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THE ANALYSIS OF GAIT IN PEOPLE WITH DOWN SYNDROME – COMPARISON WITH THE NORM IN HEALTHY PEOPLE

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Abstract. The analysis of gait in people with Down syndrome, mentally retarded to a moderate and considerable degree, and a comparison of the results achieved to the gait norm elaborated for healthy people were the main interests of the authors of this experiment.10 people suffering from Down syndrome, aged 16-22, took part in the experiment. All participants of the research had documented mental retardation to a moderate and considerable degree, with the average IQ 37.6±4.29, measured in the Terman-Merrill scale. In order to evaluate gait, we used Vicon 250, a computerised system of a three-dimensional analysis of motion, connected to five infrared video cameras. It was assumed that people with Down syndrome not only have dysfunction of gait expressed by disturbed character of angular changes in their lower extremities and pelvis movements, but changes of values of the spacio-temporal parameters in them also stray from the physiological norm. The research hypothesis has been confirmed. People with Down syndrome show dysfunction of gait as compared to the physiological norm. The spacio-temporal parameters of people suffering from Down syndrome differ significantly from the parameters of people within the physiological norm.

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Key words: Down syndrome – Gait

Introduction

Walking, running, jumping, and swimming belong to basic forms of human locomotion. These activities are natural and obvious for everyone, yet only specific disturbances make us start thinking about their mechanics. It turns out that walking, and the more so running, is one of the most complicated, cyclical motor activities of man. This complexity results from the existence of considerable quantity of degrees of freedom within the region of the pelvic girdle and lower and upper

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extremities, and a minimum number of degrees of freedom within the trunk, as well as from the necessity of simultaneous maintenance of the state of balance of the whole body.

The dysfunction of the lower extremities automatically releases the phenomenon of compensation which equalises disturbances. Compensation measures, to a lesser or greater degree, lead to overload and unfavourable changes in different sections of the locomotor system [8]. The above-mentioned observation explicitly shows to fundamental significance of the research of gait mechanics, both in people not manifesting and manifesting disturbances of this activity. The analysis of gait in people with Down syndrome, mentally retarded to a moderate and considerable degree, and comparison of the results achieved to the gait norm elaborated for healthy people – that is determination of substantial differences in the test group in relation to the gait norm of healthy people - constituted the main interests of the authors of this experiment.

According to many authors [1,3,4] the following factors have crucial influence on the motor development of the mentally retarded: hypotonia, abnormal development of reflexes, instability, obesity and also individual condition of health. All the above-mentioned factors cause specific locomotive disturbances, problems with stability of posture and motion, including also generation of disturbances of gait.

The following research hypothesis was set forth: people with Down syndrome have dysfunction of gait, manifesting itself by a disturbed character of angular changes in their lower extremities and movements of the pelvis, as well as fluctuation of values of spacio-temporal parameters differing from the physiological norm.

Materials and Methods

10 people with Down syndrome, aged 16-22, including 9 males and 1 female, attending the Complex of Special Schools in Cracow, took part in the experiment; the average age equalled 17.8±2.69. All the participants of the research had documented mental retardation to a moderate and considerable degree, with the average IQ 37.6±4.29, measured in the Terman-Merrill scale.

In order to evaluate gait, we used Vicon 250, a computerised system of a three-dimensional motor analysis, connected to five infrared video cameras.

Employing this system, we analysed the reference pattern of gait for people with Down syndrome in comparison to the picture of physiological gait expressed by the double standard deviation band. The data collected concerned the average angular values in ankle, knee and hip joints, movements of the pelvis, as well as spacio-temporal parameters [7].

Results and Discussion

The graph below shows the average values of angular changes in ankle joints for the right and left leg against the background of results obtained in the comparison group of healthy, young people with the average age of 21 years.

