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PHYSICAL REHABILITATION IN PEDIATRIC ORGAN RECIPIENTS

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The paper analyzes the literature on physical rehabilitation in transplantology. The medical and social aspects of rehabilitation and peculiarities of physical rehabilitation in child organ recipients are reflected. A rise in the number of organ recipients, including children, is noted. The role of physical rehabilitation in increasing the body's adaptive reserves at the pre- and postoperative stage and improving the quality of life is described.

Keywords: transplantology, children, organ donation, physical rehabilitation, exercise, rehabilitation, quality of life.

INTRODUCTION

Transplantology, along with genetic engineering and reproductive medicine, is one of the most important areas of development of life-saving high technologies. Basic explantation and transplantation surgery techniques have led to significant advances in overcoming the problem of tissue compatibility, patients who were previously considered irredeemable can now be treated.

The 2024 strategy for the development of transplant care in the Russian Federation is defined in the departmental target program "*Organ Donation and Transplantation in the Russian Federation*", approved by the Russian Ministry of Health (Resolution No. 365 of June 4, 2019).

The goal of the departmental target program is to increase the availability of medical care by organ transplantation to 25.2 per million population by 2024 [1].

According to statistical data, there is an increase in patients with transplanted organs in the Russian Federation (Table 1) [2].

There is an obvious positive trend in the provision of pediatric transplant care (Table 2) [1]. For instance, in 2021, 2,318 organ transplants were performed in the Russian Federation (16.5 per million population), of which 271 were performed in children [2]. Children on waiting lists are prioritized in donor organ distribution. The problem of pediatric liver transplantation has been completely resolved, and the practice of traveling abroad for pediatric liver transplantation and for patients suffering from end-stage kidney disease has been discontinued. Operations are performed on all recipients identified and referred to transplant centers.

Low physical activity is an obvious fact that negatively affects the quality of life of both healthy people and organ recipients [3]. Low physical activity (PA) is one of the leading risk factors for the development of major non-communicable diseases such as cardiovascular diseases (CVD), type II diabetes, etc. [4]. It is these diseases that account for a high percentage of disability and deaths among the population. Studies have shown that these conditions are often side effects of immunosuppressants and glucocorticoids prescribed after transplantation, and also indicate that low PA levels are significantly associated with the risks of CVD and mortality in kidney recipients [5, 6]. According to the clinical guidelines of the European Association for the Study of the Liver (EASL): PA of liver recipients should be considered an integral part of treatment and rehabilitation [7]. In this regard, evidence-based medicine has enough facts in favor of the fact that low PA significantly worsens the quality of life of both healthy people and patients with various diseases, and especially those who have undergone such complex operations as organ transplantation [8].

Constant improvement in transplantation techniques, expansion of indications for surgical treatment of patients, including children with end-stage liver, kidney, heart, and lung diseases dictate the need to develop new and improve traditional approaches to medical rehabilitation. However, despite the urgency of the problem, rehabilitation in children after organ transplantation has practically not been developed; there are no clinical guidelines on physical activity, no criteria for dosage and prescription of physical activity in different periods after surgery have been formed.

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MEDICO-SOCIAL ASPECT OF CHILDREN'S REHABILITATION

Medico-social rehabilitation (medical, social, professional) is a process of managing patients by a complex of medical measures aimed at overcoming limitations in life.

Medical rehabilitation includes therapeutic measures aimed at restoring the patient's health. Social rehabilitation is aimed at developing the patient's skills for independence and self-care. Vocational (industrial) rehabilitation is to prepare the patient for work and going to work. But the main task is due to the necessary focus of work on types or aspects of physical activity. This includes various activities to restore the patient's ability to work. The use of therapeutic exercises, physical factors of manual therapy and reflexology.

The need for priority development of physical rehabilitation programs in children is determined by the fact that physical education and sports in childhood, i.e. before the end of a person's physical development, can significantly impact on the health of children, improving psychomotor and physical development [9].

They promote health, improve biological mechanisms of defense and adaptive reactions, and increase nonspecific resistance to various harmful environmental influences [10]. These activities should be carried out considering the peculiarities of the child's age-specific physical development, biological age, and level of physical fitness [11]. Based on the dynamics of age-related development in pediatrics, it is customary to divide children into 5 groups, where each age category has its own features in the cardiovascular, respiratory, nervous and endocrine systems. Differences between these age periods are sometimes significant because human development in childhood proceeds unevenly, heterochronically. At the same time, it is known that children who require organ transplantation initially lag behind in physical development, in the level of physical fitness, they have deviations in the health and functional state of organs and systems, their level of physical activity is reduced, and they have severe physical inactivity and hypokinesia [12]. Most children have a low level of physical activity and lead a largely sedentary lifestyle after kidney or liver transplantation, even if they are clinically stable and have no contraindications to exercise. This attitude to the motor regimen persists even many years after surgery [13].

