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RESEARCH ARTICLE

SIX-MONTH FOLLOW-UP OF KINESITHERAPY FOR CEREBRAL MOTOR DISORDERS IN EARLY CHILDHOOD

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Cerebral Motor Disorders, Early Childhood, Kinesitherapy, Prognostic Factors, Frequency Of Kinesitherapy

Abstract

Introduction:- There is a consensus about the positive effect of kinesitherapy in cerebral motor disorders, but not about its recommended frequency. There is no consensus on the statistical significance of predictive factors.

Aim:- To compare the effect of kinesitherapy versus control, as well as to compare the statistical significance of the following factors: age, corrected age, weight, gender, pregnancy, number of pregnancies, conception, birth, twins, pathological reflexes, primitive reflexes, kinesiology tests, cranial ultrasound, follow-up and frequency of kinesitherapy.

Material and methods:- 27 children (age 8.21 ± 5.49 months) with cerebral motor disorders were followed for six months. They were divided into "kinesitherapy group" and "control group". The control group (n = 15) was followed up in the beginning, at the second week, and at the sixth month. The treatment group (n = 12) was followed up in the same way but received kinesitherapy once daily for two weeks at the beginning of every month. Parents were instructed to perform the same techniques with their children as often as possible at home. The following factors were recorded and analyzed: age, corrected age, weight, gender, pregnancy (normal or pathological), number of pregnancies, conception (normal or in vitro), birth (normal or pathological), twins (yes or no), pathological reflexes, primitive reflexes, kinesiology tests, cranial ultrasound, follow-up (short-term and long-term) and frequency of kinesitherapy.

Results:- At the beginning of the follow-up, there was no difference between the two groups regarding all factors (P>0.05). Both groups showed better results after two weeks (P<0.05) and after six months (P<0.05) regarding kinesiology tests, pathological and primitive reflexes. The kinesitherapy group showed better results versus the control group at the end of the second week (P<0.05) and at the end of the sixth month (P<0.05) regarding kinesiology tests, pathological and primitive reflexes. The regression coefficients of the factors decreased in the following sequence: frequency of kinesitherapy (0.787), kinesiology tests (0.412), primitive reflexes (0.352), conception (0.298) , birth (0.282), twins (0.221), corrected age (0.220), age (0.197), pregnancy (0.197), pathological reflexes (0.143), cranial ultrasound

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(0.127), number of pregnancies (0.0501), gender (0.0306), follow-up (0.00547), and weight (0.0000031).
Conclusion:- Kinesitherapy has a significant short-term and long-term effect that exceeds the placebo effect. Significance of the factors decreased in the following order: frequency of kinesitherapy, kinesiology tests, primitive reflexes, conception, birth, pregnancy, corrected age, age, pathological reflexes, cranial ultrasound, pregnancy, gender, follow-up, and weight. The frequency of kinesitherapy is the most important factor, which should be recommended at least three times daily in cerebral motor disorders in early childhood.

Introduction:-

Cerebral motor disorder due to pre-, peri- or postnatal injury of the central nervous system is the most common impairment in childhood and covers a wide range of manifestations - from cerebral palsy to normal function [1]. The rationales for using this broad spectrum "working" diagnosis are 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) [1-5]. The diagnosis of "cerebral motor disorder" is transient, showing a risk of developing cerebral palsy and the need for early rehabilitation interventions [1-5]. Their delay increases the risk of regression to cerebral palsy, loss of cortical connections with corresponding functions, and developing secondary complications [3]. The problem with reasonably deciding on early interventions is that, unlike the developed nervous system, damage to the underdeveloped nervous system remains masked at first and manifests later [3,6]. Early developmental delays usually do not disappear but may regress with aging [3,6].

In the diagnostic and classification of cerebral motor disorders, the following kinesiology tests are most often used: Gross Motor Function Classification System (GMFCS) [7-9]; Manual Ability Classification System (MACS) [7,10-12]; Communication Function Classification System (CFCS) [11,13,14]; Eating and Drinking Ability Classification System (EDACS) [11,13,15]; Gross Motor Function Measurement (GMFM) [16]; Bimanual Fine Motor Function (BFMF) [1,7,10,17,18] and fidgety motors [4-6,18-21].

Cranial ultrasound is used in diagnosing and monitoring cerebral motor disorders before the fontanelle closes. Abnormalities of brain development, focal and diffuse hyperechogenicity, intracranial hemorrhages, cortical and periventricular atrophic lesions, multicystic encephalomalacia, etc. are visualized [1,22].

