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PHYSIOTHERAPY IN MICROCEPHALIC CHILDREN WITH PSYCHOMOTOR DELAY

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Abstract: *The purpose of this paper highlights the fact that movement therapy improves motor skills and balance, with kinetic exercises contributing to sensory and cognitive recovery in 6-year-old children. Following the interaction with patients and the problems they face, including social integration, but also following the bond that is created between physiotherapist and patient, the importance of physiotherapy classes and the beneficial effect they have on mobility, general coordination, fine and gross motor skills, but also on intellectual development is highlighted. Thus, microcephaly is not a condition that can be recovered or remedied.*

Key words: *therapy, microcephaly, kinetic exercises.*

1. Introduction

Medical kinesiology is an interdisciplinary biological science that deals exclusively with the study of human body movement, the anatomical-functional elements that contribute to its achievement, and the ways to correct or compensate for reversible, partially reversible, or irreversible disturbances [3].

The interdisciplinarity of medical kinetology is ensured by elements of anatomy, biomechanics, physics, biochemistry, physiology, psychology, based on which it develops a specific methodology for scientific research.

Medical kinetology uses specific, non-specific means and their associations for sanogenetic or therapeutic purposes [9].

Also called "movement therapy", physical therapy has specific forms of treatment, with the main role in this context being played by physical exercise [6]. It also represents a psychological therapy, through its means and methods contributing to the removal of the inferiority complex generated by the disease. It is a social therapy that helps the patient integrate/reintegrate into society [2].

Microcephaly has an incidence of approximately 0.6-1.6 per 10,000 births and 20% of people with profound intellectual disabilities suffer from microcephaly [1].

Children with severe microcephaly are more likely to have serious abnormalities and developmental disabilities (80%) than children with mild microcephaly (40%). Comorbidities such as epilepsy (40%), cerebral palsy (20%), intellectual disability (50%), and eye damage (20% to 50%) may

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occur with microcephaly. Microcephaly is associated with abnormalities in cell production, and the pathophysiology of microcephaly provides remarkable insights into how the brain generates the appropriate number of neurons that determine brain size [5]. There is no specific treatment for microcephaly, but early intervention with stimulation programs and games has a positive impact and contributes to the child's development.

The study of microcephaly provides important insights into the developmental disorder of the brain. It has become clear that microcephaly is associated with abnormalities in cell production, and that the pathophysiology of microcephaly provides remarkable insights into how the brain generates the appropriate number of neurons that determine brain size [8].

Primary microcephaly mutations occur in genes encoding centrosome proteins, highlighting an important role of centrosomes in the development of the cerebral cortex, which is not achieved under normal parameters.

The paper proposes to demonstrate that a structured and individualized exercise program can improve motor function, cognitive skills and overall quality of life for people with microcephaly. A combination of targeted exercises aimed at improving strength, coordination, balance and mobility, as well as cognitive stimulation activities will lead to positive results.

Furthermore, it is hypothesized that the earlier the exercise intervention is initiated, the greater the potential for improving developmental outcomes.

2. The Pathology of Microcephaly

Microcephaly is a rare neurological pathology, characterized by significantly reduced dimensions of the head circumference compared to the standard average of the same age and sex.

Their origin can be genetic, or acquired through the teratogenic action of some factors in the embryo-fetal period. They can thus be the expression of developmental defects of the nervous system during the embryonic period, or of some lesions thereof, consequent to the aggressive action of some factors usually infectious, traumatic or metabolic during the fetal and perinatal period.

2.1. Congenital malformations of the central nervous system and microcephaly

Congenital malformations affecting the brain, cerebellum, brainstem or medullary substance are due in most cases to defects in the closure of the neural tube, to defects in the differentiation and maturation of the cerebral hemispheres, such as microcephaly.

