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## SPECIFIC SURGERY METHOD FOR TREATMENT OF PATIENTS WITH CEREBRAL PALSY

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### SUMMARY

*The aim of this research was to evaluate the efficacy of the specific surgery method, called Ulzibat® surgery method, in the rehabilitation of children with cerebral palsy. 83 patients, aged 2.6 to 13.4 years with spastic cerebral palsy participated in this study. The average course of treatment was 2 stages. The follow-up period was 2-5 years. GMFM-88 was used to assess the degree of motor disorders before and after treatment. Patients before and after surgical treatment were divided into 5 groups of levels of motor activity. Results showed that, after treatment, there was a significant increase in total score in average by 23 points in all observed group. There were a positive correlation between the difference in scores before and after treatment and the level of motor skills ( $p < 0.05$ ) and a negative correlation with age of operation ( $p < 0.05$ ). Most children after surgical treatment moved to a higher level of physical activity. The number of children with minimal disruption in motor activity (1st group) after treatment has doubled, and the number of children with the most severe disorders (4th and 5th group) was halved. Most of the children showed improvement either within their group movement activity (39%) or transition on level 1 above (49%). 12% of patients were passed on 2-4 levels above. It can be said, that this surgery method has shown high efficiency in the rehabilitation of children with cerebral palsy with different the severity of the disease. The most pronounced effect noted in the course of surgical treatment at an early age (3-7 years).*

Key words: cerebral palsy, surgery, rehabilitation, Ulzibat method, gradual fibrotomy

### INTRODUCTION

The main method of treatment for the patients suffering from neuro and musculoskeletal system pathologies used in the Institute of Clinical Rehabilitology in Tula, Russian Federation, is a unique surgical technique - phased (step-by-step) fibrotomia (PFT) which was invented and put into practice by Professor V.B. Ulzibat, PhD. The essence of the phased fibrotomia lies in a special method of discussion of the muscles pathologically changed areas (scars) by a specially designed scalpel, which allows avoiding large skin and healthy muscles discussions and is aimed at elimination of local muscular contractures and pain syndrome with minimum possible discomfort for the patient. Such surgeries leave no scars on the patient's body, but only punctures after the scalpel insertion. The surgery is performed in the quickest and safest possible way for the patient, which minimizes the time of being anesthetized and, most significantly for the children, the stress. Besides, the advantages of phased fibrotomia in comparison with the other surgical methods of treatment on skeletal muscles are:

1. Low possibility of injury

As distinguished from classical surgery techniques (subdermal myotomy, tenomyotomy) and their variations, the phased fibrotomia is performed with a reduced impact, without skin discussions, only in the in the scar area in a healthy muscle sparing way. No complete muscle incision or work operation on tendons or bones is performed. After surgery no plastering should be made. The surgical wounds are easy to take care of for every patient.

2. Method versatility

This method allows performing surgeries on any superficial muscle and such technique is used for different musculoskeletal system diseases due to development of similar changes in muscular tissues under the influence of different causative factors (trauma, infections, allergens, toxins, etc.).

3. Short time of the surgery

There is no need of using auxiliary complex equipment and additional procedures in the process of the surgery resulting in significant increasing of the surgery time and the patient's being anesthetized which eases the patient's postanesthetic state and decreases greatly possibility of post-surgery complications.

4. No hospitalization

The surgeries are performed at „one-day hospital“ which facilitates quick recovery under familiar home conditions.

5. No contraindications

There are no contraindications related to early age of the patients and to concomitant hyperkinetic, convulsive, hydrocephalic, asthenic syndromes, to mental and physical retardation, compensated chronic diseases and congenital anomalies (hydrocephalus, heart disease, stridor, etc.) (available at <https://www.ulzibat.ru/en/method/>).

At the average, about 3500 patients are operated annually. 86.6% of all the clients are the children suffering from cerebral palsy. Among all the operated 79.8% are the people with spastic tetraparesis and with spastic diplegia. 94% of patients have mean and advanced degrees of motion disorders, 97% of the patients have a stable recovery effect, 71% of the patients note the positive result and return to this method again.