There are currently over 64 different therapeutic approaches used in clinical settings for cerebral motor disorders in early childhood [3]. This number is much higher if adding experimental research interventions [3].

The most commonly used active kinesitherapy methods for cerebral motor disorders in early childhood are the methods of Vojta and Bobath [13,15,23]. The most commonly used passive kinesitherapy method is the massage [24-27].

There is only a general consensus on the positive effect of kinesitherapy, but not about its recommended frequency. There is no consensus on the statistical significance of the predictive factors. To aim was to compare the effect of kinesitherapy versus control, as well as to compare the statistical significance of the following factors: age and corrected age, gender, number of pregnancies, conception (normal or in vitro), pregnancy (normal or pathological), birth (normal or pathological), twins, weight, pathological reflexes, primitive reflexes, kinesiology tests, cranial ultrasound, follow-up (short-term and long-term) and frequency of kinesitherapy.

Material And Methods:-

27 children (age 8.21 ± 5.49 months) with cerebral motor disorders were followed for six months. They were divided into "kinesitherapy group" and "control group". The control group (n = 15) was followed up in the

beginning, at the second week, and at the sixth month. The treatment group (n = 12) was followed up in the same way but received kinesitherapy once daily for two weeks at the beginning of every month. Parents were instructed to perform the same techniques with their children as often as possible at home.

Vojta kinesitherapy included exteroceptive and proprioceptive facilitation techniques, reflex rotation and reflex crawling, key positions, trigger zones, and three-dimensional directed pressure in trigger zones [13,15,23,28]. The combination of starting zones and positions was determined by motor skills, age, clinical signs, and degree of disability [13,15,23,28].

Bobat kinesitherapy included neuro-developmental treatment: key joints, fixation, stimulation of equilibrium and upright reactions, development of motor skills, and automation of motor skills in everyday life [9,29].

The massage was applied analytically [24,25]. Static muscles with increased tone, shortening, rigidity, and spasticity are treated by inhibitory massage techniques [24,25]. Dynamic muscles with decreased tone, elongation, decreased strength, and atrophy, were treated with stimulating massage techniques [24,25,27].

The following factors were recorded and analyzed in absolute value: age (in months); corrected age (in months); pregnancies (in number); weight (in grams); follow-ups (at the beginning -"1", on the second week - "2", and on the sixth month - "3"); frequency of kinesitherapy (in number of procedures per day), which included the daily procedure performed during the two-week therapeutic courses, added to the daily number of home exercises. The following factors were recorded and analyzed in binary code: gender: male - "0", female - "1"; pathological and primitive reflexes: pathology - "0", norm - "1"; primitive reflexes: pathology - "0", norm - "1"; pregnancy: pathology - "0", norm - "1"; birth: pathology - "0", norm - "1"; twins: no - "0", yes - "1"; conception: in-vitro - "0", norm - "1"; cranial ultrasound: pathology - "0", norm - "1" (pathology was verified in case of visualization of abnormalities of brain development, focal and diffuse lesions, intracranial hemorrhages, cortical and periventricular atrophic lesions, multicystic encephalomalacia, etc. [1, 22]); kinesiology tests: pathology - "0", norm - "1". The following kinesiology tests were used: Gross Motor Function Classification System (GMFCS) [7-9]; Manual Ability Classification System (MACS) [7,10-12]; Communication Function Classification System (CFCS) [11,13,14]; Eating and Drinking Ability Classification System (EDACS) [11,13,15]; Gross Motor Function Measurement (GMFM) [16]; Bimanual Fine Motor Function (BFMF) [1,7,10,17,18]. As the separate kinesiology tests were very dynamic and their results varied in a very wide range during the two-week and six-month follow-up, the result of all kinesiology tests were averaged as an overall binary code.

Quantitative statistical analysis included ANOVA with post-hoc multiple comparisons by the Bonferroni method. Qualitative statistical analysis included Pearson correlation with post-hoc multiple regression analysis.