Congenital malformations of the central nervous system, presenting in a remarkable diversity of anatomic-clinical forms, can be clinically known from the neonatal period or later, in other stages of childhood, through more or less obvious manifestations, as some of them are incompatible with life, or have an evolution accompanied by profound mental deficits [4].

Microcephaly can be present at birth or develop in the first few years of life. Since brain growth is directly proportional to head growth, people with this disorder typically have intellectual disability, poor motor function, speech difficulties, abnormal facial features, seizures and

dwarfism, reduced ability to learn and function in daily life, balance disorders, difficulty swallowing, vision problems, and hearing loss.

In newborns with microcephaly, the brain weight is reduced to 250-300 grams (normal weight is 350-400 g); in adults with microcephaly, the brain weight is often less than 300 g (normal adult brain weight is 1100-1500 g). The incidence of microcephaly is 0.6-1.6 per 10,000 births, figure 1.

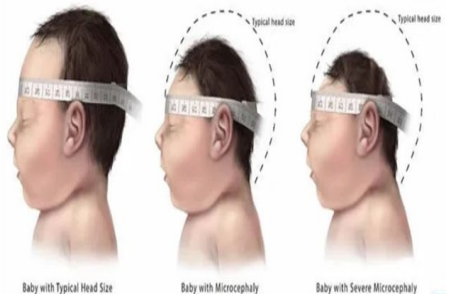

Fig. 1. *The incidence of microcephaly*, [10]

2.2. Types of microcephaly

There are 2 etiological forms of microcephaly:

- primary (genetic);
- secondary (non-genetic).

Primary (hereditary) microcephaly is caused by genetic disorders and occurs with chromosomal abnormalities, such as trisomy 21 (Down syndrome), trisomy 13 (Patau syndrome) and trisomy 18 (Edward syndrome). Microcephaly is also found in other genetic conditions: Smith-Laemmli-Opitz syndrome, Meckel syndrome, Cornelia de Lange syndrome.

Primary microcephaly reflects an imbalance between progenitor cell production and cell death. Disruption of neural progenitor proliferation (defects in mitotic division or cell cycle regulation of progenitors) or the response to DNA damage can lead to reduced numbers of neuronal and glial cells within the brain.

Secondary (non-genetic) microcephaly is caused by infectious diseases transmitted vertically from mother to fetus (cytomegalovirus infections, herpes, chickenpox, congenital rubella, probably Zika fever), intrauterine or postnatal anoxia, severe malnutrition or may be the consequence of toxins (maternal alcoholism, drug administration). Secondary microcephaly can also be caused by maternal phenylketonuria, massive irradiation during the embryonic period.

Patients with secondary microcephaly often present with progressive motor and cognitive deterioration, as well as seizures, but their symptoms may appear non-progressive/stationary.

2.3. Clinical picture

The first sign that may indicate the presence of microcephaly is a reduced skull circumference compared to the standard averages of the same sex and age. The skull circumference is measured around the head, one of the landmarks being the frontal prominence and the occipital protuberance.

This measurement is compared to that of the standard averages. Some children have only a small skull circumference, located at the lower limit of normal, but in children with microcephaly, the size of the skull circumference is significantly reduced compared to the lower normal value.

Newborns with microcephaly have a small skull and an abnormal facial and cranial configuration. The forehead is narrow, sloping back, beveled, the supraorbital arches are prominent, the

ears are large, and the anterior fontanel is very small or absent.

Many children with microcephaly may lack specific symptoms at birth, but go on to develop epilepsy, cerebral palsy, learning disabilities, hearing loss, and vision problems.

2.4. Psychomotricity of children with intellectual disability

a) Motricity and psychomotricity

Motricity - This notion refers to the totality of movements performed by man, obviously only with the help of skeletal muscles, to maintain his relations with the natural or social environment in which he exists.

There are three categories that summarize the components of motor skills, namely: motor acts, motor actions and motor activities.