Table 1

Number of organ transplants performed in the Russian Federation in 2013–2021

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total organs transplanted	1400	1522	1485	1704	1896	2193	2427	1960	2318
Kidney	935	1026	945	1084	1175	1361	1473	1124	1384
cadaveric	747	836	755	852	974	1161	1290	967	1183
from a living donor	188	190	190	232	201	200	183	157	201
Liver	273	302	325	378	438	505	584	559	618
cadaveric	154	176	192	229	307	341	437	390	455
from a living donor	119	126	133	149	131	164	147	169	163
Heart	164	162	179	220	252	282	335	249	290
Pancreas	16	19	12	6	6	17	10	16	10
Lungs	10	12	24	16	25	25	23	9	13
Heart-lung transplant	1	–	–	–	–	3	2	2	2
Small intestine	1	1	–	–	–	–	–	1	1

Table 2

Number of pediatric organ transplants performed in the Russian Federation in 2013–2021

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total organs transplanted	128	152	163	181	215	233	227	256	271
Kidney	57	73	65	81	105	89	101	119	122
Liver	69	76	92	96	106	133	113	131	134
Heart	2	3	6	2	3	9	11	6	15
Pancreas	–	–	–	–	–	–	–	–	–
Lungs	–	–	–	2	1	2	2	–	–
Heart-lung transplant	–	–	–	–	–	–	–	–	–
Small intestine	–	–	–	–	–	–	–	–	–

FEATURES OF PHYSICAL REHABILITATION OF CHILDREN AFTER ORGAN TRANSPLANTATION

An analysis of modern Russian and foreign literature and articles in periodicals shows that physical activity prescribed by specialist physicians and conducted by specialized personnel (physicians in therapeutic physical training, doctors in medical and physical rehabilitation, instructors and methodists in therapeutic exercises) is able to improve both the biological parameters and physical condition of an organ recipient [9, 14].

Solid organ transplantation gives many children the opportunity to lead a normal life. However, as survival rates increase, these patients are at increased risk of developing diseases associated with lifelong drug therapy [15]. For example, liver transplantation can lead to kidney disease, diabetes, infectious diseases, and childhood developmental delays. The use of high-dose corticosteroids predisposes to the development of growth and bone mineralization deficits, causing osteoporosis in children; moreover, the use of these drugs increases the risk of hypertension and diabetes in children [16]. Calcineurin inhibitors (cyclosporine or tacrolimus) can cause chronic kidney disease, infections and gastrointestinal diseases [17].

In addition, immunosuppressive therapy significantly increases the risk of skin cancer, soft tissue cancer, lymphoma, leukemia and diseases of other organs [18]. Solid organ transplantation studies have shown that these children have an increased risk of developing cardiovascular disease (hypertension, left ventricular hypertrophy and/or dilatation), obesity, dyslipidemia, and diabetes [19]. The use of immunosuppressive drugs and corticosteroids in children with kidney transplants may increase the risk of infection, osteoporosis, and secondary malignancies [20].

Kidney transplantation is expected to increase the life expectancy of children. However, many children treated with transplantation do not return to optimal health and have low physical activity. For example, after kidney transplantation, for many, the physical component of quality of life decreases while the psychological component remains unchanged, and thirty years after organ transplantation, the physical component of quality of life remains low, which affects patients' socialization [9, 15].

There are few studies evaluating the effectiveness of exercise after transplantation, but it is noted that exercise therapy is an effective method of reducing exercise-related limitations [21].

Physical activity is an effective tool for preventing cardiovascular risk factors, osteoporosis, and kidney failure [22]. It can restore both physical, functional and psychological abilities [23]. Physical activity has been demonstrated to be safe, feasible, and effective in preventing decline in quality of life in pediatric transplant recipients [24]. Regular physical activity, even light exercise, can improve exercise capacity in children with a transplanted kidney or liver and hence their quality of life [25]. Due to lack of sufficient physical activity, many patients with CKD suffer from muscle wasting, which may reduce their physical activity [26].

In a multi-year study (over 4 years), the effects of two therapeutic exercise programs in two groups among patients on hemodialysis were compared. Aerobic capacity was assessed using a modified Bruce protocol treadmill test and spiroergometric testing. One group participated in a supervised outpatient exercise training program 3 times a week on non-dialysis days, while the other group followed a training program with stationary bicycles during their dialysis sessions thrice a week. After one year and 4 years, both groups showed significant increase in aerobic endurance and considerable improvement in general well-being, which confirms the benefit and necessity of physical activity in patients with chronic kidney disease [27].