Results:-

ANOVA results showed that at the beginning of the follow-up there was no difference between the two groups regarding all factors ($P>0.05$) (Figure 1). Both groups showed better results after two weeks ($P<0.05$) and after six months ($P<0.05$) regarding kinesiology tests, pathological and primitive reflexes (Figure 1). The kinesitherapy group showed better results compared to the control group, both at the end of the second week ($P<0.05$) and at the end of the sixth month ($P<0.05$) regarding kinesiology tests, pathological and primitive reflexes (Figure 1). In both groups at the beginning of the follow-up the average binary value of the kinesiology tests, cranial ultrasound, primitive and pathological reflexes was comparable ($P>0.05$), while at the second week and the sixth month it was significantly different ($P<0.05$) (Figure 1). The two-week and six-month dynamics showed the highest statistical significance regarding the kinesiology tests ($P<0.001$), followed by primitive reflexes ($P<0.04$), and by pathological reflexes ($P<0.05$). The cranial ultrasound showed insignificant dynamics ($P>0.05$) (Figure 1).

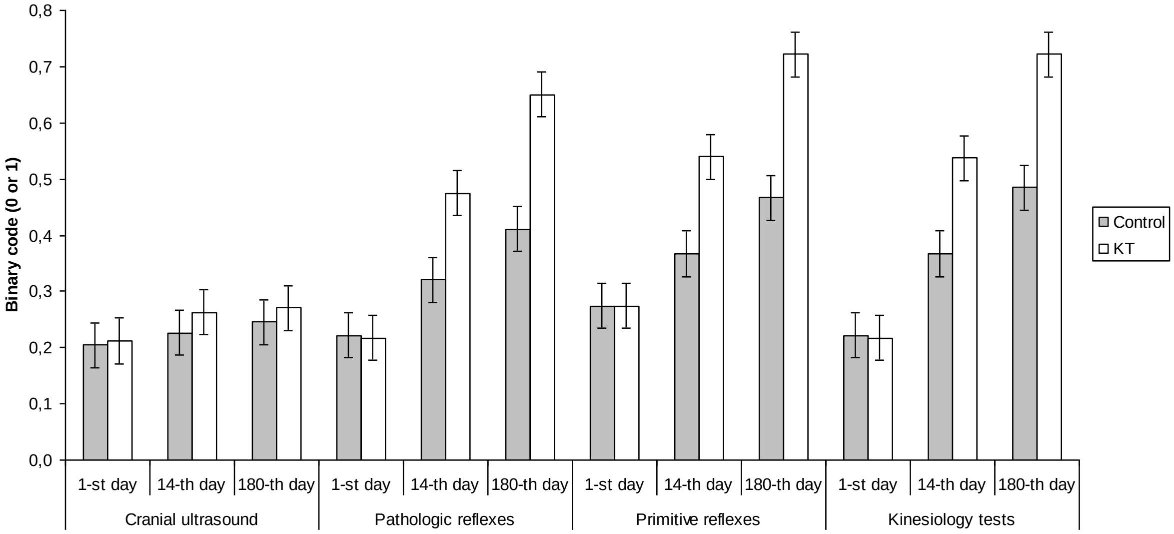

Figure 1:- Results from cranial ultrasound, kinesiology tests, primitive and pathological reflexes on the 1-st, 14-th, and 180-th day of the follow-up in both groups (kinesitherapy group “KT” and control group “Control”), registered in binary code: pathology – “0”; norm - “1”.

Multiple regression analysis found that the results of kinesiology tests correlated simultaneously with all other factors according to the following formula:

Kinesiology tests = –2.17 + (0.787 * frequency of kinesitherapy) + (0.352 * primitive reflexes) + (0.298 * conception) + (0,282 * birth) - (0,221 * twins) + (0,220 * corrected age) + (0,197 * age) + (0,197 * pregnancy) + (0,143 * pathological reflexes) + (0,127 * cranial ultrasound) - (0.0501 * number of pregnancies) - (0.0306 * gender) + (0.00547 * follow-up) + (0.00000310 * weight). The regression coefficient of the kinesiology tests was 0.412.

Correlation analysis found that the statistical significance decreased in the following order: frequency of kinesitherapy versus kinesiology tests (P=8.95E-23), frequency of kinesitherapy versus primitive reflexes (P=2.74E-05), frequency of kinesitherapy versus pathologic reflexes (P=0.0467), and frequency of kinesitherapy versus cranial ultrasound (P=0.0452).

Multiple linear regression analysis between the frequency of kinesitherapy and kinesiology tests is shown in Figure 2.