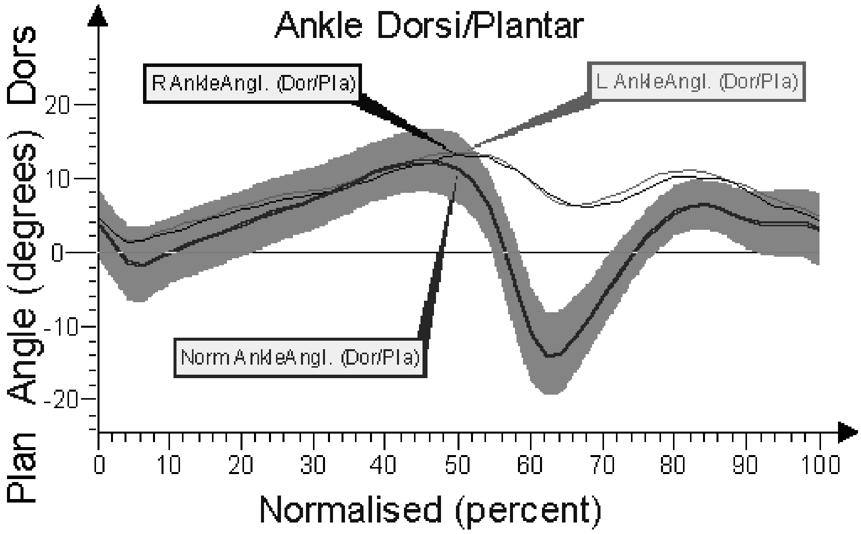

Fig. 1
Angular changes in ankle joints within the range of plantar flexion and dorsiflexion of feet in the sagittal plane

The course of angular changes for both legs is very similar, yet in some phases of gait they stray from the physiological norm to a considerable extent [2]. The initial contact takes place in a slight dorsiflexion of feet. In loading response and midstance phases, the curves of angular changes follow the course within the double standard deviation band, characteristic of scattering of results for the population of healthy people. Subsequently, there can be noticed elongation of relative duration time of the stance phase by approximately 5% in relation to healthy people. However, the most distinct differences concern the values obtained and relating to plantar flexion of the foot in terminal stance and pre-swing phases, where differences between the average values for healthy and mentally retarded people amount to 20°. The feet of people taking part in the experiment do not perform plantar flexion in the above-mentioned phases of motion but they remain in dorsiflexion in approximately 6°. This causes significant impairment of terminal stance and pre-swing phases and decreases the effectiveness of the triceps sure activity. In the initial swing, the values of angles still considerably differ from normative changes and only in midswing and terminal swing they return to the region of band 2s. Moreover, there was noted increased abduction in the stance phase in the frontal plane.

Akerstrom and Sanner [1] observed manifestation of hyper dorsiflexion of foot in children with Down syndrome taking part in their experiment. The examinations carried out also confirm manifestation of hyper dorsiflexion of foot without the proper plantar flexion of foot causing restriction of terminal stance and pre-swing phases.

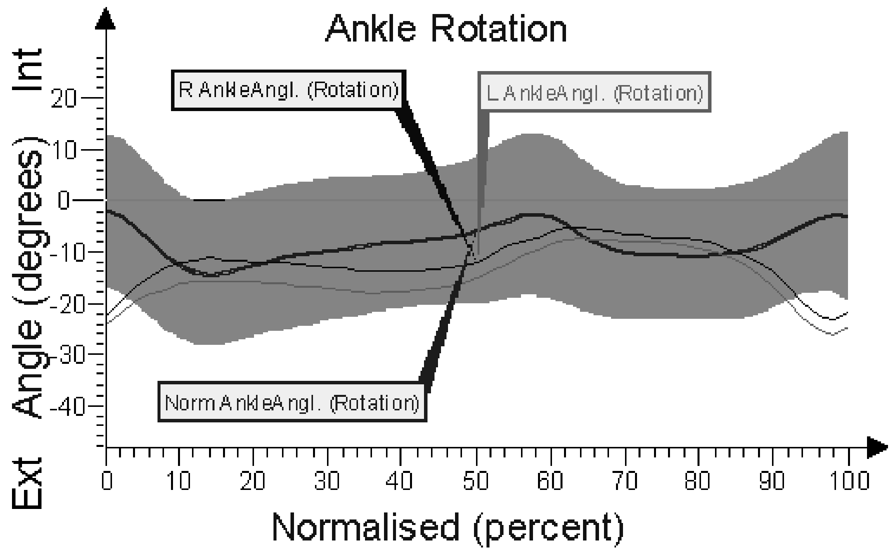

Fig. 2
Angular changes within the range of position of feet in the transverse plane

In the initial contact in the transverse plane the position of feet in people with Down syndrome is different than in healthy people. There appears to be distinct external rotation, about 22°-24°, and towards the end of the cycle in the terminal swing phase we also observe supra-normative, 20° external rotation.

