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Case report of a patient with cerebral palsy using non-robotic equipment for re-education movements of paretic upper limb

Opis przypadku pacjenta z porażeniem mózgowym rehabilitowanego przy użyciu sprzętu typu 'non-robotic' służącego do reedukacji ruchów niedowładnej kończyny górnej

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ABSTRACT

Use of the equipment (non-robotic rehabilitation therapy) in adolescent patient with cerebral palsy. Impact of therapy for re-education movements of the paretic upper limb. Brief description of the equipment Armeo® re-education, efficiency and utilization. A case report of a patient with cerebral palsy – hemiparesis consisted a method of a prospective survey. The analysis of results have shown that after treatment the patient has improved the range of motion in hemiparetic upper limb and improvement in functional test of working skills and also improvement in grip ability of paretic hand. Improvement has been not only on physical, but also on mental level and we would like to emphasize the success rate of motivation of the patient in his adolescent age.

Keywords: non-robotic therapy, upper limb, cerebral palsy, hemiparesis

STRESZCZENIE

W pracy opisano możliwości wykorzystania sprzętu Armeo® (non-robotic rehabilitation therapy) u pacjenta w wieku rozwojowym z mózgowym porażeniem dziecięcym. Przedstawiono wpływ terapii na reedukację ruchów niedowładnej kończyny górnej. Dokonano krótkiego opisu i możliwości wykorzystania sprzętu Armeo®. Opisano przypadek pacjenta z mózgowym porażeniem dziecięcym, z niedowładem połowiczym. Po zakończonej rehabilitacji zaobserwowano u pacjenta poprawę funkcjonalną, zwiększenie zakresów ruchów niedowładnej kończyny górnej, a także poprawę zdolności chwytnych dłoni. Poprawa dotyczyła nie tylko aspektu fizycznego, lecz również psychicznego, gdyż zaobserwowano również poprawę w poziomie motywacji pacjenta.

Słowa kluczowe: non-robotic terapia, kończyna górna, mózgowe porażenie dziecięce, niedowład połowiczy

Introduction

Functional limitations in mobility of hemiparesis severely limit the patient's activity in all areas of life. Hemiparesis is most frequently caused by the development of cerebral palsy, stroke, brain injury or spinal cord injury. Spasticity as a major effect of the damage to the central nervous

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system reduces the patient's mobility, self-sufficiency and ultimately the quality of life too [1]. Focused Development of Kinesiology for the first 12 to 18 months after the birth, is a considerable approach to the study of treatment and movement disorders. Motor development obviously has been in progress during intrauterine life and it continues also after 18-th month throughout the whole childhood and in some purpose for entire life [2]. Hemiparesis is usually a lifelong health problem, but not unsolvable. By the effort to stifle debilitating disorder in hemiparesis and to prevent their progression, followed by restoration of lost functions of paretic upper limb, different methodological techniques and concepts were created, which are mostly based on the neurophysiologic basis [3]. Armeo® is a medical-technical equipment by which we can improve physical movement function of the upper limb. It is used to support functional movement in therapy for patients who have lost or have limited functionality of the upper limbs. Armeo® equipment is an arm orthosis equipped with various components, including a pressure-sensitive handgrip. Armeo® equipment is based on the product "T - Wrex" [4]. Product "T-WREX" - is passive (non-robotic) upper limb orthosis, which lightens the weight of the upper limb in 3D space using an ergonomic and adjustable backrest upper limb (antigravity effect) and allows natural movement in the workspace. This makes it easier for users with moderate to severe hemiparesis to achieve greater range of motion [5] (Figure 1).

A case report

A 17-year old student, born on 37th week with subsequent development of cerebral palsy.

The patient rehabilitates from her birth for the possible development of cerebral palsy. The patient was sent to non-robotic rehabilitation by the references of rehabilitation physician. The diagnosis, established according to the International Classification of Diseases, Children Cerebral Palsy (G 80.0) of hemiparetic form with right-sided spastic hemiparesis and hypotrophy right extremities. The patient completed twenty of therapies by Armeo® equipment, where one therapy lasted for 45 minutes of active exercise. She was coming to the therapy at least two to three times a week. In the case report, we qualitatively processed patient´s data and the use of observation and measurement of functional (goniometric investigation [6], functional skills working test [6] and testing grips [6]). We evaluated the obtained results by comparing the tables. Patient had before therapy in the equipment Armeo® flexion and pronation holding of the forearm, limited range of motion in supination, wrist dorsiflexion and deficit of fine hand´s motor. After this therapy was a significant improvement in the patient range of motion in the shoulder joint, in flexion of the elbow and also movements of the wrist was also improved (Table 1). Moderate improvement has occurred in the functional test of patient´s working skills, the patient can some of them perform about few seconds faster, and some of them have improved the amount of performance over exact time (Table 2). After this therapy have improved the grip abilities mainly: tip to tip pinch, lateral pinch, spherical grip, cylindrical grip and conical grip. In our patient was a reduction of the distance finger-tip - palm from 1 cm to 0 cm, thus the patient grips fingers into the palm (Table 3).