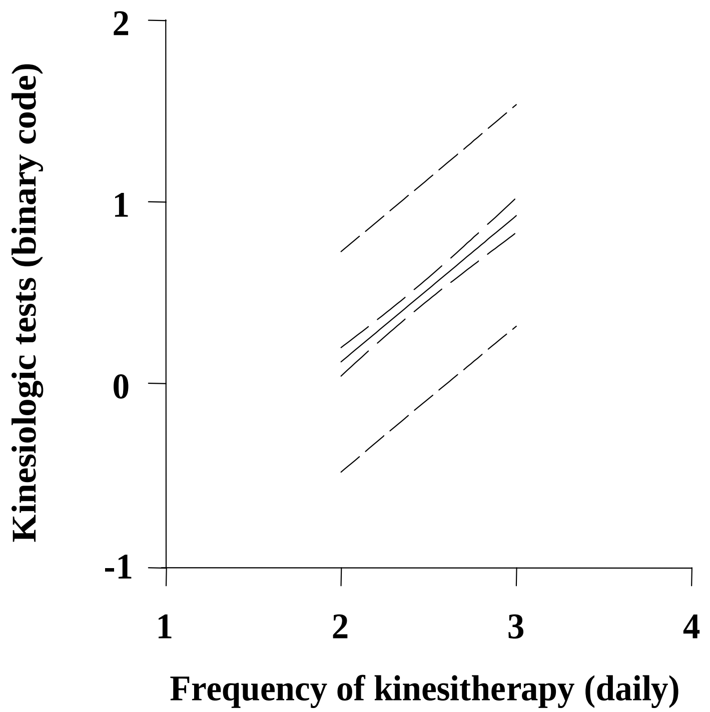

Figure 2:- Multiple linear regression analysis between frequency of kinesitherapy and kinesiology tests.

The same analysis found that the results of kinesiology tests were determined by the frequency of kinesitherapy according to the following formula:

Kinesiology tests = – 1.50 + (0.806 * frequency of kinesitherapy)

According to this real regression formula, at a frequency of kinesitherapy twice daily, the overall binary index of kinesiology tests was 0.112, while at a frequency three times a day, it was 0.918.

Multiple linear regression analysis between frequency of kinesitherapy and primitive reflexes is shown in Figure 3.

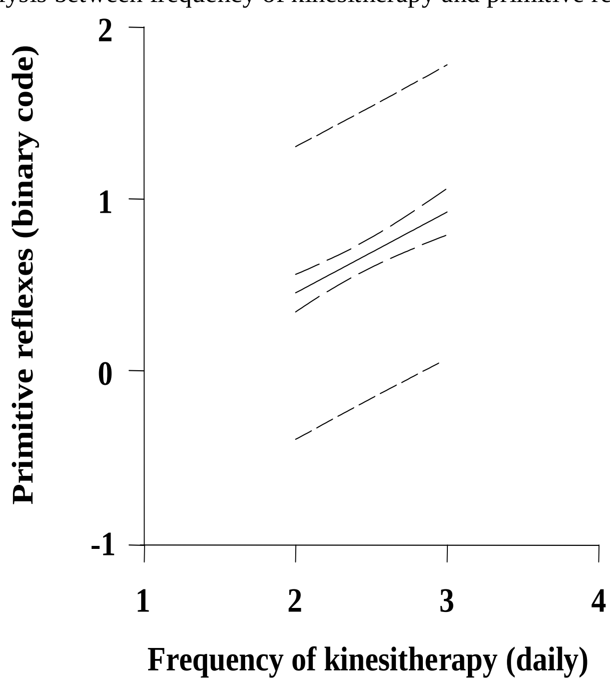

Figure 3:- Multiple linear regression analysis between frequency of kinesitherapy and primitive reflexes.

The same analysis found that the results of primitive reflexes were determined by the frequency of kinesitherapy according to the following formula:

Primitive reflexes = – 0.496 + (0.473 * frequency of kinesitherapy)

According to this real regression formula, at a frequency of kinesitherapy twice daily, the binary index of primitive reflexes was 0.45, while at a frequency three times a day, it was 0.923.

Multiple linear regression analysis between the frequency of kinesitherapy and cranial ultrasound is shown in Figure 4.