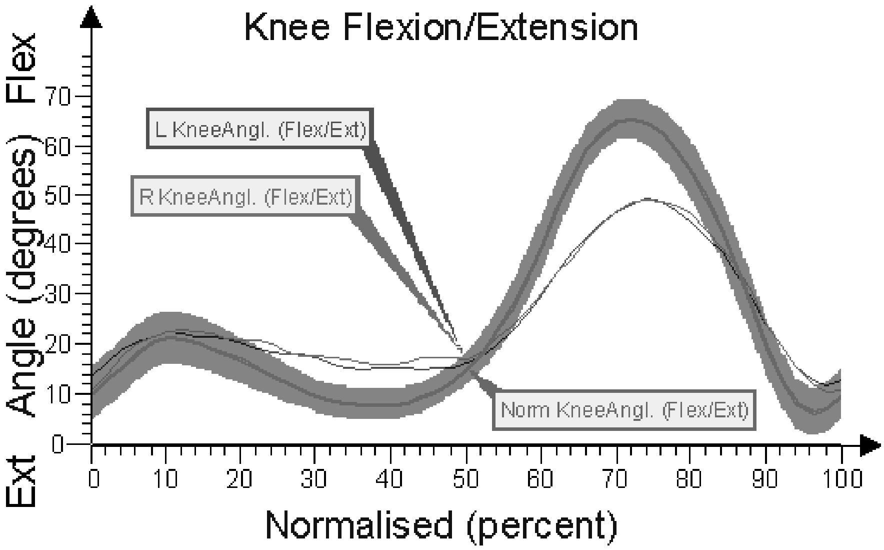

Fig. 3
Angular changes in knee joints within the range of flexion and extension in the sagittal plane

Angular changes in knee joints in initial contact and loading response phases do not differ from the ones achieved by healthy people. Tangible differences appear only after the completion of approximately 20% of the cycle. Knee joints, to a significantly lesser degree, extend in the terminal stance phase than in the case of healthy people. Discrepancies between average values in both groups amount to 8°. The following distinct disturbance manifests itself as a considerably limited flexion of knee joints in the swing phase which is smaller by about 17°. No radical changes within the shank rotation and Valgus/Varus position have been noted in the remaining planes of motion.

Within the range of angular changes in hip joints we observe a distinctly smaller, by approximately 18°, total range of angular changes of bending and extending the joints. The greatest differences between average values of parameters are observed, like in ankle joints, also in the terminal stance and pre-swing phases. Hyperextension of both hip joints is distinctly smaller than in the group of healthy people, and differences range from 8° for the left hip to 10° for the right one. A smaller flexion of hip joints in the swing phase, where differences amount to 9°, constitutes the following distinct dysfunction. Moreover, there was noted a slightly decreased range of abduction and adduction changes of hips in the frontal plane and a delayed phase of internal rotation of hips in the transverse plane in the phases of terminal stance and pre-swing.

Analysing the average values of angular changes in the pelvic tilt, one should state that they belong to the region of physiological norm as compared to the total range of changes. The research of Lydic and Steele [5] showed that a great percentage of children with Down syndrome is characteristic of the gait with legs put widely astride and Duchenne's gait at a considerably big external rotation in the hip joint and incorrect position of arms.