The realization of a certain movement, from conception to execution, is:

- The conscious, cortical act of making the decision to move is determined by the requirements of the environment and reality, reaching consciousness through nerve impulses.
- The transmission of the motor act to the cortex based on sensory information.
- The transmission of command to the effector apparatus.
- The realization of the voluntary movement by the effector apparatus in accordance with the plan that the cortex has developed and transmitted, based on the sensory-sensory nerve impulses.

Psychomotricity is a complex act that combines motor and psychic forces in the performance of the action, in which perceptual, sensory and even intellectual functions are also involved. Psychomotricity generically refers to any motor action, attitude or behavioral model that is under the influence of psychic processes, its two sides (motor and psychic) not being able to be separated. It is a characteristic of motor behavior resulting from the individual particularities of the organization and coordination of muscular movements, being, therefore, a complex function, a human characteristic, an aptitude, which integrates and combines motor and psychic aspects related to sensory, perceptual, motor and intellectual functions, to the reception of information and to the adequate execution of the response act, which determines a specific, individualized conduct [7].

b) Psychomotor deficiencies

Psychomotor impairments are disorders of the normal relations of the person with the environment, determined by the insufficient conjugation of the motor and psychic forces in the performance of the action, because of perceptual, sensory, intellectual and motor insufficiencies that diminish the capacity to receive information, as well as the adequate execution of the act of response.

The highest frequency of psychomotor difficulties is found in the mentally disabled, in whom the motor difficulties, secondary to lesions of the central or peripheral nervous system, are associated as an expression of the same organic etiology. In this category, psychomotor difficulties can reach 70-80%, being associated with the severity of the mental deficiency.

Sensory-perceptual, motor and intellectual disabilities lead to disorders of movement control and coordination, resulting in an inadequate quality of body

movement and psychomotor difficulties, which disrupt proper adaptation and integration into the environment. The different combination of motor, sensori-perceptual and mental disorders determine a specific, individual behavior, which is characterized by insufficiencies, incapacities, difficulties, which give a complex picture of psychomotor deficiencies [7].

2.5. The peculiarities of the psychomotor development of children with intellectual disability

In the research of psychomotor skills of children with intellectual disability, the starting point is made by comparing their psychomotor performances with those of healthy children. Through this comparison, it is found that those who suffer from intellectual disability present psychomotor immaturity, inefficient perceptual-motor development.

The main aspects that define psychomotor skills in the case of these children are:

- Poor development of complicated movements.
- Spatial-temporal disorganization.
- Laterality and body schema disorder.
- In the case of children with moderate and profound mental deficiency, the following are more pronounced:
- Profound disorders of static and postural balance.
- Large number of existing paratonias and synkinesis.
- Profound disorders of spatial-temporal realization and orientation.
- Inefficient coordination of movements in space.
- Impossibility of achieving adaptive behavior, based on motor action.
- Disorders of precision in movements.
- Poor posture.
- Due to subcortical lesions, coordination of motor behavior is not allowed.
- Difficulty in voluntary relaxation, or even impossibility.
- Disorders in respiratory rhythm.
- Motor functions of the upper limbs present a pronounced difficulty.

3. Material and Methods

The research was conducted over a period of 7 months, starting in October 2022, when the initial assessment was also carried out, and ending in April 2023, when the final assessment took place.

The study involves a 6-year-old female patient who was diagnosed at birth with congenital microcephaly. In addition to this pathology, the patient also suffers from neuropsychomotor retardation, partial agenesis of the corpus callosum, and parieto-occipital parencephaly. No member of her family suffers from microcephaly, and her brother is healthy.

3.1. Research procedure

- The first stage consisted of establishing the bachelor's thesis topic, followed by searching, gathering and placing the information on the page, necessary to compile the study on microcephaly. All of this contributed to the completion of the fundamental part of the study.
- The second stage consisted of searching for a patient whose diagnosis would be the one chosen by me to carry out the bachelor's study.
- In the third stage, I documented myself regarding the tests that the patient would undergo to carry out the

assessments, I designed the objectives of the recovery program, followed by its preparation respecting, of course, the formulated objectives, but also the principles of physiotherapy.