Resistance exercise can increase muscle strength, muscular endurance as well as exercise tolerance in CKD as described above [27]. For example, resistance exercise for 6 months improves skeletal muscle function and structure in patients on dialysis [26]. According to muscle biopsy data, there is an increase in the cross-sectional area of muscle fibers and new muscle fiber formation, and atrophic fibers regenerate, improving O_2 transport capacity and, consequently, exercise tolerance in patients on dialysis [26].

All this dictates the need to study the effect of physical activity on the body of children with transplanted organs, to determine the indications, contraindications to therapeutic and recreational physical training, sports, development and introduction of individual physical rehabilitation programs into clinical practice. Physical activity should become the most important part of the child's life [28].

Currently, there are no official clinical recommendations on medical rehabilitation after organ transplantation in children. Restorative measures are described only in separate guidelines on transplantation of a particular organ jointly for adults and children [29].

The clinical guidelines "*Lung transplantation, heart-lung transplantation, presence of a transplanted lung, presence of a transplanted lung, presence of a transplanted heart-lung complex, lung graft death and rejection, heart-lung graft death and rejection*", Z94.2, Z94.3, T86.3, T86.8 (adults, children), recommend strict adherence to personal hygiene, infection safety, instrumental and laboratory control, diet, as well as maintaining an optimal level of physical activity [29]. They suggest respiratory exercises for donor lung recipients

early after transplantation to improve external respiratory function with or without respiratory simulators [30], regular physical aerobic exercise to improve the function of transplanted lungs and as part of general physical health-improving measures [31]. Contraindications to exercise, according to the authors, include an unfavorable course of the postoperative period, the threat of complications from breathing exercises and/or other physical activity.

After heart transplantation, a properly designed physical and psychological rehabilitation program helps to increase adherence to drug treatment and lifestyle changes, including diet, regular physical activity and quitting smoking [21]. After determining individual exercise tolerance and assessing associated risk, carrying out a regular aerobic physical activity 3 times a week for at least 30 minutes is recommended. Patients with sedentary lifestyles should be actively encouraged to initiate low- to moderate-intensity exercise [32]. Guidelines for the use of physical rehabilitation programs in patients after heart transplantation are of great importance [33]. Recipients are recommended to undergo physical training with aerobic exercise because it improves adaptation to physical activity and contributes to modification of cardiovascular disease risk factors such as obesity, impaired glucose tolerance and hypertension [13]. However, the effect of physical training on long-term prognosis and mortality in patients after heart transplantation has not been studied.

Strength physical exercises (with weights) is a part of complex therapy for the prevention of bone mineral density loss and skeletal muscle atrophy and is recommended for patients with signs of decreased bone mineral density, as well as for the prevention of osteoporosis and undesirable effects of glucocorticoids and tacrolimus or cyclosporine drugs on muscle tissue [16].

The World Games for Children after Transplantation is a unique event in the field of medicine and sport and confirms the effectiveness of rehabilitation. These are some of the observations that most clearly demonstrate the achievements of modern transplantology. For example, Kelly Young underwent a liver transplant at the age of 7.5 months for biliary atresia. For the first time at the age of 12, Kelly competed at the World Games in 2007 (Thailand) and won 7 gold medals in swimming. Then in 2009 (Australia), she took home 5 gold medals and 1 silver medal; in 2011 (Sweden), she won 6 gold medals and 1 silver medal; and in 2017 (Spain), he cleared 4 gold and 3 bronze medals in swimming. She was recognized as an outstanding female athlete in the younger age categories from 2007 to 2015 [34].

CONCLUSION

Physical activity plays an important role in the formation of physical and psychological health in children [9, 10]. Therapeutic, health-improving physical training and sports improve the quality of life and reduce cardiovascular disease risk factors in patients with transplanted organs [13]. After organ transplantation, it is possible to lead an active lifestyle, engage in physical exercise and sports, as evidenced by various sporting events among organ recipients [35]. Improving the condition of patients after organ transplantation, increasing the life expectancy of recipients, limitations in possible labor activity, and social insufficiency determine the need [36] to combine the efforts of specialists of different profiles in the development and implementation of modern medical rehabilitation technologies in inpatient and outpatient organizations, in which the physical aspect of rehabilitation is a priority.

The medical community faces the task of providing optimal conditions for organizing and conducting medical rehabilitation activities for pediatric organ recipients in order to restore their social status and integration into society, creating conditions for the development of sports and physical training for persons with transplanted organs.

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