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ELECTROMYOGRAPHIC ANALYSIS OF ERECTOR SPINAE MUSCLE FOR A CHILD WITH CEREBRAL PALSY

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ABSTRACT

The aim of this study was the electromyographic analysis of the erector spinae muscle, using the Noraxon Tele Myo DTS equipment. It's used to test the neuromuscular function, during physical activity. It allows for detailed localization of the pathological changes in the muscle tissue. It can be also helpful to define the functional disorders of the muscular system in children with cerebral palsy. For the purpose of the study, a six-year-old girl with this disease was examined, one of the types of EMG - surface electromyography being used. The problem which is of primary importance in children with cerebral palsy is a widely understood damage of the musculoskeletal system. The test was performed in five starting positions, with the electrodes placed on the lumbar spine. As a result of the analysis, a motor skills disorder, asymmetry of muscle tension and dystonia was diagnosed. Dystonia may be the result of other disease, characteristic to children with cerebral palsy – scoliosis.

Key words: electromyographic analysis, cerebral palsy, muscle tone disorders, dystonia.

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INTRODUCTION

Electromyography testing (EMG) is a method consisting for analyzing the myoelectric signals, caused by the selective permeation of sodium and potassium ions in the cell membranes of the muscle fibres. In kinesiology EMG is used to monitor the nervous and muscular activity, during the functional movements, work or training [1].

Electromyographic diagnosis can be used for example in children to develop their speech, including articulation and intonation [2]. Measuring technology of muscle function from a skin surface is called a surface EMG (SEMG). It is a record of muscle action potentials, registered on an area of skin, and followed by unrestrictive or reflexive stimulation [3]. Ali and Sundaraj demonstrated that through the SEMG studying, we can monitor the fatigue of different muscle groups simultaneously [4].

A survey, conducted by Coleman-Wood et al. shows that using this type of analysis, it is possible to detect and diagnose a muscular dystonia [5]. Surface EMG was used in this study for a muscular analysis in a child with cerebral palsy (CP). This disease is a syndrome of symptoms, created within the central nervous system. In particular, this ailment concerns the motor neuron and occurs during pregnancy, parturition or the perinatal period [6,7]. The frequency of cerebral palsy is estimated at 1,5 – 3 per 1000 births [6].

Another sources indicate that it is 2-2,5 per 1000 newborns [8]. In Poland, the number of children affected by this disease is estimated at 20-25 thousand [9]. The latest South Korean studies show that cerebral palsy is the most common cause of central nervous system damage in infants, and is responsible for 57,8% of all cases of brain diseases in children aged 0-9 years [10].

There are several factors which cause this illness. The most common are perinatal hypoxia and brain ischemia [11]. Moreover, neonatal jaundice as well as intracranial bleeding may also be reasons [12]. In recent times, a close relationship between the development of cerebral palsy, and clinical inflammation of the membranes and placenta [13] has been discovered. In children with cerebral palsy, the disability primarily affects their movement.

Borkowska pays attention for a key importance of the tension of extensor muscles, which are the basis to the normal motor development [9]. Michałowicz and Zabłocki also indicate broad disorders in the muscle tone [6,7]. Other dysfunctions characteristic for this disease include: vision and hearing impairment, problems with speech and motor coordination, and also mental retardation [7].

The treatment is based largely on a widely understood rehabilitation. The overriding goal is to reduce spasticity [14]. For this purpose, the kinesiotherapy methods like NDT Bobath, Vojta Therapy or the Petö Method are used [15]. As an adjunct, a therapy using specially trained dogs and hippotherapy has brought a satisfactory results in children with cerebral palsy [16,17]. In order, to improve the coordination and postural control in patients with this illness, specially adapted swings are used [18].

The latest, safest method which contributes towards improving motor skills in people with cerebral palsy, is a therapy based on the application of botulinum toxin [19].

MATERIAL AND METHODS

An electromyographic survey was carried out in the Department of Rehabilitation at Starachowice Hospital. It was made on May 15th, 2015. The study involved a 6-year-old girl with right-sided hemiparesis in cerebral palsy. The first symptoms had been observed in the 9th month of her life, and at the age of 18 months, improving by the Vojta method had been started.

The mother's pregnancy proceeded without any incidents or complications. Vision and hearing have been defined as normal. In the assessment of neurokinesiological examination, the depth of lumbar lordosis, right hip dislocation and functional dextroscoliosis of the thoracic – lumbar region of the spine has been found. The analysis was performed using Noraxon Tele Myo DTS, a 12-channel receiver.

The EMG test was carried out in the following starting positions: sitting, standing, lying on front, during running, walking and also in the resting position. The electrodes were placed medially, in the middle of the erector spinae muscle, in the lumbar spine. Pre-gelled, surface electrodes, comprising silver or silver chloride were used. The diameter of the electrodes was less than 1 centimeter.

