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RESEARCH ARTICLE

SIX-MONTH FOLLOW-UP OF THE EFFECT OF A MAGNETIC FIELD ON CEREBRAL MOTOR DISORDERS IN EARLY CHILDHOOD

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Abstract

Introduction:- There is a consensus about the short-term efficacy, but not about the long-term effect of the low-frequency impulse magnetic field in early childhood cerebral motor disorders. There is no consensus about the statistical significance of the two-week and six-month dynamics of the kinesiology tests, cranial ultrasound, pathological and primitive reflexes.

Objective:- To compare the short-term and long-term effect of the low-frequency impulse magnetic field versus placebo control and compare the statistical significance regarding the two-week and six-month dynamics of the kinesiology tests, cranial ultrasound, pathological and primitive reflexes.

Material and Methods:- 29 children (age 8.10 ± 5.98 months) with cerebral motor disorders were followed for 6 months. They were divided into two groups - physiotherapeutic and control. The physiotherapy group (n = 14) received a once-daily low-frequency impulse magnetic field for two weeks at the start of the follow-up. The control group (n = 15) received a once-daily placebo magnetic therapy for two weeks at the start of the follow-up. Kinesiology tests, cranial ultrasound, pathological and primitive reflexes were recorded at the beginning of the follow-up, after two weeks, and after six months.

Results:- At the beginning of the follow-up, there was no difference between the two groups regarding all parameters ($P > 0.05$). Both groups showed better results after two weeks versus the start of the follow-up ($P < 0.05$) and after six months versus after two weeks ($P < 0.05$). The physiotherapy group showed better results versus the control group after the second week ($P < 0.05$) and after the sixth month ($P < 0.05$). The two-week and six-month dynamics of the kinesiology tests showed the highest significance ($P < 0.001$), followed by primitive reflexes ($P < 0.04$), followed by pathological reflexes ($P < 0.05$), and finally - the cranial ultrasound ($P > 0.05$), at comparable baseline parameters ($P < 0.05$).

Conclusion:- The low-frequency impulse magnetic field showed a significant short-term and long-term therapeutic effect that exceeded the corresponding placebo effects. The statistical significance at the second week and the sixth month of kinesiology tests was the highest, followed by primitive reflexes, and pathological reflexes. The cranial ultrasound did not show significant two-week and six-month dynamics.

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Despite the relatively stationary morphological changes, verified by cranial ultrasound, the developing nervous system in children aged 8.10 ± 5.98 months showed significant positive dynamics and plasticity for two weeks and six months, verified by kinesiology tests, primitive and pathological reflexes.

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Introduction:-

Cerebral movement disorder is the most common impairment in childhood [1-3]. It covers the widest range of central motor manifestations (from normal to pathological) - varying degrees of asymmetric muscle imbalance (shortening, hypertonicity, spasticity, and rigidity of predominantly static muscles versus elongation, weakness, hypotonus, dystonia, hypotrophy, and atrophy of predominantly dynamic muscles), developmental delay, prolonged presence of primitive and pathological reflexes, inadequate gross motor skills, pathological global and reciprocal movements, central coordination disorder (according to Vojta) in four degrees (very mild, mild, moderate, or severe) and cerebral palsy of various forms and severity [1-6]. This "working" diagnosis is used for children with pathological manifestations or increased risk (reproductive damage, in vitro fertility, multiple or pathological pregnancy, prematurity, low birth weight, male gender, birth complications, forceps, asphyxia, microcephaly, premature closure of the fontanelle, brain damage, intracranial hemorrhage, meningitis or other infections, antibiotic or corticosteroid therapy, hyperbilirubinemia, hearing impairment, visual impairment, epilepsy or other neonatal seizures, and imaging abnormalities) [1-6]. The diagnosis of "cerebral motor disorder" is transient, showing a risk of developing cerebral palsy, alarming the need for monitoring and including early rehabilitation measures. Their delay increases the risk of regression to cerebral palsy, loss of cortical connections with corresponding functions, and developing secondary complications [5,7]. The problem with reasonably deciding on early measures is that, unlike the developed nervous system, damage to the underdeveloped nervous system remains masked at first and manifests later [5,7]. Early developmental delays usually do not disappear but may regress with aging [7].

In the diagnostic and classification of cerebral motor disorders, the following kinesiology tests are most often used: Gross Motor Function Classification System (GMFCS) [8-11,14]; Manual Ability Classification System (MACS) [8,12,13]; Communication Function Classification System (CFCS) [13]; Eating and Drinking Ability Classification System (EDACS) [13]; Gross Motor Function Measurement (GMFM) [14]; Bimanual Fine Motor Function (BFMF) [2,8,12,15]; and Fidgety Movements [6]. The clinical picture of cerebral motor disorder includes a delay of motor development and position-balance mechanisms; lag positional or abnormal reactivity; changes in muscle tone of hypotonic, hypertonic, and dystonic nature; persistence of primitive and pathological reflexes; reflex hyperexcitability; strabismus (converging or diverging, bilateral or unilateral); eating problems (discoordination between sucking/swallowing and breathing) and insufficiency of movements [6,7,9,15-23].