• The fourth stage consisted of applying the previously designed recovery program, performing exercises and playing games. At the beginning of the program, the initial evaluation was carried out - October 2, 2022, and at the end of it, the final evaluation - April 30, 2023.

• The fifth stage summarized the representation of the data collected during the recovery program by creating specific tables and graphs, considering the assessments and the patient's progress or regression.

• The last stage, the sixth, consisted of outlining the conclusions and drawing up recommendations.

3.2. Patient assessment tests

a. Balance test – "get up and walk", figure 2.

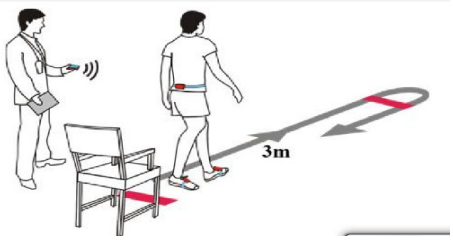

Fig. 2. *Balance test* [11]

The quantification of this test is done on a scale of 0-1-2-3:

- 0 – unable
- 1 – performs with difficulty and with help from the physiotherapist
- 2 – performs alone with difficulty
- 3 – performs without difficulty.

The test is performed as follows: the patient will sit on a chair, then stand up and walk 6-10 m, after which he will turn around, sitting back on the chair. The duration of these actions can be timed.

b. The Pearl Test, (figure 3) designed to determine manual dexterity [7].

Materials:

- 30 cylindrical beads of the same color, perforated in the center (lengthwise), with a hole of 2-3mm.
- A 28-30 cm long thread, passed through the "eye" of a canvas needle. At the other end of the thread is tied the 31st bead, used as a stopper
- Stopwatch.

Technique: the subject will take the beads with the dominant hand and insert them into the needle that he holds in the non-dominant hand. After inserting the beads onto the needle, he releases them onto the thread. Proceed in the same way until they string all 30 beads onto the thread. The execution time is timed.

Instruction: Showing the subject: you have 30 beads that you must string on this thread. After you pass them through the needle, you let them go on the string. You must string all the beads as quickly as possible. You will start when I start the timer, which I will stop when you finish stringing, on your command, when you say Stop!

Scoring: The time obtained by the subject for stringing the 30 beads is reported to the standard.

Fig. 3. *The Pearl Test*

c. Laterality test:

• *Hand dominance* in which the subject must mimic the following: throwing a ball; combing hair; wiping nose; turning a key in a door; brushing teeth and greeting.

All the above are shown by the examiner first.

Assessment: note which hand the child used:

- R- right, when 5-6 tests were performed with the right hand.
- L- left, when 5-6 tests were performed with the left hand.
- 2- ambidexterity.

• *Eye dominance* - you need cardboard with a hole drilled in the center, with a hole of 1 cm in diameter. The examiner will ask the child:

- to look, through the hole created, at certain objects in different parts of the room.
- to look out the window.
- to look through the keyhole.

Assessment: After each test, the eye used is noted:

- R - right, if the actions are performed with the right eye
- L - left, if the actions are performed with the left eye
- 2 - when the subject performs the actions with both eyes, sometimes with the right, sometimes with the left.

• *Dominant lower limb* – the subject will have to perform the following:

- kick a ball.
- climb the stepper.
- jump on one foot.

Assessment: after each test, the leg used is noted:

- R - right, when the subject performed all actions with the right leg
- L - left, when the subject performed all actions with the left leg
- 2- the actions were performed with both legs.

The result is:

- R.R.R.- for right-handed people
- L.L.L. - for left-handed people
- R.L.R. – crossed laterality.

d. Perceptual motor assessment based on color:

• *Distinguishing colors*

Identification test:

Materials: for this test, a set of 21 cubes is used. Of these, 7 will be red, 7 blue and 7 green.