The skin was cleaned using abrasive liquid, prior to the application of the electrodes. The electrodes were placed perpendicularly to the direction of the tested muscle fibres. The distance between them was about two centimeters. The raw EMG signal was expressed in microvolts (μV). Voltage frequency is on the Y-Axis, and the recording time on the X-Axis. The measurement results have been presented as a bar and line charts, in which a voltage intensity in the time interval amounting to 100 milliseconds was included. Continuous recording mode has been chosen.

The sampling frequency was 1000 Hz. There were five electromyographic tests, where two pairs of electrodes on both sides of erector spinae muscle in the lumbar region have been used. A fifth channel means that the electrodes were placed on the left side of the spine, and the sixth channel – on the right side.

RESULTS

The first electromyographic test was carried out in the resting, front lying position. The duration of the test was 1,2 seconds. In the case of electrodes located on the left side (channel 5), the chart shows deviation from a straight line lasting 0,4 seconds from the beginning of the study. Then a graph spread decreases, and increases further in 0,9 second. The electrodes provided on the right side (channel 6) shows that the graph, beyond single, clear deviations (in 0,5 s and 1,1 s), runs equally with the axis 0 (Figure 1). The amplitude of 100 milliseconds interval, in case of channels 5 and 6, was 34,5 μV and 9,49 μV, respectively (Figure 2).

The second electromyographic test was performed, when the patient was in a sitting position, with a support in the thoracic spine. The test of muscle reaction time was 0,6 seconds. The measurement from the electrodes in channel 5 showed a slight deviation from the axis 0 at 0,52 second of the test duration. In the case of channel 6, the record has shown variations from a straight line, starting at 0,32 second and continuing till the end (Figure 3). As a result of amplitude calculation, the score of 8,59 µV for the fifth channel and 25,1 µV for sixth has been obtained (Figure 4).

The same starting position, excluding the support in thoracic spine, was the basis for the electromyographic studies in the third test. The duration of this attempt was 0,84 seconds. Recording electrodes, placed on the left side, revealed a significant deviation from the axis 0, lasting from the beginning to 0,31 second. Then, there was an almost imperceptible muscle tone phase, lasting up to 0,59 second, after which a growth of intensity of muscular work has been recorded again. In the case of the erector spinae muscle located on the right side, a constant muscle tension, which deviation from a straight line increases with the passage of time, has been observed (Figure 5). The amplitude was 24,2 µV for channel 5, and 22,7 µV for channel 6 (Figure 6).

The fourth electromyographic test was performed, when a patient was in the standing position. Recording lasted 0,84 seconds. Similarly to the previous studies, electrodes were placed on the bellies of erector spinae muscles, on both sides of the lumbar spine. Constant muscle tension is visible in both recordings of the electrodes. In the case of fifth channel, the recording shows a long-lasting deflection from a straight line, with particularly visible contraction in 0,43 second. Recording from the sixth channel is also characterized by permanent deviations from the axis 0, with visible contractions at 0,16, 0,49, 0,62 and 0,79 second (Figure 7).

The amplitude was 33,4 µV for channel 5, and 48,6 µV for channel 6 (Figure 8). The fifth EMG recording was performed when the patient changed from the motion of running to walking. The test duration was 0,9 second. Phase change from running to walking occurred at 0,45 second. The results from the fifth channel showed a noticeable deviation from the axis 0 lasting 0,4 second. Then there was a period of overlapping of the electromyographic recording with the straight line. As for the sixth channel, a pronounced deviation from the axis 0 lasted to 0,6 second. Furthermore, the recording line also overlapped with the axis 0 (Figure 9).

As a result of the amplitude calculation, a score of 23,3 µV for the left side, and 27,3 µV for the right have been obtained (Figure 10).

DISCUSSION

An EMG analysis is useful in the diagnosis of many neuromuscular diseases, because it allows to find the exact location of lesions in the muscles, and also determines their nature and size. It also determines the dynamics of the illness in the studied muscle. Electromyographic test performed in a child with cerebral palsy allowed for detailed analysis of muscles, taking into account their activity, strength and action potential.

The erector spinae muscles, located on the left and right side of the spine in the lumbar region have been examined, which coincides with tests conducted by Ali and Sundaraj [4] who made simultaneous measurements, monitoring and electromyographic analysis of the different muscle groups.

The study confirmed the disorders in motor coordination and asymmetrical muscle tension in each of five tests carried out. Differences in the tension of the erector spinae muscles have been observed, proving their abnormal development. Via electromyographic analysis, it has been proven that in patients with dextroscoliosisof the thoracic – lumbar region of the spine, only the resting, front lying position gives a higher amplitude on the left side.