The infantile cerebral palsy treatment has several stages. On each stage, the necessary amount of muscular and fascial contractures is debrided at a time under general anesthesia, so the number of PFT performed under local anesthesia varies from 4 to 6 per each stage. On each stage, an agreement is reached with a patient or his representative (a parent) about the surgery plan and execute the relevant documents.

The time of the next surgery stage depends upon the movement disorders complexity, on the presence of associated diseases and on the development rate, applise to children.

Due to low possibility of injury, postoperative recovery of motion functions shortens significantly – from 5-7 days to 3-4 weeks. This depends on the gravity of the surgery.

The removal of muscular contractures and pain syndrome enables substantial increase of the range of motions. It helps to receive new motion skills and to improve the existing ones. The increase of the overall motion activity stimulates mental development, broadens the scope of interests, betters self-service skills. In difficult cases, it makes the nursing considerably easier.

The surgical treatment high effectiveness and the applied techniques uniqueness attract people from various cities of the Russian Federation and from near and far-abroad countries (Ukraine, Belorussia, Moldova, Kazakhstan, Uzbekistan, Kirghizia, Georgia, Armenia, Azerbaijan, Estonia, Latvia, Lithuania, Spain, Greece, Serbia, Montenegro, Croatia, Bosnia and Herzegovina, Slovakia, Egypt, Finland, Italy, Poland, Germany, Sweden, United States of America, Israel, India, Argentina, Australia, Venezuela, Mexico, Great Britain, Canada, etc.).

During the last twenty years, in The Institute, more than 40000 patients were admitted for the treatment, and about 81% of them were children. An average of 4000 patients per year were operationally treated, and more than 2000 of them applied for the first time, including 82% of children.

The age structure of all patients admitted for the treatment of locomotor system pathology was the following: 1–3 years: 14.4%; 4–7 years: 36.3%; 8–10 years: 14.8%; 11–14 years: 15.4%; 15–17 years: 17.7%; and older than 18 years: 1.4%.

The largest group of patients includes people with the incoming diagnosis of “infantile cerebral palsy”. The patients with cerebral palsy accounted for 84.3% of total patients number. Among patients with infantile cerebral palsy, 86.9% were children. The following age distribution of patients with infantile cerebral palsy was determined: 1–3 years: 16.3%; 4–7 years: 40.2%; 8–10 years: 16%; 11–14 years: 15.3%; 15–17 years: 11.9%; and older than 18 years: 1.2%. The structure of patients according to the type of infantile cerebral palsy was the following: the double hemiplegia: 42%; spastic diplegia: 36.7%; hemiparetic form: 13.3%; hyperkinetic form: 6.3%; atonic-astatic form: 1.5%. Patients with severe and moderate level of motoric disorders were prevailing.

The analysis of treatment results of 3849 patients over a long period of time, compiled by the doctors from different cities of Russia and the experts of the Institute in the period from the year 1993 till 2011, showed that on average of 92.8% of cases has achieved a *good clinical effect* which is manifested through the increasing range of motion, the emergence of new or substantial improvement of previously existing motor habits, the forming of a qualitatively new motoric stereotypes, and the disappearance or reduction of pain syndrome and hyperkinesia. In the case of 4.3% of patients *satisfactory result* was found, the improvement of individual motor habits was noted, and also the expansion of the features within the initial level of motor development. In the case of 2.8% of patients, their condition was “*unchanged*”. In the case of 0.03% of patients, the occurrence of pain in the muscle areas that were not previously operated, was considered to be *the deterioration*, however, these changes were eliminated in the following phases of treatment. In 52% of cases, the motor function changes had a qualitative character and were manifested through the development of new habits (sitting, crawling, walking, self-service habits). The effectiveness of phase fibrotomy in relation to local organic muscle contracture or the pain spot was 97.5% in average (Nazarkin, 2012).

