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Wpływ lecznictwa uzdrowiskowego na funkcję ręki u kobiet z reumatoidalnym zapaleniem stawów

The effects of health resort treatment on hand function in female rheumatoid arthritis patients

Ocena zmian przeciążeniowych kręgosłupa lędźwiowego pracowników o siedzącym charakterze pracy

Assessment of overload changes in the lumbar spine of employees with sedentary nature of work

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Ocena efektów plastrowania dynamicznego (PD) z wykorzystaniem inteligentnego robota neurologicznego fourier M2 u chorych po udarze mózgu z niedowładem połowiczym

Evaluation of effects of kinesiotaping with use of the intelligent fourier M2 neurological robot in patients with hemiparesis

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Streszczenie

Cel. Celem badania jest ocena efektów plastrowania dynamicznego (PD) z wykorzystaniem inteligentnego robota neurologicznego Fourier M2 u chorych po udarze mózgu z niedowładem połowiczym.

Materiał i metody. W badaniu udział wzięło 28 pacjentów (10 kobiet i 17 mężczyzn, średnia: 63,48 lat) po udarze mózgu niedokrwiennym z niedowładem połowiczym (14 lewostronnych, 13 prawostronnych), którzy wyrazili świadoma zgodę na udział w badaniu. Pacjentów podzielono przy pomocy komputerowego programu ALEA, z własnym algorytmem randomizującym, na grupę BA – 14 oraz KO – 14 osób. W celu przeprowadzenia badania wykorzystano inteligentnego robota rehabilitacyjnego Fourier M2, służącego do diagnostyki i terapii kończyny górnej.

Wyniki i wnioski. W badaniu wykazano istotne statystycznie efekty w 1, 3, 4 dobie badania pod postacią procentowej poprawy aktywnego ruchu w grupie BA jako efekt działania aplikacji plastrowania dynamicznego.

W ocenie pozostałych wyników badania, wykazano efekty zarówno plastrowania dynamicznego jak i terapii z udziałem robota neurologicznego, u chorych po udarze mózgu z niedowładem połowiczym. W ocenie tych wyników efekty terapii były porównywalne w obu grupach.

Inteligentny robot Forier M2 jest przydatnym i obiektywnym urządzeniem do diagnostyki, terapii oraz oceny efektów fizjoterapii u chorych po udarze mózgu z dysfunkcją kończyny górnej.

Słowa kluczowe:
plastrowanie dynamiczne, robot neurologiczny, fourier M2, udar mózgu, niedowład połowiczy

Abstract

Purpose. The purpose of the study is to assess the effects of dynamic taping (DT) using a smart neurological robot Fourier M2 in patients after cerebral stroke with hemiparesis.

Materials and methods. The study included 28 patients (10 women and 17 men, average age: 63, 48) after ischemic cerebral stroke with hemiparesis (14 left-sided, 13 right-sided) who expressed their informed consent for participation in the study. The patients were divided into groups using the ALEA software, with its own randomization algorithm, into group TG and CG – 14 participants in each. In order to conduct the study, there was used the Fourier M2 smart rehabilitation robot designed for diagnostics and therapy of upper limbs.

Results and conclusions. The study demonstrated statistically relevant effects on the 1st, 3rd and 4th day of the study in the form of a percentage improvement in active movement in the TG group as a result of application of dynamic taping.

The assessment of the remaining study results demonstrated both the effects of dynamic taping and the effects of the therapy with the use of a neurological robot in patients after cerebral stroke with hemiparesis. The assessment of those effects showed the therapy effects were comparable in both groups.

The Fourier M2 smart robot is s useful and objective tool for diagnostics, therapy and assessment of the effects of physical therapy in patients after cerebral stroke with upper limb dysfunction.

Key words:
kinesiotaping, neurological robot, fourier M2, cerebral stroke, hemiparesis

Introduction

The treatment of patients with upper limb dysfunctions is difficult and of little satisfaction for the patient and the physician. The treatment comprises the methods based on neurophysiological foundations, such as PNF, Bobath and others, as well as standard physical therapy consisting in individual kinesiotherapy and physical therapy. Dynamic taping and neuro physical therapy using a smart robot are innovative methods of treatment. The positive effects of DT and robots in neuro physical therapy were proven in numerous studies.

