methods such as plaster corrections and wearing orthopedic products, orthopedic shoes, braces, etc., are not so psychologically safe and come with a price for the child. The general opinion of researchers confirms the need to consider the role of subjective and psychological factors in the quality of life of patients.

As regards specific treatment methods, the most widely used methods involve a standardized approach and are minimally invasive. The widespread adoption of the Ponseti technique for the treatment of congenital clubfoot is an excellent example of this trend. Owing to the universal nature of this method, the clarity of its stages, and convincing results, the Ponseti method has practically become the "gold standard" for the treatment of congenital clubfoot in children worldwide. However, this does not indicate at all the impossibility of improving the results of its use. This is mainly true for complex forms of clubfoot, relapses, and secondary deformities [4]. Today, the possibilities of modified techniques are being actively discussed in cases where the standard Ponseti method is ineffective. Nevertheless, the general trend in the treatment of clubfoot remains unchanged nowadays, and the Ponseti method is effective in the treatment of most forms of congenital clubfoot and should be used as a fundamental one. Improving manipulation techniques enables us to count on even more positive and lasting results.

Platypodia in children remains to be of interest to orthopedic specialists and is a subject of constant concern for parents. Recent studies clearly indicate the benign nature of platypodia in the majority of healthy children and the advantages of the "active non-intervention" approach in this condition. At present, the widespread use of orthopedic shoes and other orthopedic products, such as insoles, various types of foot supports, and night orthoses, cannot be considered a positive practice [5]. The principles of evidence-based medicine applied to the management of platypodia in children indicate the ineffectiveness and redundancy of this approach. Changing the attitude of orthopedists toward this problem takes time, and these processes are not entirely painless; however, reliance on best practices in accordance with the principles of evidence-based medicine is a persistent and positive trend in modern pediatric traumatology and orthopedics. In the surgical treatment of platypodia, general progress exists toward personalization both in Russia and the world. Most studies do not support the idea that platypodia in children is an inevitable cause of health problems in adults. Indications for surgical interventions for platypodia in children are being evaluated and discussed. In the absence of high-level evidence in the world literature, indicating the priority of one or another treatment method, the principle of consensus enables the formulation of a generalized opinion of specialists and provides practical healthcare representatives a starting point for decision-making [6].

NEURO-ORTHOPEDICS AS MULTIDISCIPLINARY APPROACH AND HIGH TECHNOLOGY

The treatment of the orthopedic manifestations and complications of neurological diseases occupies an increasingly large niche in the overall scope of pediatric orthopedics. This

trend is attributed to both the improvement of general medical care for pediatric patients with neurological diseases, increasing the life expectancy and its quality, and the creation of new methods for treating the orthopedic manifestations of neurological diseases.

Infantile cerebral palsy (CP) remains the most significant problem in pediatric neuro-orthopedics because of the lack of a downward trend in its global incidence [7]. Moreover, the efficiency of early rehabilitation of patients with CP determines new requirements, including orthopedic treatment. In recent decades, the indications for antispastic therapies, including surgical ones, have been quite clearly formulated. The role and place of botulinum therapy, selective dorsal rhizotomy, and intrathecal chronic therapy with baclofen in children of different ages and with different levels of motor disorders have been determined. Thanks to this, the need for surgical treatment of patients with CP is reduced, although nowadays orthopedic surgical corrections are indicated in children at a certain stage of growth and development [8]. Among the achievements in the orthopedic treatment of patients with CP in recent decades, two achievements should certainly be noted, namely, a program for monitoring the hip joints and one-stage multilevel surgical correction. The monitoring program for hip joints in patients with CP helps minimize the risk of irreversible orthopedic changes, which require extensive, including palliative, surgical interventions. Despite the improvement in the surgical methods of treating hip joint pathologies in CP, the optimal approach for these patients is the prevention of serious complications such as progressive hip subluxation and dislocation through timely detection of the pathology at the stages of its progression and the use of conservative and surgical techniques until the onset of irreversible changes in the hip joint.

Simultaneous multilevel surgeries for CP have now become the standard approach to the correction of associated orthopedic deformities. Modern trends in the development of orthopedic surgery for CP bring to the fore not so much technical solutions in the correction of individual deformities of certain anatomical areas but the achievement of the general goal of treatment, namely, correction of the pathological posture and pathological motor patterns. Nowadays, achieving this goal is possible only with a comprehensive analysis of biomechanical disorders, neurophysiological assessment, and consideration of all anatomical aspects. Solving orthopedic problems is not equivalent at all to solving motor problems in CP. In this regard, in recent years, orthopedists, along with other specialists involved in the treatment of patients with CP (rehabilitation specialists, neurologists, orthotists, and neurosurgeons), use a common terminological principle, a kind of universal international "language" for assessing motor function, including the assessment of gross motor functions (gross motor function classification system [GMFCS]), functional scales, and quality-of-life questionnaires. This principle ensures the main condition for achieving results in the treatment of patients with CP, that is, a multidisciplinary approach. Thanks to a common "language of communication," the possibility of setting common treatment goals and objectives, and the emergence of tools for objective assessment of movement disorders, a multidisciplinary approach becomes a real factor in achieving the best treatment results.