The afterhistory analysis made by independent medical experts from different cities of Russia and by the Institute staff shows that it can be seen the constant improvement in the general clinical performance. The increased range of motions, the onset of new movement skills and the improvement of existing ones were considered to be the cure rate. In the definite period of treatment 10 – 18% of patients had no substantial changes, 1 – 3% suffered from pain on the muscle zones which hadn't been operated

on before. This medical phenomenon was considered to be the deterioration. The changes connected with pain were temporary and were eliminated on the following stages of treatment. In accordance with pain and muscle contracture localization the effectiveness of phased fibrotomy was 97.5%.

Furthermore, it was notice supplementary positive effects such as: the improvement of speech (62%), mastication (49%), swallowing (50%), emotional and behavioral indexes (64%), memory (37%), attention (41%), sleep (49%), appetite (58%), the decrease of strabismus (55%), nystagmus (22%) and salivation (56%), the improvement of visual (17%) and hearing acuity (15%), the normalization of urination and defecation (28%) (Nazarkin, 2012).

Having observed the patients during 24 years, it can be confirmed that the optimum time for the operation is the stage of the early muscle contractures onset before the occurrence of persistent contractures and joints deformations. In this connection it's highly advisable if you wish to get positive permanent results quickly with minimum number of operations, you should begin the surgical treatment in the early age (from 3 to 5 years).

Also, katamnestic monitoring of patients during the period of 20.5 years confirms that the surgical procedure is optimal at the early stages of organic muscle contractures, before the occurrence of persisting contractures and deformities of locomotor apparatus. In relation to this, in order to achieve the maximum results, in the cases of adequate indications, it is the most appropriate that surgical treatment starts at age of 2–3 years of life when pathology is congenital, and at age of 3–5 years of life when it comes to acquired pathology of the locomotor apparatus and infant cerebral palsy.

The qualitative characteristics of technology "Phase Fibrotomy in Orthopedics" are following:

- universality in terms of nosologically different types of locomotor pathology related to the unity of the mechanisms of development of identical processes in muscle tissue (dystrophy, necrosis, sclerosis), whose outcome is the forming of organic muscle contractures, irrespective of the type of primary etiological factor;
- functionality which is provided by the simultaneous action on different muscle groups taking into account their synergism and antagonism, the possibility of a combination of operations on all superficial skeletal muscles of the head, trunk and extremities in order to achieve maximal effect;
- minimally traumatic which is achieved through precise movements of specially constructed scalpel; absence of skin excision, blood loss, and complete muscle excision and transplantation, there is no working on tendons and bones, and subsequent cast immobilizations are unnecessary, which all further contribute to the shortening of the recovery period and a patient's early activation after surgery;
- the possibility of working *in the outpatient setting* which contributes to faster recovery under the conditions that are usual for the patient (Nazarkin, 2012).

This method has some specific indications and contraindications for applications.

The following indications to treatment according to V.B. Ulzibat's technique are determined:

- presence of organic muscle contractures and chronic myofascial pain syndrome;
- absence of effect of the conservative therapy application.

Absolute contraindications for surgery are considered to be the following:

- presence of developmental disorders and chronic diseases in the stage of decompensation;
- dysfunction of vital organs.

Relative contraindications for surgery are:

- acute infectious and somatic diseases, including the convalescence period;
- acute and subacute period of neuroinfection, head injury and cerebral vascular disorders;
- chronic disease in the deterioration period;
- intolerance of medical anesthesia products;
- presence of severe allergic reactions in anamnesis;
- presence of injuries, inflammatory skin and soft tissue diseases;
- post spastic seizure status: after the "small" seizures – at least 3 months, after the "big" (generalized) seizures – at least 6 months; after status epilepticus – at least 12 months;
- status after the Botox intervention (Dysport) – at least 6 months;
- status after vaccination – at least 1 month (Nazarkin, 2012).

## Cerebral Palsy

Cerebral palsy (CP) is the one of the most commonly occurring childhood physical disability (Benfer, Jordan, Bandaranayake, Finn, Ware, & Boyd 2014). There is no precise definition of cerebral palsy. The diagnosis is understood as symptomatology of chronic disorders of movement function. Cerebral palsy is caused by brain damages, and the causes of cerebral palsy can be obvious and hidden. In some cases several risk factors simultaneously can cause the disease. More than 100 potential causes lead to cerebral palsy. They can be integrated into three large groups:

1. Pregnancy course. This group of causes includes Rh incompatibility, hereditary diseases, placental insufficiency, as well as infectious diseases (herpes, rubella, etc.) which adversely affect the child's brain, chromosomal mutations, hypoxia, and ischemia (MacLennan, 1999).