Cranial ultrasound is used to diagnose and monitor cerebral disorders until the fontanelle closes. Abnormalities of brain development, focal and diffuse lesions, intracranial hemorrhages, cortical and periventricular atrophic lesions, multicystic encephalomalacia, etc. are visualized [2,16].

There are currently more than 64 different interventions for cerebral palsy [5]. This number is much higher if including interventions being studied at clinical trials [5].

Of the physical factors, the electromagnetic field is most often used [24-26]. There is a consensus on its short-term effectiveness, as it is believed to stimulate axonal reinnervation, improve tissue oxygen deposition, stimulate oxidative processes, improve microcirculation, increase cell membrane permeability, accelerate biochemical reactions, and have anti-edematous effects [24-26].

There is no consensus about the long-term effect of the low-frequency impulse magnetic field in cerebral motor disorders in early childhood. The aim of the study was to compare the short-term and long-term effects of the low-frequency impulse magnetic field versus placebo control and compare the statistical significance regarding the two-week and six-month dynamics of the kinesiology tests, cranial ultrasound, pathological and primitive reflexes.

Material And Methods:-

29 children (age 8.10 ± 5.98 months) with cerebral motor disorders were followed for 6 months. They were divided into two groups - physiotherapeutic and control. The physiotherapy group ($n = 14$) received a once-daily low-frequency impulse magnetic field for two weeks at the start of the follow-up. The control group ($n = 15$) received a once-daily placebo magnetic therapy for two weeks at the start of the follow-up.

Kinesiology tests, cranial ultrasound, pathological and primitive reflexes were recorded at the beginning of the follow-up, after two weeks, and after six months in binary code. The presence of pathology was marked with "0", and the absence of pathology - with "1". For example, cranial ultrasound visualization of abnormalities of brain development, focal and diffuse lesions, intracranial hemorrhages, cortical and periventricular atrophic ultrasound scars were considered as pathology ("0") [2,16].

The following kinesiology tests were used: Gross Motor Function Classification System (GMFCS) [8-11,14]; Manual Ability Classification System (MACS) [8,12,13]; Communication Function Classification System (CFCS) [13]; Eating and Drinking Ability Classification System (EDACS) [13]; Gross Motor Function Measurement (GMFM) [14]; Bimanual Fine Motor Function (BFMF) [2,8,12,15]; and Fidgety Movements [6]. They were registered in binary code. The presence of pathology was marked with "0", and the absence of pathology - with "1". As the kinesiology tests were very dynamic and their results varied in a very wide range during the two-week and six-month follow-ups, all kinesiology tests were averaged and registered as an overall averaged binary index.

The low-frequency impulse magnetic field was applied transcranially with inductive electrodes [24-26]. The intensity of the magnetic field was 8 milli-Tesla and its frequency was 10 Hertz [24-26]. The duration of the procedure was 10 minutes [24-26]. One procedure daily was applied. Ten procedures were applied within two weeks (excluding the weekends) [24-26]. Placebo magnetic therapy was administered using a similar algorithm, except that the intensity of the magnetic field was 0 milli-Tesla.

Results:-

At the beginning of the follow-up, there was no difference between the two groups regarding all parameters ($P > 0.05$) (Figure 1). Both groups showed better results after two weeks versus the start of follow-up ($P < 0.05$) and after six months versus at the second week of the follow-up ($P < 0.05$) (Figure 1). The physiotherapy group showed better results versus the control group at the second week ($P < 0.05$) and at the sixth month ($P < 0.05$) (Figure 1). At the beginning of the follow-up the mean binary value of the kinesiology tests, cranial ultrasound, primitive and pathological reflexes was comparable ($P > 0.05$) (Figure 1). The two-week and six-month dynamics of the kinesiology tests showed the highest significance ($P < 0.001$), followed by primitive reflexes ($P < 0.04$), and pathological reflexes ($P < 0.05$). The cranial ultrasound did not show significant two-week and six-month dynamics ($P > 0.05$) (Figure 1).