Discussion

In the description of case report of 17-year-old student, we analyzed the effect and confirmed improvement of coordination and total functional ability of the upper limb with non-robotic equipment Armeo® on mobility of hemiparetic upper limb. Studies have confirmed significant improvement in mobility of the upper limb

Figure 1. Patient's training in 3D workspace
Ryc. 1. Szkolenie pacjenta w przestrzeni roboczej 3D

Table 1. Input and output values of goniometric investigation
Tabela 1. Wejściowe i wyjściowe wartości goniometryczne

Goniometric investigation of Upper Limb	Input	Output
Shoulder Flexion	140°	180°
Shoulder Extension	20°	40°
Shoulder Abduction	80°	90°
Shoulder Adduction	20°	20°
Elbow Flexion	120°	130°
Elbow Extension	0°	0°
Wrist Flexion	20°	50°
Wrist Extension	80°	90°
Radial Deviation	0°	10°
Ulnar Deviation	20°	30°

The range of motion is displayed in table above (in degrees [°])

Table 2. Input and output values of functional test of working skills
Tabela 2. Wejściowe i wyjściowe wartości funkcjonalnego testu zdolności pracy

Right Upper Limb	Input	Output
1. Threading beads 25 sec.	2 piece	3 piece
2. Stuck pins 25 sec.	1 piece	1 piece
3. Cubes – tower 10 sec.	4 cubes	4 cubes
4. Tear paper A4 16 sec.	5,5 sec.	2, 6 sec.
5. Crumple the paper into a ball 10 sec.	14, 8 sec.	4, 5 sec.
6. 3 vertical lines, 1 erase 30 sec.	32 sec.	30, 8 sec.
7. Cut off a piece of paper 15 sec.	unable	begin motion
8. 2 elastic bands on cylinder 10 sec.	14,1 sec.	14,5 sec.
9. Close 5 safety pins 25 sec.	25,9 sec.	17,8 sec.
10. 5 pushpins in wood 20 sec.	unable	1 piece
11. Hammer 3 nails 25 sec.	1 piece	1 piece
12. Twist out light bulb 10 sec.	8, 9 sec.	7, 1 sec.
13. Insert three-pin plug 25 sec.	11, 5 sec.	8, 2 sec.
14. Wipe 4 glasses 15 sec.	13,3 sec.	13,1 sec.
15. Paint with the brush A4 20 sec.	19,8 sec.	18,9 sec.

Table 3. Testing of grip paretic´s hand
Tabela 3. Testowanie uścisku niedowładnej dłoni

Grip´s of right Upper Limb	Input	Output
Palmar pinch	2	2
Tip to tip pinch	2	3
Pinch grip	1	2
Lateral pinch	2	3
Spherical grip	2	3
Cylindrical grip	2	3
Hook grip	1	1
Distance finger-tip - palm	1 cm	0 cm
Key (lateral) grip	1	2
Pencil grip	2	2
Tweezers grip	1	2
Conical grip	2	3

0 - investigation handle not executed, 1 - grip implemented in signs, 2 - implemented grip on ¼, 3 - implemented to handle ½, 4 - implemented to handle ¾, 5 - grip implemented in full range

in patients with hemiparesis, increase the muscle strength, and increase the range of joint mobility, improvement of the neuromuscular coordination, improvement of the upper limb function, increase of the patient motivation and lastly improvement of self-sufficiency. The results of studies support the current theory of motor learning by repeating the motions, what describes the correlation between the repetition of activities and improving motor function, which it is the key to stimulate motor plasticity [5]. We agree with authors opinion in regards of that in pursuance of acquired results we describe similar findings in a patient with cerebral palsy after treatment in non-robotic equipment Armeo®.

Robotic therapy allows the patients to practice independently without the therapist, and thus helps to improve their own functional level. In particular, there is strong evidence for robotically assisted therapy that because it will increase compliance with therapy by means of introduction of incentives to the patient, such as games [7]. We have to agree here with the authors of international clinical studies, because it has showed greater interest in the therapy from the patient´s side and greater motivation, especially in child and adolescence age when, as is well known, that is difficult to motivate and to improve attention in therapy.

Armeo® Spring is an effective tool for rehabilitating the affected arm in patients with hemiparesis secondary to ictus, even in the chronic stage [8]. We agree with the authors of the study, and we deliver treatment success with using Armeo® in patient with cerebral palsy, namely primary hemiparesis.

Robotic and non-robotic training devices are increasingly being used in the rehabilitation of upper limb function in subjects with neurological disorders. Use of such devices can also provide ongoing assessments during the training sessions. Therefore, it is mandatory to understand the reliability and validity of such measurements when used in a clinical setting [9]. We consent, and therefore we also started to use non- robotic Armeo® equipment in our rehabilitation centre.

Robot assisted upper extremity therapy has been shown to be effective in adult patients after stroke and in children with cerebral palsy (CP) and other acquired brain injuries (ABI). The patient's active involvement is a factor in its efficacy. However, this demands focused attention during training sessions, which can be a challenge for children [10]. We agree with the authors, but in case of our patient, we would like to highlight the increased attention, because the games interested her and she was completely focused on the therapy.

Conclusion

Based on the analysis of results, we can say that non-robotic therapy of Armeo® positively affects the rehabilitation of the patients with cerebral palsy (hemiparesis). We have observed the improvement in patient not only on the physical dimension, but also on psychological dimension (concentration on exercise and a positive attitude to therapy). We would like to emphasize not only the positive effect of therapy, but also the patient's improvement of motivation in the adolescent age.

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