2. Childbirth. Quick and prolonged uterine contraction/strains can cause cerebral palsy. Risk factors also includes the following: medical labor induction, premature birth, artificial rupture of membranes, abnormal presentation, heavy fetal weight, lack of oxygen, placenta abruption, suffocation due to cord entanglement, obstruction due to contracted pelvis (Stanley, Blair, & Alberman, 2000).

3. Newborn adaptation period (from 4 weeks to 2 years). External factors can negatively affect the child. Some of them can be avoided or minimized. This risk group includes head trauma, neuroinfection (meningitis, encephalitis), poisoning with chemicals, brain hypoxia (Stanley et al., 2000).

Severity level, character, volume of these damages and the precise location of brain injury determine the form of disorders of muscular structure and total body function. Types of Cerebral Palsy are:



- Spastic quadriplegia;
- Spastic diplegia;
- Hemiplegia;
- Dyskinetic (hyperkinetic) type;
- Extrapyramidal form;
- Atonic - astatic form.

The most common form of cerebral palsy in all age groups is the spastic form, which occurs in 80% of cases (Van Naarden Braun, Doernberg, Schieve, Christensen, Goodman, & Yeargin-Allsopp, 2015). The prevalence of cerebral palsy is 2-4 cases per 1,000 children (Benfer et al., 2014; Van Naarden Braun et al., 2016).

High prevalence of cerebral palsy, the severity of clinical manifestations, early disability patients make the problem of treatment of patients with this pathology is extremely relevant and socially important. Rehabilitation of children with cerebral palsy is a lengthy and time consuming process, due to the early formation of pronounced contractures and the formation of vicious poses.

Cerebral palsy can be recognized for the number of core symptoms:

- muscle hypertonia;
- uncontrolled contraction of any muscles;
- uncontrolled involuntary movement;
- restriction of joint movement;
- muscle hypotonia (Reddihough & Collins, 2003).

Symptoms are also often accompanied by impairment of vision and hearing loss, or delay in brain development. Additionally, people with cerebral palsy can have such symptoms as mental and psychic disorders, speech disorders, epilepsy, convulsions, gasp, swallowing difficulties and more (Sewell, Eastwood, & Wimalasundera, 2014).

Treatment of the children with cerebral palsy should begin immediately upon its diagnostic and carry out throughout life. This is of particular importance to do everything possible to support and recover the brain function under the age of 8 years. During this period, the child is vulnerable and able to adapt to life in society.

Causes of cerebral palsy can be different, but in any case the child should undergo the rehabilitology courses and be under continuing medical supervision.

Treatment for CP necessarily includes exercise therapy, physical therapy, Vojta method, massage, Bobath therapy, systematic work with a speech language therapist and a psychologist.

### **The method of treatment for children with cerebral palsy**

One of the modern effective surgical treatments for the effects of cerebral palsy is GRADUAL FIBEROTOMY BY V.B. ULZIBAT. The Institute of Clinical Rehabilitology offers this unique method of treatment of the cerebral palsy consequences, manifested in impaired motor functions. The Institute accepts patients with spastic and hyperkinetic forms of cerebral palsy.

Surgical removal of contractures by this method allows in short terms to increase the amount of motion in the joints, improving motor function in the affected segment, reducing pain, improving the quality of life of patients and facilitating the care of

patients with severe form of the disease. In addition, the technique is minimally invasive (Nazarkin & Eremin, 2016).