The subject will be given the above set.

The physiotherapist will mix the cubes, and the subject must sort the cubes according to the color they have.

Recognition test:

The child will be given the same set of cubes, and he must sort them, one by one, according to the color that the physiotherapist indicates verbally. The child has 3 minutes, after which he will be stopped.

The test is considered successful if he completes the test in less than 3 minutes and does not have more than 2 errors.

e. Perceptual-motor evaluation according to shape:

Shape identification test:

Materials: set of geometric figures, which have the same color and size: square, circle, triangle and rectangle, 20 in number (5 of each).

Instructions: the figures will be placed and mixed on a table, in front of the subject, and he will be asked to choose and put separately those that are the same. The child has 3 minutes to solve this test.

The test will be considered successful if he has a maximum of 2 errors during its solution.

3.3. Individualized recovery program

There is no known standard recovery program for this condition, but recovery is based on the integration of the individual into society and the attempt to improve certain insufficiently developed functions.
The kinetic program was carried out based on the following objectives:

- Cognitive stimulation of the individual; through imitation exercises/games, exercises for sorting objects by category (color, shape, size), coloring by contour.
- Social integration; exercises for personal hygiene and for daily activities: dressing, putting on shoes.
- Development of gross and fine movements; easy walking and running variations, exercises involving prehensions.
- Development of general coordination; laterality exercises, applicative routes.
- Stimulation of vision and hearing, exercises to music, following objects with the gaze.

These were realized using a varied range of exercises:

- Exercises for cognitive stimulation.
- Exercises for social integration through mortician activities.
- Exercises for the development of fine and gross motor skills.

4. Results and Discussions

The following results were obtained in the applied balance test, figure 4.

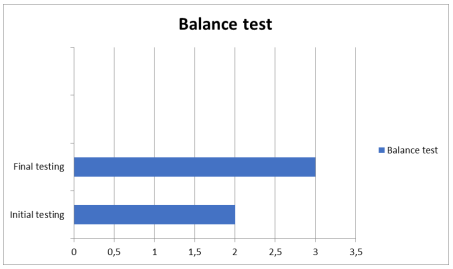

Fig. 4. *Balance test values*

A Thus, the results obtained at the initial and final evaluation show the values: initially, the patient obtained 2, which shows that he has balance disorders, performing actions alone with difficulty. At the final evaluation, improvement can be observed, the patient managing to perform actions alone and without difficulty.

Results for determining manual dexterity - Perle Test, figure 5.

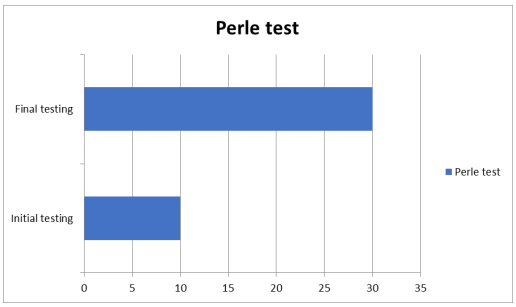

Fig. 5. *Values obtained in the Perle test*

In Figure 5 you can see the patient's evolution. At the initial evaluation he obtained a score of 10 percentiles, which indicates poor manual skill, and at the final evaluation he obtained a score of 30 percentiles, which shows us that manual skill has improved, being average.

Results regarding hand dominance at initial and final assessment, figures 6-7.

