The effects of a physiotherapeutic programme on bone mineral density, in individuals of postpuberty age (18–30 years), with cerebral palsy

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Celebral palsy (CP), unlike many other neurodevelopmental disorders, is associated with abnormalities of pregnancy and birth, particularly "birth asphyxia" and low birthweight.

The aim of this research was to define and evaluate the degree up to which the physiotherapeutic treatment after puberty, when the musculoskeletal system is almost developed, can have a positive influence on bone mineral density (BMD).

In the research 26 individuals having different forms of CP, 13 males and 13 females, participated. The percentage according to the form of the disease gender was tetraplegic 50% (13 individuals), 8 men and 6 women, average age 25.4 years, diplegic 26.9% (7 individuals), 2 men and 6 women, average age 27.2 years, hemiplegic 23.1% (6 individuals), 3 men and 3 women, average age 27.2 years. Before the measurements there were clinical tests and EEG's.

The program was conducted 3 times per week for twenty six (26) weeks and included energetic, energopathetic and energetic with resistance exercises. Each session consisted of a one-on-one program of exercise with the upper, lower extremities and lumbar region.

Dual energy X-ray absorptiometry (DEXA) was used to assess bone mineral density (BMD) of the lumbar spine and femoral neck. To minimize operator-related variability, all scans were performed and analyzed by the same trained technologist. For the control of the statistical importance of the value changes the ANOVA test was used from the statistical package SPSS.

After intervention, the physiotherapy group had a significantly greater increase in bone mineral density in femoral neck, compared with control subjects, but not in the lumbar region (L2-L4), where the physiotherapy program was not intense.

The results of this investigation show that a 6-month physiotherapeutic program enhances bone mineral density in individuals with cerebral palsy. This supports the concept that a minimal period of exercise is successful in eliciting an osteogenic response in these groups. The therapeutic goal of physiotherapists and orthopaedics is to promote exercise, especially weight-bearing activity, to decrease fragility and susceptibility to fractures in patients with decreased activity.

Keywords: Celebral palsy, tetraplegic, diplegic, hemiplegic, bone mineral density BMD, exercise

1. Introduction

Cerebral palsy is a disease, due to the permanent non developing damage of the brain, without the existence of primary muscular damage. This disease is manifested with chronic mobility disorders, as well as with others, which can be related to intelligence, speech and hearing.

The term "cerebral palsy" is used for the determination of a group of chronic neurocinetic disorders, which appear at birth, in a great variety, concerning the causality, the clinical manifestations and their gravity and have as common feature the mobility disorders. The mobility disorders are the key element but often it is also noticed reduction of the sensibility, of the intellectual qualifications, of the sentimental development and of speech.

The facing of various problems, developmental, neurological, psychological, educational is governed by common rules, in the initial stages as well as during the rehabilitation. The special therapeutic treatment is applied in the early stages, after the diagnosis of the

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Journal of Back and Musculoskeletal Rehabilitation 15 (2000) 41–45
ISSN 1053-8127 / $8.00

Table 1
The basic characteristics of the two research groups

Group	Kinetic dysfunction			Walking		Mental level		
	Diplegic	Hemiplegic	Tetraplegic	Good	Medium	Good	Medium	Low
Experiment	3	3	8	5	9	8	4	2
Control	4	3	5	5	7	3	4	5
%	26.9	23.1	50.0	38.5	61.5	42.3	30.8	26.9

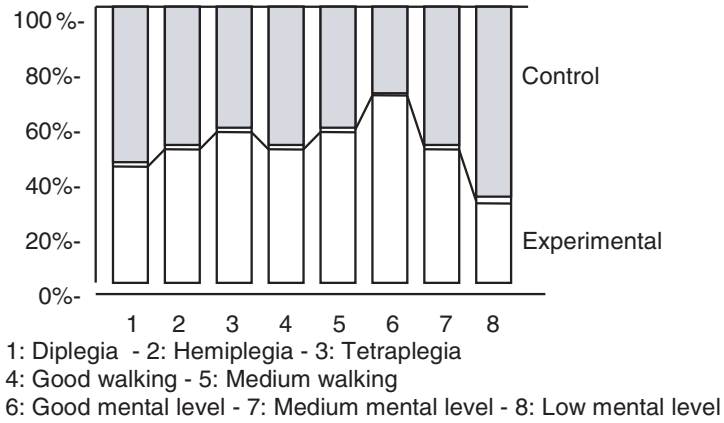

Fig. 1. The basic characteristics between the research groups.

disease. Physiotherapy has gained a significant position and aims to render the individual capable of independent walking and self-servicing, and if possible independent from his family and social environment [3].

The charge is the main factor in the determination of the bone strength during the period of development of the skeleton and up to the third decade of life of a person. Walking disorders, which mark the cerebral palsy, have as a result reduced charge, which leads to the reduction of the bone mineral density (BMD) [4,5].