As mentioned, the method of gradual fibrotomy is a way to remove muscle contractures and myofascial pain syndrome, based on gradual subcutaneous decision of fibrously modified muscle fibers using a special scalpel. Pathogenetic substantiation used for the surgical treatment of patients with congenital and acquired disorders of the musculoskeletal system by Ulzibat® method were the results of clinical and instrumental and morphological studies conducted by the Institute with the participation of independent medical experts. It was established that one of the causes of muscle dysfunction, myofascial pain and movement disorders in various diseases of the musculoskeletal system is the development of skeletal muscle in dystrophic and sclerotic changes. Exodus expressed dystrophic process is the fibrosis of the muscle fibers, the formation of organic muscular contractures - fixed shortened and compacted muscle areas, painful on palpation and does not disappear when the muscle relaxation (Ульзибат, 1993).

The ultimate goals of surgical treatment by the Ulzibat® method are to increase volume of movement in joint, to prevent development of heavy bone and joint deformation, to decrease hidden and explicit pain syndrome.

This method has many undeniable advantages: Low possibility of injury; Short time of the surgery; No post-surgical sutures and scars; No post-surgical plaster immobilization; No hospitalization; Successful treatment in more than 97% of cases.

In addition the patient does not need a long time to stay in the hospital, he can be discharged the next day after surgery. Also the next day after surgery patient can seat and move in the bed without any restriction. Through 3-5 days after surgery patient can crawling, and through 14 days can stand on feet. Active rehabilitation is possible in one month since the operation.

Of course as with any surgical procedure there may be some complications: postoperative hematomas in operated zone (20-30%), the treatment of which typically requires only the application of alcohol compresses; anesthesiological complication (2-5%); injury of main blood vessel (less 1%); injury of main peripheral nerve (less 1%).

It is important to understand that cerebral palsy treatment should be complex and include combination of conservative and surgical methods. Children rehabilitation should be provided permanently. In addition, while growing -up of the child the surgical correction of movement disorders should be performed. And then you can achieve really good results and bring children with cerebral palsy back to normal social life.

Over 25 years of existence method, operated on more than 45000 patients with diseases of musculoskeletal system (over 37000 children), of which 84.5% of the patients with cerebral palsy.

Therefore, the aim of this research was to evaluate the efficacy of the Ulzibat® surgery method in the rehabilitation of children with cerebral palsy.

## METHOD

### Participants

Research involved 83 patients, aged 2.6 to 13.4 years with spastic forms of cerebral palsy. The average course of treatment was 2 stages. The follow-up period was of 2-5 years. To assess the degree of motor disorders before and after treatment used the conventional scale GMFM-88 (Alotaibi, Long, Kennedy, & Bavishi, 2014) to assess motor 88 acts on 5 categories: A – lying and rolling, B - seating, C - crawling position on knees, D – standing, E – walking, running, jumping. The total score was calculated in % of the maximum score. Patients before and after surgical treatment were divided into 5 levels of motor activity:

- I Sitting, alone gets up and walks without additional support, runs, climbs the stairs;
- II Difficult to balance when sitting, stands up independently, crawls, walks with additional support;
- III Sits up with help, crawls, walks a few steps with additional support;
- IV Sits down and sits with assistance, move around the room by rolling or crawling, not walking;
- V Limited all levels of movement, not sitting, not crawling, not walking.

For different age groups, there are certain criteria for the distribution of motor activity through the levels.

### Statistical analysis

Statistical processing of the obtained data was performed using the statistical software package Statistica 6.0 (USA). Data are represented as mean values. To compare two dependent samples qualitative test was used  $\chi^2$ . To analyze the relationship of the two signs was used in the analysis of rank correlation by Spearman. For all benchmarks and tests differences were considered significant at  $p < 0.05$ .

## RESULTS AND DISCUSSION

The study involved 83 participants divided in 5 groups according to the clinical characteristics and levels of physical activity.

After treatment in all groups we observed a significant increase in total score ( $p < 0.05$ ) in average by 23 points. The total difference scores were higher, the worse the initial level of patients (Figure 1). So, in group I with minimal motor impairment total score increased by an average of 17 and has almost reached 100. In group II was also observed almost complete restoration of motor skills, the total score increased by an average of 18, from 78 to 96 points. In III, IV, V groups, the total score increased by 26, 29 and 23, respectively. In the first groups, a small difference in scores due to the initially mild loss of motor skills in patients, that is, the children in these groups after treatment reached normal or near normal physical activity. But, obviously a significant improvement of motor skills in children with severe impairments.