On the other hand, in the case of every other starting position for the examined girl, there was a compensation of the scoliosis, which resulted in a higher amplitude on the right side. Borkowska notes the fundamental relationship between the correct muscle tone and proper motor development [9]. Michałowicz and Zabłocki also indicates the differences in muscle tone, as one of the characteristic features in children with cerebral palsy, which has been authenticated by electromyographic study [6].

It has been confirmed that by electromyographic analysis we can detect involuntary muscle contractions, defined as dystonia. It is compatible with studies conducted by Coleman – Wood et al [5]. The effect of dystonia may be, occurring in children with cerebral palsy, scoliosis.

CONCLUSIONS

1. The electromyographic test allows for a detailed muscle analysis, both in the resting phase, and during functional movements.
2. EMG analysis enables simultaneous comparison of a different muscle groups.
3. Electromyographic recording allows the detection of neurological disorders, such as dystonia.
4. EMG diagnosis gives the opportunity to specify the amplitude value of a muscle, which is helpful to identify a scoliosis.

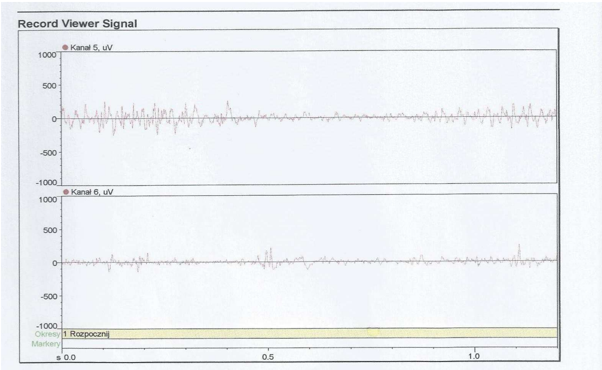

Fig. 1. Resting, front lying position.

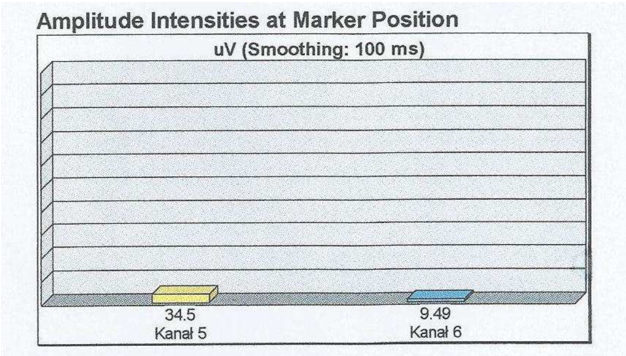

Fig. 2. Amplitude for resting, front lying position.

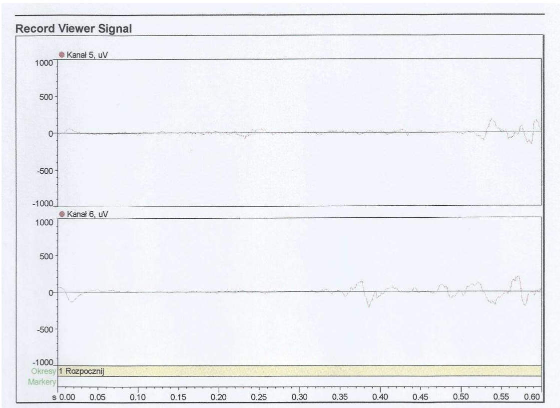

Fig. 3. Sitting position, with a support in the thoracic spine.

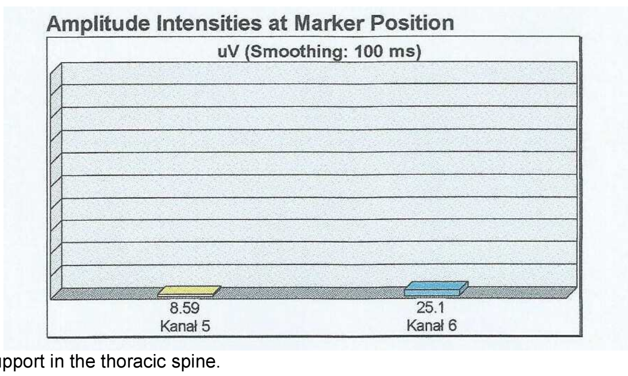

Fig. 4. Amplitude for sitting position, with a support in the thoracic spine.

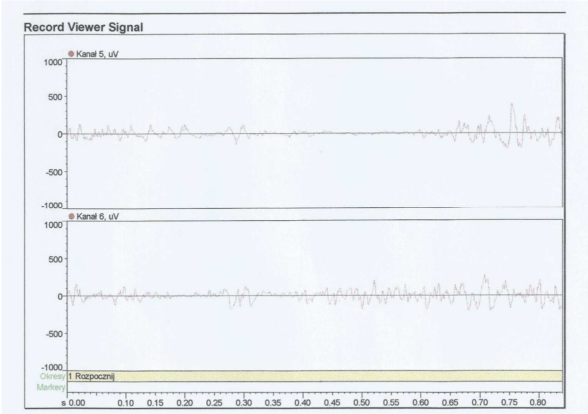

Fig. 5. Sitting position, excluding the support in thoracic spine.