The creation of spina bifida centers is an excellent example of the implementation of this approach, which allows integrating the efforts of high-level specialists, namely, orthopedists, rehabilitation specialists, neurologists, urologists, neurosurgeons, orthotists, ophthalmologists, pediatricians, and other specialists, to provide the highest level of care for children with this disease [9]. The high appreciation of the described approach in professional and parental communities has led to the fact that today a form of assistance such as a spina bifida case conference has appeared in many leading institutions in the country and continues to evolve and improve.

ORTHOPEDIC TREATMENT OF CHILDREN WITH RARE HEREDITARY DISEASES

In recent decades, diagnostics and treatment of rare diseases have ceased to be the prerogative of specialized medical and genetic centers. This problem has grown from the category of medical casuistry into a major medical and social problem and is being solved to a large extent by considering the achievements of modern pediatric orthopedics. With most diseases classified as orphan, one or another orthopedic manifestation occurs, from minor disorders that require timely prevention to disabling ones that threaten the life and health of children with these diseases. Diseases such as spinal muscular atrophy, myopathies, hereditary polyneuropathies, mucopolysaccharidoses, metabolic osteopathies, and many others are accompanied by natural orthopedic disorders, which, as the pathology progresses, become leading and largely determine the decline in the child's quality of life. Until the last decade, the treatment of these diseases was solely symptomatic, and the orthopedic manifestations of orphan diseases did not cause optimism among pediatricians, neurologists, and geneticists. As a result, the incurability of orthopedic disorders in this group of diseases was proposed, and individual attempts by orthopedic surgeons to perform surgical treatment for these diseases, particularly progressive neuromuscular diseases, were considered dangerous and ineffective. The paradigm has changed radically with the emergence of new therapeutic options in the treatment of these diseases. For the first time, significant changes have occurred in the treatment of children with mucopolysaccharidosis resulting from the development of specific enzyme replacement therapy. Nowadays, patients

with mucopolysaccharidosis types I, II, IV, and VI and alpha-mannosidosis in the Russian Federation receive specific targeted therapies. Over the past few years, hundreds of Russian children have received a chance at a more fulfilling life, and in some cases, treatment has become tantamount to the possibility of life. The successes of enzyme replacement therapy and bone marrow transplantation for mucopolysaccharidosis have presented pediatric orthopedists with completely new tasks that could not have arisen before. In this regard, the accumulation of experience by the professional community of pediatric orthopedists in the treatment of such nonstandard cases is important. Owing to the rarity of these diseases, evaluating large cohorts of patients within one or even in highly specialized clinics is difficult. To generalize the experience of individual clinics, multicenter studies have been attempted, they are often international in nature, and the experience of individual clinics, doctors, and countries becomes an invaluable part of general knowledge [10].

ORTHOPEDIC ASPECTS OF TREATMENT OF PATIENTS WITH PROGRESSIVE NEUROMUSCULAR DISEASES RECEIVING TARGETED DRUG THERAPY

Without exaggeration, the emergence of specific therapy for hereditary neuromuscular diseases in pediatric patients is one of the most significant breakthroughs in modern medicine, both from a fundamental and practical point of view. The tragic inevitability of the progression of motor disorders, leading to the complete loss of motor functions and slow general decline, was the only possible scenario a few years ago when diagnosing diseases such as spinal muscular atrophy, muscular dystrophies, and many types of hereditary polyneuropathies. The role of orthopedists in these diseases, at best, was limited to monitoring and ascertaining the progression of orthopedic pathologies. Despite the primary neurological nature of the disease, orthopedic manifestations such as motor disorders, contractures, and deformities of the limbs and spine serve as the first clear clinical sign of the disease in most cases. However, as the disease progresses, they become the leading clinical syndrome, causing the greatest concern among parents.

The first real breakthrough in this field occurred in December 2016 when Nusinersen, better known as Spinraza, became available to patients. This date can be considered the beginning of a new era in medicine, including pediatric neuro-orthopedics [11]. If in neurology and pharmacology this moment implied the end of a long period of its development, then for pediatric orthopedists, it became the starting point for solving fundamentally new problems.