Table 1. The distribution of patients according to level of physical activity before surgery and their clinical characteristics

	Level of physical activity				
	I	II	III	IV	V
<b>N</b>	15	15	19	16	18
<b>Mean age (min-max)</b>	5.5 (3.1-13.1)	5.8 (2.6-13.4)	4.9 (2.6-8)	6.1 (3-10.5)	4.5 (2.7-6.3)
<b>Spastic tetraparesis</b>	1	0	5	8	12
<b>Spastic hemiparesis</b>	9	4	0	0	0
<b>Spastic diplegia</b>	5	11	14	8	6
<b>The average score before treatment (min-max)</b>	80 (63-92)	78 (61-87)	62 (50-72)	46 (26-57)	17 (2-40)

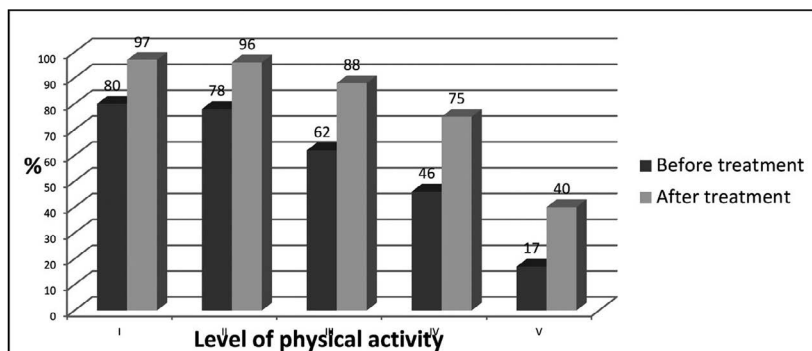


Figure 1. The total score of the motor activity before and after treatment by the Ulzibat® method in the patients of 5 groups.

Correlation analysis confirms a direct positive relationship between the difference in scores before and after treatment and the level of motor skills ( $r_s = 0.4$   $p < 0.05$ ). Also revealed a negative significant association between the difference score before and after treatment and age of operation ( $r_s = -0.5$   $p < 0.05$ ). Thus, the sooner the surgery is performed, the better the treatment outcome. As a result of this treatment changed the distribution of children into groups according to level of motor skills (Figure 2). Most children after surgical treatment moved to a higher level of physical activity. So, if before the treatment in the 1st group with a minimum of movement disorders was 18% of children after treatment, this group made up the majority of patients – 40%. In addition, we see significant improvement in the group of children with low movement (V group). After surgery, the percentage of children in this group was halved, from 22% to 9%.

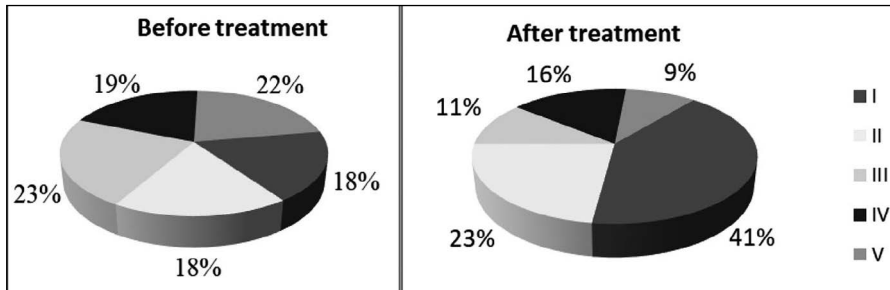


Figure 2. The distribution of patients by levels of motor activity before and after treatment by the Ulzibat® method

It should be noted that the degree of improvement of motor skills in children was different. Most of the children showed improvement either within their group movement activity or transition on level 1 above (Table 2). So, 39% of children improved their performance, but remained in the same group, and 49% improved the performance so much that switched to 1 level up. A lot of children, 8.4% moved to 2 levels above. Also 3 children of the 83 showed so marked an improvement in the movement skills that were passed on 3 and 4 levels above.