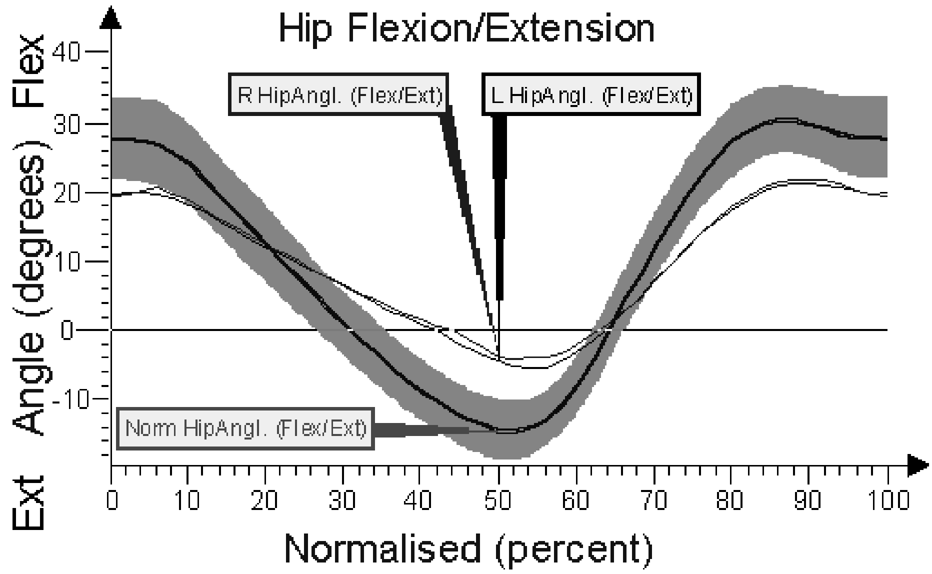

Fig. 4
Angular changes in hip joints within flexion and extension in the sagittal plane

Slight changes in the initial contact phase of the foot are noted in the pelvic obliquity graph seen as a decreased elevation of the hip. The pre-swing and swing phases are characteristic of more distinct deviations where we observe elevation of hips above normal. The total range of angular changes at pelvic obliquity up and down is smaller in the group of people with Down syndrome by approximately 4° in relation to the average value noted in healthy people.