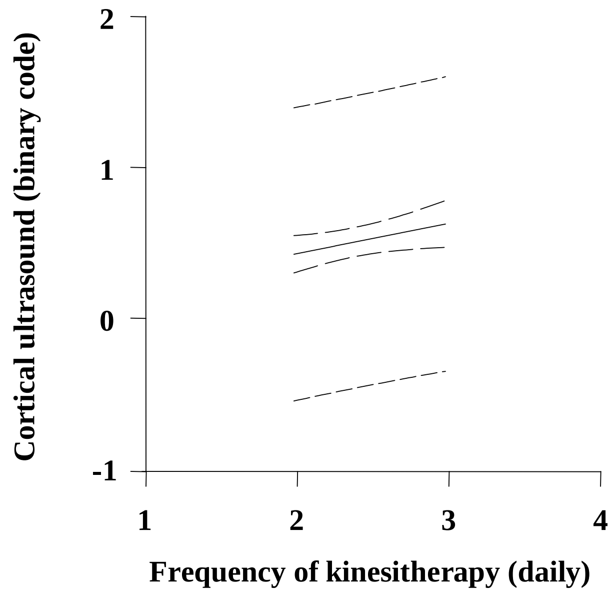

Figure 4:- Multiple linear regression analysis between frequency of kinesitherapy and cranial ultrasound.

The same analysis found that the results of the cranial ultrasound were determined by the frequency of kinesitherapy according to the following formula:

Cranial ultrasound = 0,114 + (0,201 * frequency of kinesitherapy)

According to this real regression formula, at a frequency of kinesitherapy twice daily, the binary index of cranial ultrasound was 0,516, while at a frequency three times a day, it was 0,717.

Discussion:-

Kinesitherapy had a significant therapeutic effect that exceeded the placebo effect, as the kinesitherapy group performed better than the control group after two weeks and sixth months, at comparable values at the beginning of follow-up. This supports the opinion of other authors that kinesitherapy has a short-term and long-term therapeutic effect [9,13,23-25,28,29].

In addition, the frequency of kinesitherapy had the highest regression coefficient of all factors. Moreover, twice the daily frequency of kinesitherapy was insufficient to achieve a significant effect, while three times daily was sufficient. This means that parents cannot rely on once-daily visits of the child to a specialized pediatric kinesitherapy facility. The instruction to perform kinesitherapy two-three times daily is incorrect, because twice a day is insufficient. Therefore, the frequency of kinesitherapy at least three times daily should be an important recommendation in cerebral motor disorders in early childhood.

The probable reason that the statistical significance of the kinesiology tests was the highest was their fastest dynamics, both in the short and long term. Some of these tests were verified earlier in the child development and others later. Some of them persisted for a shorter time and others – longer. Therefore, despite the averaging of the results of all kinesiology tests, their dynamics continued to be the fastest but changing in a very wide range during the two-week and six-month follow-up. This required statistical replacement of individual missing real data with corresponding missing statistical values due to the impossibility to verify the results of some kinesiology tests in different periods of the six-month follow-up.

The statistical significance of the factors decreased in the following order: frequency of kinesitherapy, kinesiology tests, primitive reflexes, conception, birth, pregnancy, corrected age, age, pathological reflexes, cranial ultrasound, pregnancy, gender, follow-up, and weight. Primitive and pathological reflexes had lower significance compared to kinesiology tests, but higher one compared to cranial ultrasound, which showed comparable results during the follow-ups. Therefore, despite the relatively stationary morphological changes verified by cranial ultrasound, the developing nervous system in early childhood showed significant positive dynamics at the second week and the sixth month, verified by kinesiology tests, primitive and pathological reflexes. A disadvantage of cranial ultrasound was the impossibility of performing it after the fontanelle closes. This required statistical replacement of individual missing real data with corresponding missing statistical values due to the impossibility of performing cranial ultrasound in different periods of the six-month follow-up. Due to the lack of significant dynamics, any successful performance of cranial ultrasound (before closing the fontanelle) was sufficient to verify the morphological findings, relevant up to six months.

Conclusion:-

Despite the relatively stationary morphological changes verified by cranial ultrasound, the developing nervous system in early childhood showed significant positive dynamics and plasticity, verified by kinesiology tests, primitive and pathological reflexes in cerebral motor disorders. Kinesitherapy has a significant short-term and long-term effect that exceeds the placebo effect. Significance of the predictive factors decreased in the following order: frequency of kinesitherapy, kinesiology tests, primitive reflexes, conception, birth, pregnancy, adjusted age, age, pathological reflexes, cranial ultrasound, pregnancy number, gender, follow-up, and weight. The frequency of kinesitherapy is the most important factor, which should be recommended at least three times daily in cerebral motor disorders in early childhood.

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