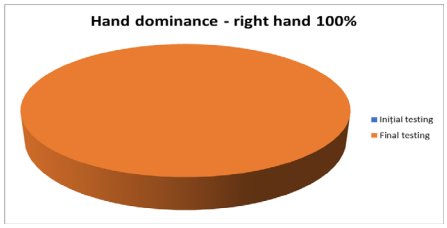

Fig. 6. *The value regarding the subject's hand dominance*

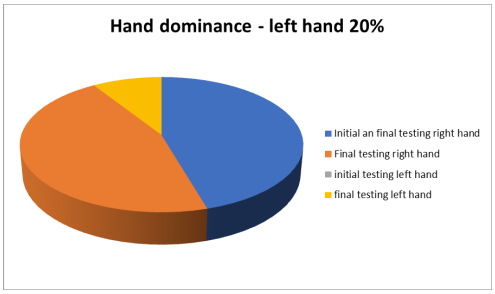

Fig. 7. *Hand dominance values at final testing*

The values obtained show that at the initial evaluation, the patient preferred to use his right hand, but during the program, he was able to use both his right and left hands, with a 20% improvement in his left hand.

Values regarding eye dominance at initial and final assessment, figure 8.

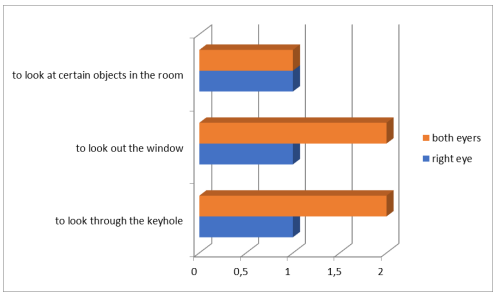

Fig. 8. *Values for the dominance of the subject's eyes*

Patient results at initial and final assessment regarding lower limb dominance, figure 9.

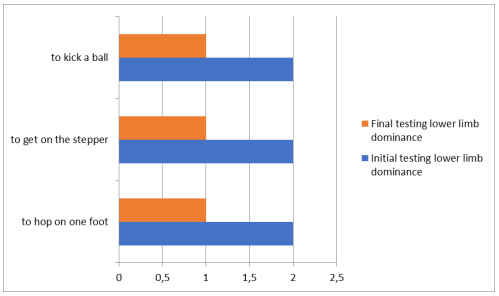

Fig. 9. *Lower limb dominance values*

Results regarding perceptual motor assessment based on color – color discrimination, figure10

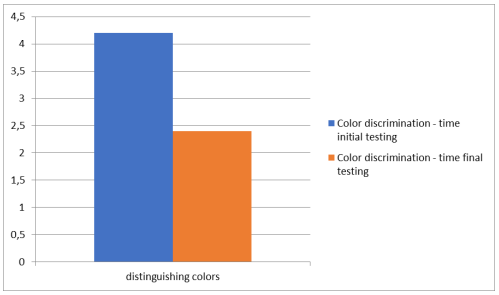

Fig. 10. *Values for color discrimination*

In Figure 10, the patient's evolution can be observed, he being able to differentiate the main colors, finally reaching the requirement within the allotted time..

Patient results obtained in the perceptual-motor assessment according to shape, figure 11.

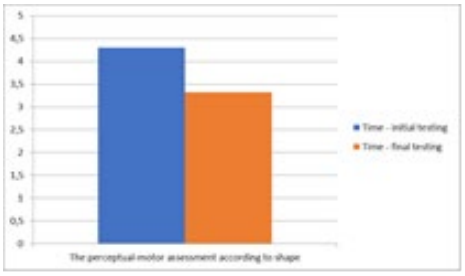

Fig. 11. *Values in the perceptual-motor assessment according to shape*

5. Conclusions

The implementation of a structured exercise program adapted to individual needs leads to significant improvements in motor function, cognitive skills and quality of life. The patient showed a clear evolution in balance, at the initial assessment obtaining a coefficient of 2, i.e. alone with difficulty, and then, at the final assessment, obtaining a coefficient of 3, i.e. alone without difficulty. Also, manual dexterity progressed from poor to average, and the laterality of the hand improved, the patient initially performing activities with only the right hand, gradually starting to use the left hand. At the final assessment, the use of the left hand was at a percentage of 20%.

During the application of the recovery program, an improvement was also highlighted from a social point of view, at first the patient was quiet and even anxious.

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