Purpose of the present paper was the study of the effect of physiotherapeutic treatment on the bone mineral density, during puberty.

The research was attended by 26 individuals with different forms of cerebral palsy, 13 males and 13 females. The age of the individuals ranged from 18 up to 30 years (average: 26.08 years). The age was chosen due to the fact that after the age of 18 physiotherapeutic intervention is significantly reduced in persons with cerebral palsy.

The program lasted 26 weeks and included energetic, energopathetic and energetic under resistance exercises, exercises of mobility, flexibility and of conceptual ability. We studied the bone mineral density at the lumbar spine (L2-L4) and at the femoral neck, with double photon absorptiometry, with X-R (Roentgen) source or the method DEXA. For the control of the statistic significance of the changes of the values, the ANOVA test and the test "of the impact size" of the statistical package SPSS ver.8 was used.

2. Materials and method

For the control of bone mineral density, two groups were formed from a sample of 26 individuals with cerebral palsy, with as far as possible similar conditions. The experimental group consisted of seven (7) males and seven females, average age 25.8 years, while the control group was formed by six (6) males and six females, average age 27 years. The age (18–30 years) was chosen because after the age of 18 years, physiotherapeutic intervention is reduced significantly in persons with cerebral palsy.

The percentages according to the form of disease and sex (gender) were: Tetraplegic: 50% (13 persons) 8 males and 5 females, average age 25.4 years. Diplegic: 26.9% (7 persons), 2 males and 5 females, with average age 27.2 years. Hemiplegic: 23.1% (6 persons), 3 males and 3 females, average age 27.2 years.

Table 1 gives the basic features of the two groups. The small differences between the two groups, which are noted in the form of cinetic disorder ($\chi^2 = 0,68537;\ p = 0.70986$), in the walking ability ($\chi^2 = 0,09673;\ p = 0.75579$) and in intellectual condition

Table 2
The values of variables age-height-weight by the two groups

Code	Experimental group				Control group			
	Avg.	SD	S^2	(n)	Avg.	SD	S^2	(n)
AGE	25,79	4,79	22,95	14	27,00	3,28	10,73	12
Height	1,66	0,07	0,00	14	1,64	0,10	0,01	12
Weight	68,93	21,58	465,76	14	64,58	11,23	126,8	12

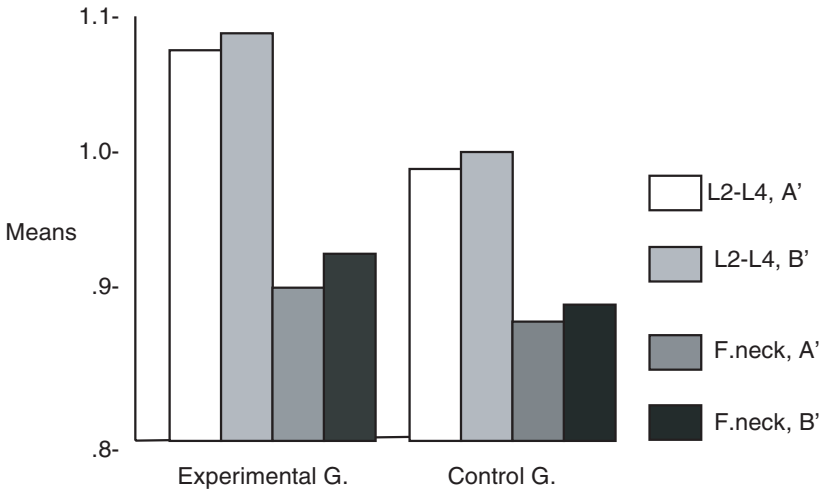

Fig. 2. The changes of the bone mineral density between groups.

($\chi^2 = 3,42486;\ p = 0.18043$) are considered statistically unimportant (Fig. 1).

Before the measurements, the participants were submitted to detailed medical examination and electroencephalogram (EEG). The electroencephalographic control was deemed necessary, in order to restrict the possibility of appearance of an epileptic episode during the measurements. The program included combined exercises of upper and lower limbs as well as of the lumbar spine, which were realised under the direct supervision of a physiotherapist and orthopaedician. The exercises took place 3 times in a week, whilst the duration of the program was 26 weeks.

The bone mineral density was calculated with double photon absorptiometry with x-ray source (Dual-energy x-ray absorptiometry or DEXA). The bone mineral density of the lumbar spine (L2-L4) and of the femoral neck [3,6,7] were studied. For reduction of the error risk, all measurements were realised by the same technician.

The statistical processing of the data was based on the comparison of frequencies (χ^2-Test) and averages (T-Test) for the independent variables. The changes in the depending variables were calculated with the fluctuation analysis (ANOVA) combining the first measurement as co-fluctuating variable. Also, further statistical analyses were realised for the development of the depending variables in each group separately (WILCOXON). For the analyses the statistical program SPSS ver.8 was used.