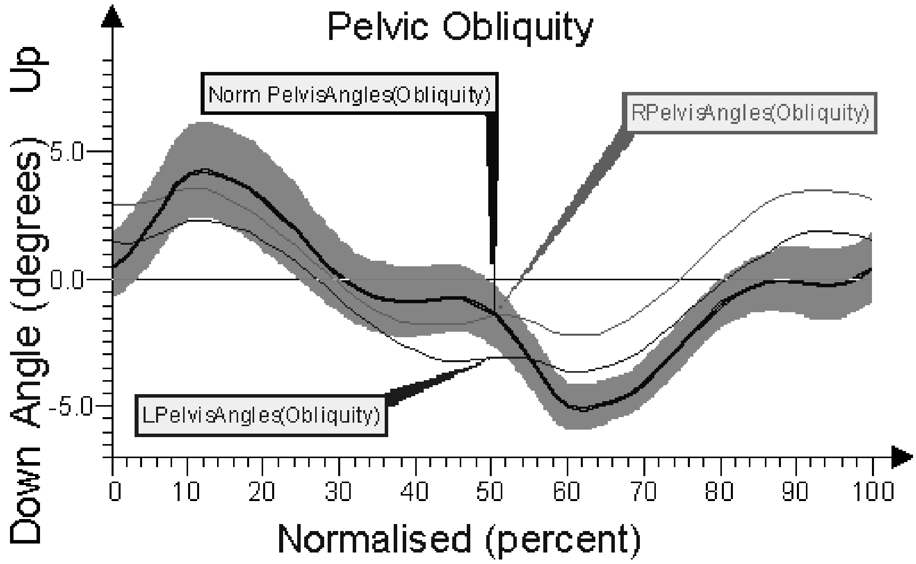

Fig. 5
Pelvic obliquity

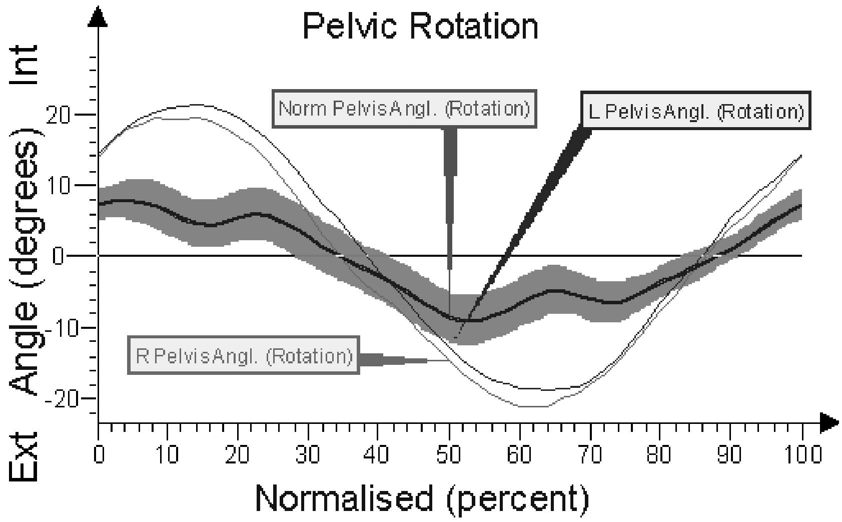

Fig. 6
Pelvic rotation

While analysing pelvic rotation in the transverse plane we can observe the existence of considerably supra-normative, increased rotation, both in the internal loading response phase–the average value equals 21° - and in the external pre-swing phase, where the average value amounts to 19°. The whole normalised cycle of gait ends with a slightly bigger than normal, equalling approximately 6°, internal rotation.

Lydic and Steele [5] pointed out to the existence of a significant external rotation in the hip joint in children with Down syndrome. The analysis carried out showed increased rotation, both external and internal, in the group of people taking part in the experiment.

Table 1.
The spacio-temporal parameters of people taking part in the research

Spacio-temporal parameters	Down syndrome Left leg (L)	Down syndrome Right leg (P)	Physiological norm (L and P)
Step length	0.39±0.12m	0.39±0.13m	0.69±0.045m
Cadence	103±25.3 steps/min	102±25.4 steps/min	113±9.68 steps/min
Speed	0.68±0.29 m/s	0.68±0.29 m/s	1.30±0.14 m/s
Single support	0.44±0.11 s	0.43±0.091 s	0.47±0.022s
Double support	0.44±0.43 s	0.47±0.49 s	0.19±0.025s

Parker [6] examined rhythm, step length and the phase of standing and swinging in 5 year-old children with Down syndrome and in healthy children. They drew attention to significant differences in gait models between the groups in the research. These differences were observed as for the step length, shorter length of legs ascribed to children with Down syndrome, and a shortened phase of standing connected with instability and impossibility of increasing the step length. Similarly, among young people with Down syndrome the length of step is shorter and the phase of double support is elongated in relation to the physiological norm.

There are a few elaborations in Physical Therapy literature referring to the analysis of gait in people with Down syndrome, although this syndrome is classified as a pathology of human genotype most frequently met and occurring in total population with the frequency of 1 case per 600-800 children born live. The research of other authors quoted in this paper deals with children suffering from Down syndrome, while the experiment and analysis of gait carried out by us concern adult, mentally retarded people.

The establishment of the norm of the spacio-temporal parameters for healthy people and a comparative research of people with locomotive disturbances may, in consequence, lead to and affect the elaboration of kinetic therapy which would improve the gait parameters restricting negative results of compensatory overload changes. Following this track we examined the parameters of gait of a selected group of young, mentally retarded people suffering from Down syndrome, and later on we elaborated a set of corrective exercises. After the lapse of 12 months of implementing this kinetic therapy, we intend to determine whether and to what extent the indices of gait of the people taking part in the experiment improved in relation to the control group of mentally retarded people, not rehabilitated.

Conclusions

The research hypothesis set forth has been confirmed.

1. People with Down syndrome show dysfunction of gait in comparison to the physiological norm.
2. The spacio-temporal parameters of people with Down syndrome significantly differ from the parameters of people within the physiological norm.

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