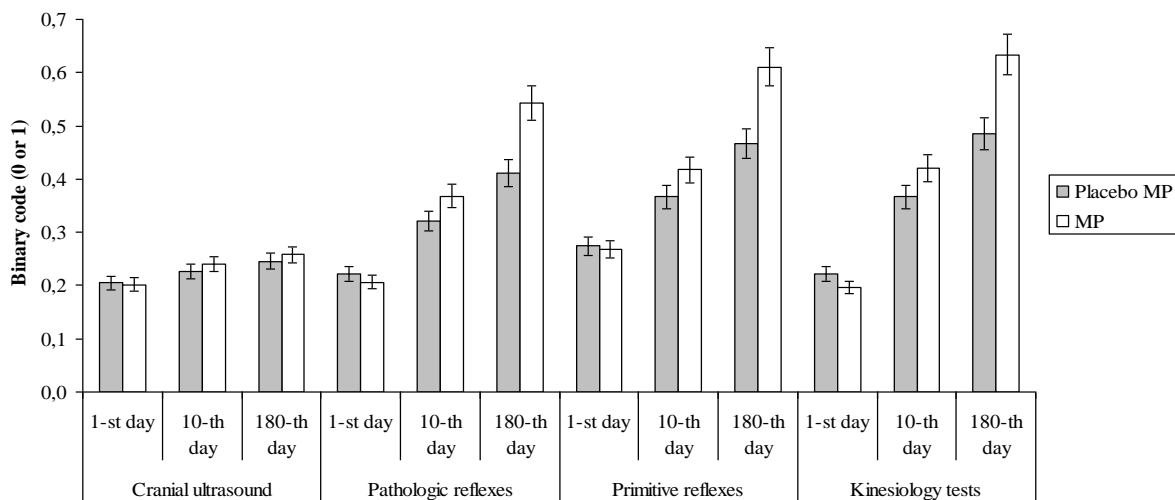


Figure 1:- Results from cranial ultrasound, kinesiography tests, primitive and pathological reflexes on the 1st, 10th, and 180th day of the follow-up in both groups (magnet physiotherapy group “MP” and control group “Placebo MP”), registered in binary code: pathology – “0”; norm - “1”.

Discussion:-

The low-frequency impulse magnetic field had a significant short-term (two-week) therapeutic effect, exceeding that of the placebo control, as the physiotherapy group showed better results than the placebo control group in the second week of follow-up, at comparable values at baseline. This supports the opinion of other authors that magnetic therapy has a short-term therapeutic effect [24-26].

The low-frequency impulse magnetic field had a significant long-term (six-week) therapeutic effect, exceeding that of the placebo control, as the physiotherapy group showed better results than the placebo control group at the sixth month of follow-up, at comparable values at the start of follow-up.

The finding that at the beginning of the follow-up the average binary value of the kinesiography tests, cranial ultrasound, primitive and pathological reflexes was comparable, while at the second week and the sixth month it was different, showed that they had different dynamics and plasticity. The probable reason that the statistical significance of the kinesiography tests was the highest was their fastest dynamics and the greatest plasticity, both in the short term and in the long term. Some of these tests were possible to be verified only in the early follow-up and others only later. Some of them persisted for a shorter time and others for a longer time. Therefore, despite the averaging of the results of all kinesiography tests, their dynamics and plasticity continued to be the fastest, changing in a very wide range during the two-week and six-month follow-ups. This necessitated statistical replacement of individual missing real data with corresponding missing statistical values due to the impossibility to verify the results of some kinesiography tests in different periods of the follow-up.

From the results, it was concluded that primitive and pathological reflexes had slower dynamics and less plasticity compared to kinesiography tests, but faster dynamics and greater plasticity compared to cranial ultrasound, which showed relatively consistent results at the beginning, two weeks, and six months later. Therefore, despite the relatively stationary morphological changes verified by cranial ultrasound, the developing nervous system in children aged 8.10 ± 5.98 months showed significant positive dynamics and plasticity for two weeks and six months, verified by kinesiography tests, primitive and pathological reflexes. This is in concordance with the opinion of other authors [1-14]. The disadvantage of cranial ultrasound was the impossibility to perform it after closing the fontanelle. This necessitated statistical replacement of individual missing real data with corresponding missing statistical values due to the impossibility of performing cranial ultrasound during all three follow-ups. Due to the lack of significant dynamics of the cranial ultrasound, even a single successful performance (before closing the fontanelle) was sufficient to verify the morphologic findings.

Conclusion:-

The low-frequency impulse magnetic field showed a significant short-term and long-term therapeutic effect that exceeded the corresponding placebo effects. The statistical significance at the second week and the sixth month of kinesiography tests was the highest, followed by primitive reflexes, and pathological reflexes. The cranial ultrasound did not show significant two-week and six-month dynamics. Despite the relatively stationary morphological changes, verified by cranial ultrasound, the developing nervous system in children aged 8.10 ± 5.98 months showed significant positive dynamics and plasticity for two weeks and six months, verified by kinesiography tests, primitive and pathological reflexes.

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