According to Table 2, the persons of the two groups do not differ significantly in age ($t = 0.74;\ p = 0.466$), height ($t = 0.86;\ p = 0.396$) and weight ($t = 0.63;\ p = 0.536$). The fact that the two groups have comparable presumptions allows the yield of the supposed results on the effects of the exercise program (Fig. 2).

3. Results

Table 3 shows the values of variables in the two measurements. The relative stability of the bone mineral density is obvious, especially at the area L2-L4, at the interval of 26 weeks of exercising. This is attributed to the nature of the feature, which is relatively stable and under stable conditions of nutrition, taking of medicines, movement and physical activity it does not demonstrate temporary increases-reductions.

From the study of the changes of the bone mineral density at the interval L2-L4 no significant changes were seen in any group, nor differences between the

Table 3a
Values of bone mineral density between groups, before rehabilitation program

Measure	Group	Sex	Mean	SD	N
Bmdensity fem. Neck A'	experimental	boy	0.85971	0.21299	7
		girl	0.89617	0.21037	6
		Total	0.87654	0.20366	13
	control	boy	0.81650	0.09756	6
		girl	0.84800	0.16159	6
		Total	0.83225	0.12832	12
	Total	boy	0.83977	0.16477	13
		girl	0.87208	0.18060	12
		Total	0.85528	0.16970	25
Bmdensity L2-L4 A'	experimental	boy	1.07186	0.24410	7
		girl	1.04600	0.15136	6
		Total	1.05992	0.19879	13
	control	boy	0.92133	0.05389	6
		girl	1.01533	0.09311	6
		Total	0.96833	0.08758	12
	Total	boy	1.00238	0.19262	13
		girl	1.03067	0.12087	12
		Total	1.01596	0.15955	25

Table 3b
Values of bone mineral density between groups, after rehabilitation program

Measure	Group	Sex	Mean	SD	N
Bmdensity fem. Neck B'	experimental	boy	0.92486	0.18112	7
		girl	0.91583	0.19743	6
		Total	0.92069	0.18074	13
	control	boy	0.80283	0.10947	6
		girl	0.95367	0.27129	6
		Total	0.87825	0.21238	12
	Total	boy	0.86854	0.15939	13
		girl	0.93475	0.22707	12
		Total	0.90032	0.19358	25
Bmdensity L2-L4 B'	experimental	boy	1.08786	0.25754	7
		girl	1.05267	0.12264	6
		Total	1.07162	0.19941	13
	control	boy	0.92667	0.06328	6
		girl	1.04167	0.11557	6
		Total	0.98417	0.10723	12
	Total	boy	1.01346	0.20452	13
		girl	1.04717	0.11376	12
		Total	1.02964	0.16474	25

two groups ($F = 0.102;\ p = 0.753$). This may be due to the face that only a part of the kinesiotherapy program was referring to the lumbar part of the spine.

In the development of the bone mineral density of the femoral neck, improvements were noticed in both groups. The improvement in the experimental group is statistically important ($Z = -2.1965;\ p = 0.0281$) and possibly due to the more intense mobilisation of the articulation of the hip during the program. In the control group, the respective improvement could not be considered as significant ($Z = -6276;\ p = 0.5303$). Due to the positive developments in both groups, the assumption of the positive impact of the program in the experimental, against the control group ($F = 0.003;\ p = 0.957$), could not be supported. It is also important to point out that there was no observation of any statistically important differences in bone mineral density between the two genders in both groups / between measures ($p = 0.825$ and $p = 0.90/p = 0.910$ and $p = 0.83$, respectively), maybe because normally there are no differences in bone mineral density between the two genders at the age range selected for this research [1,2].

4. Discussion

The assumption that the kinesiotheraphy program could cause significant changes in the bone mineral

density of the exercising persons, was not verified, despite the results of other researches [3,7–9]. Only in the bone mineral density of the femoral neck were significant changes recorded in the experimental group, a fact which is due to the greater mobilisation of the hip against the lumbar spine (L2-L4) and against the control group. If we consider the relatively small size of the groups, the results are encouraging.

In healthy people the threshold of the mechanical stimulus, for the osteogenesis (bone birth), which is called "mechanostatis", requires a more intense stimulus than in people with mobility problems, like in cerebral palsy [10]. The non prevalence of the program against the usual physical activity, is attributed to the short time period of its application (26 weeks) and to some qualitative elements of the program, like the restricted mechanical charge of the skeleton due to the application of exercises of sub-maximum intention. Despite this result, the tendency of increase of the bone mineral density encourages the continuation of application of the program.

5. Conclusions

From the results of the study, it is realised that the 6-months physiotherapeutic program assisted in the increase of bone mineral density in persons with cerebral palsy. This fact supports the assumption, that even a time restricted exercise program can favour the osteogenetic reaction of the organism of those persons. The goal of the people engaged with this is the reduction of fragility of the bones and of the risk of causing fractures through the program, which must also include exercises with weights.

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