Table 2. Distribution of patients according to the degree of improvement in motor activity after treatment

The degree of improvement of motor skills	The number of patients	% patients
<b>Within the initial level</b>	32	38.6
<b>With the transition to the 1 level up</b>	41	49.4
<b>With the transition to the 2 level up</b>	7	8.4
<b>With the transition to the 3 level up</b>	2	2.4
<b>With the transition to the 4 level up</b>	1	1.2

The degree of improvement of motor skills (within initial level and with the transition to a higher level) in five groups of patients is presented in figure 3. In group 1 with minimal disruption, all 15 patients showed improvement of skills within their group. In 2 group 80% of patients moved on his movement skills in group 1. In group 3, more than 70% of patients after treatment have moved to the second group, 15% to the first. In 4 group – third of children improved motor skills within its group, a third – moved to the group above, almost 20% – is moved to the second group, and 2 children moved to 1. In the 5, the heaviest group, about 40% of children improved their performance within their group, just over 40% moved to level 4, 2 kids - third level, and 1 patient at fist level.

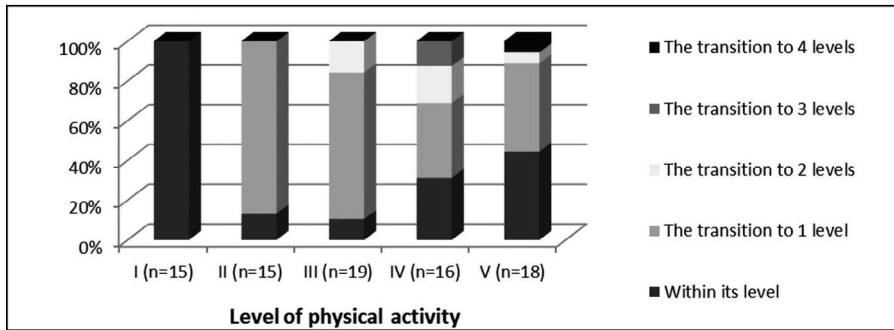


Figure 3. Improved motor skills after treatment in patients with different initial levels of physical activity.

## CONCLUSION

The Ulzibat® surgery method has shown high efficiency in the rehabilitation of children with cerebral palsy. Improving motor skills is noted in patients of all 5 levels of physical activity. Even in patients with severe motor disabilities there is a strong positive trend. The method is effective in any age period, but more pronounced results are achieved in the age group of 3 to 7 years. The advantages of the method – quick increase of volume of movement in joints after elimination of muscle contractures, which in addition to pronounced self-effect, significantly increases the effectiveness of other rehabilitation measures, and potentiates their action. In addition, an unquestionable advantage of the method is its minimally invasive, especially given the large percentage of children of small age and concomitant pathology. Given the above advantages, we can assume high economic efficiency of the method by reducing the duration of treatment, a pronounced effect recovery of motor function with a decrease in the degree of physical disability. It should be noted that simultaneously with the return of motor activity from a large number of patients showed improvement of speech, intellectual-mnemonic functions, the acts of chewing and swallowing. Such observations suggest that the improvement of motor function, reduction of pain syndrome leads to the activation and functioning of the entire nervous system, not just the motor center responsible for the segments subjected to surgical interference. However, this assumption needs further detailed research.

Thus, the Ulzibat® surgery method being high-effective and minimally invasive, can be widely put into practice in patients with cerebral palsy that will accelerate and facilitate subsequent rehabilitation.

And finally, it should be noted that comparative analysis of the effectiveness of treatment of children with disorders of locomotor apparatus and infantile cerebral palsy from different age subgroups showed that the percentage of positive results in pre-school children is higher than in older children. Reason for this lies in more pronounced changes in the muscles of school-aged children and older boys and girls, and also in the forming of fixed deformation of locomotor apparatus over time. A higher

efficacy of the treatment of patients with spastic types of infantile cerebral palsy, and in the cases of moderate motoric disorders, unless there are changes in the joints, or they are minimal, was found.

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