Just as decades ago, after the victory over the global polio epidemic, when new questions arose regarding the treatment of the complications of this disease, which stimulated the rapid development of neuro-orthopedics, now new methods of pathogenetic treatment of diseases such as spinal muscular atrophy, Duchenne muscular dystrophy, Charcot–Marie–Tooth hereditary polyneuropathy, should serve as an impetus for development. Pediatric orthopedists are faced with a daunting task, comparable to that which our colleagues solved decades ago, namely, the development of a care system for children who have received a chance to live. Today, there is no such a system, and the experience of each surgeon and each clinic becomes an invaluable contribution to the common cause of creating a systematic approach to the orthopedic treatment of these patients. There will almost inevitably be obstacles and difficulties along this path; however, the result will certainly be a more effective solution to orthopedic problems in children with neuromuscular diseases.

SYSTEMIC HEREDITARY SKELETAL DISEASES AND THEIR COMPREHENSIVE TREATMENT

The term “orphan” diseases implies a dual meaning: (1) these diseases are historically associated with children left by their parents in the care of the state, brought up in “orphan” institutions and without prospects for integration; and (2) these diseases have long held a kind of “orphan” position among other, more “noble” diseases. Thanks to the latest advances in fundamental science, this traditional scheme has become a thing of the past. Rare diseases are receiving their breakthrough treatment technologies, which helps ensure the survival of children with previously incurable diseases, and patients with diseases that have significantly reduced their quality of life and their families receive new hope for a full life, not associated with significant restrictions. Diseases traditionally associated with the activities of pediatric orthopedists are an excellent example of this type of achievement. Achondroplasia, hypophosphatemic rickets, fibrodysplasia ossificans progressiva, hypophosphatasia, and osteogenesis imperfecta represent an incomplete list of diseases for which pathogenetic therapy has been developed in the last few years. Again, the unconditional joy of doctors who have the opportunity to improve the quality of life, and sometimes even ensure the possibility of the very life of patients, is followed by inevitable questions regarding further orthopedic treatment.

For example, the emergence of real prospects for drug treatment of achondroplasia does not at all exclude surgical limb lengthening but makes this task fundamentally different [12]. Specifically, limb lengthening is one of

the possible treatment options after the child has completed growth, which will not only avoid the potentially negative effect of lengthening on growth plates but also reduce the risk of other complications and predict more accurately the amount of the required lengthening. The use of intramedullary automatic lengthening systems also involves new technologies for surgical treatment, replacing traditional hardware correction. Additional prospects are also opened up with the use of modern computer methods of planning and intraoperative navigation.

PUBLICATION AND POPULARIZATION OF ACHIEVEMENTS OF MODERN PEDIATRIC TRAUMATOLOGY AND ORTHOPEDICS

Scientific journals play vital roles in disseminating scientific ideas and shaping the opinions of the professional community. Today, publications in ranking journals are virtually equivalent to the actual existence of a scientific idea. However, the global pediatric orthopedics and traumatology cannot present an abundance of regular specialized publications. In fact, specialized periodicals are limited to only three authoritative positions, namely, the *Journal of Pediatric Orthopedics*, which has existed for several decades, *Journal of Children's Orthopedics*, which relatively recently appeared but reflected the position of the European Society of Pediatric Orthopedics, and *Pediatric Traumatology, Orthopaedics and Reconstructive Surgery,* which occupies its own, without false modesty, legitimate and a worthy place and has become an authoritative Russian and international platform for the exchange of opinions and publication of the latest achievements of our specialty.

CONCLUSION

Pediatric orthopedics is probably the most creative of modern medical disciplines. A pediatric orthopedist must have strict fundamental scientific knowledge that forms an integral part of classical medical education, with the broadest opportunities for self-development and implementation of creative potential, which require independent thinking and intuition. In addition to general medical knowledge, a modern pediatric orthopedic traumatologist must be knowledgeable in mechanics, physics, and mathematics. However, when dealing with a perfect structure, which is the human musculoskeletal system, he/she must be able to create fully and effectively and esthetically comprehend his/her work. The human musculoskeletal system is an inexhaustible source of inspiration for doctors who, while correcting its defects and damage, must see the effects of their creation, giving us a feeling of beauty that is integrally associated with the results of our work. Thus, an orthopedist cannot fully succeed without a creative, artistic, and esthetic understanding of his/her work, and due to the balance of forward movement, combining the latest achievements of fundamental science with creativity, we hope that in the foreseeable future, pediatric orthopedics and traumatology will receive a new impetus, without losing the historical relation with scientific and clinical roots. The directions of the development of pediatric orthopedics, as mentioned in this paper, cannot cover all possible vectors of the specialty, particularly taking into account the intensive development of technologies that pose new problems and challenges for scientists and doctors. Nevertheless, identifying these directions of the development of our science, which are already supported by practical achievements, appears important.

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