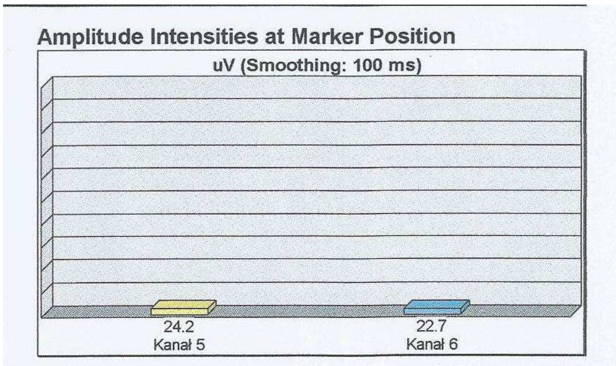

Fig. 6. Amplitude for sitting position, excluding the support in thoracic spine.

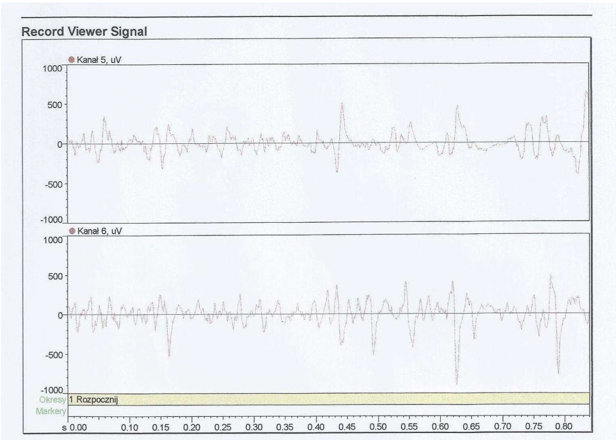

Fig. 7. Standing position.

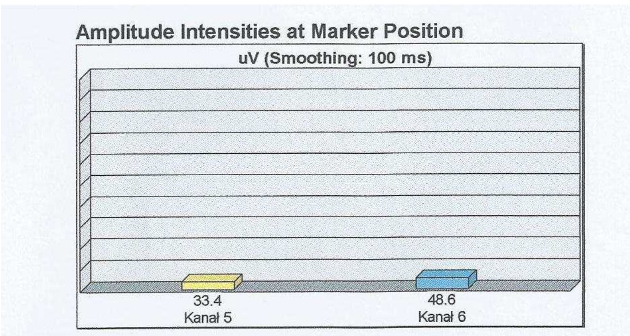

Fig. 8. Amplitude for standing position.

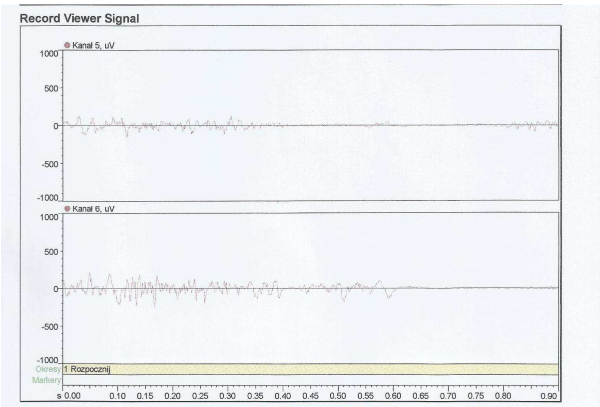

Fig. 9. Changing the motion from running to walking.

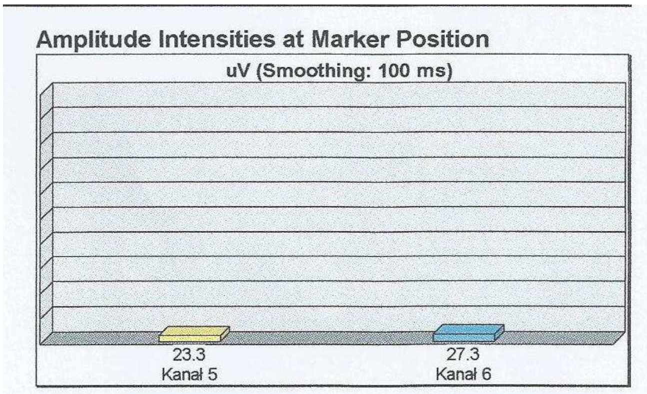

Fig. 10. Amplitude for changing the motion from running to walking.

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