Purpose

The purpose of the study is assessment of the effects of dynamic taping (DT) using an intelligent neurological robot Fourier M2 in patients after cerebral stroke with hemiparesis.

Materials and methods

The study included 28 patients (10 women and 17 men, average age: 63, 48) after ischemic cerebral stroke with hemiparesis (14 left-sided, 13 right-sided) who express their informed consent for participation in the study. The patients were divided into groups using the ALEA software, with its own randomization algorithm, into group TG and CG – 14 participants in each. One person resigned from the study.
In order to conduct the study, there was used the Fourier M2 intelligent rehabilitation robot designed for diagnostics and therapy of upper limbs. The study was conducted on the basis of the consent from the Bioethical Commission.

Study exclusion criteria:
• hemiparesis resulting from ischemic cerebral stroke,
• increased muscle tone of the paretic upper limb (spasticity),
• patient with retained kinaesthetic feeling (of movement),
• patient with mental response,
• patient who understands instructions,
• cooperative patient.

Study exclusion criteria:
• hemiparesis resulting from hemorrhagic cerebral stroke,
• decreased muscle tone of the paretic upper limb (limpness),
• patient without kinaesthetic feeling (of movement),
• fever,
• advanced osteoporosis,
• fractures, sprains of the occupied girdle or of the upper limb,
• orthostatic disturbance,
• disturbances of consciousness,
• acute inflammations,
• advanced disturbances of heart and lung activity,
• motor function impairment,
• patient without mental response,
• uncooperative patient,
• sensitivity to acrylic glue,
• epilepsy,
• no cooperation from the patient.

Table 1. Study program

Study		distance (m)	(kcal)	speed cm/s	activeness %	score	task complit	Brunnstrom's hand recovery	muscle tone based on Ashworth scale
0	before the therapy	x	x	x	x	x	x	0 x	0 x
1	examination on the 1,2,3,4,5,6,7,8,9 day of the study	x	x	x	x	x	x	9 x	9 x

Brunnstrom's hand recovery
1 point – no movements,
2 points – attempt to make a fist, any movement of the hand,
3 points – flexing and extending the wrist while making a fist, holding an object using the hook hold,
4 points – rotary movements of the wrist, making a fist and then straightening the fingers, ability to grasp a small object between the thumb and index finger, lateral hold,
5 points – possible opposition, cylindrical, spherical hold and then straightening the fingers,
6 points – catching and throwing a small ball, buttoning and unbuttoning clothes [1].

Muscle tone based on Ashworth test
Modified Ashworth scale of spasticity:
0 – correct or reduced tone,
1 – slight increase in muscle tone while holding and releasing or demonstrated as resistance in the final phase of the movement of flexing and extending,
1+ – slight increase in muscle tone while holding and releasing and demonstrated in the second half of the movement range of the joint,
2 – more significant increase in muscle tone in the majority of the movement range of the joint, but the affected part of the limb may be moved easily,
3 – significant increase in muscle tone, passive movement is difficult,
4 – the affected part (parts) is/are rigid in flexion or extension.

Tests on all the patients were performed on the basis of the developed test program. The results were statistically analyzed.
Program of the Fourier M2 robot subject to assessment:
• assistive mode,
• warm-up – 3 minutes,
• test duration – 10 minutes
• movement trajectory – rosette,
• range: large,
• assistance level (level 3).

• Result analysis:
the distance the patient has to cover to reach the aim – distance (m),
• number of calories burned – energy (kcal),
1. variable indices:
2. speed of reaching the aim – speed cm/s,
3. patient's own activeness %,
4. points after reaching the aim – score,
5. task complete,
6. Brunnstrom's hand recovery assessment,
7. muscle tone based on Ashworth test.

Apart from the tests, all the patients participated in a training program. After the testing program, the patients from the TG and CG groups performed a training program based on the following schedule.

Training parameters:
• assistive mode,
• therapy duration – 10 min.,
• movement trajectory – selected individually based on the existing motor deficit,
• range – large,
• assistance level (level 3).

Fig. 1. Fourier M2 rehabilitation robot, source: own materials

Fig. 2. Fourier M2 rehabilitation robot. Team of physical therapists; source: own materials

Dynamic taping applications

Fig. 3. Dynamic taping in patients from the TG group (application on the deltoid muscle using the muscle technique, functional application on the forearm erector muscle); source: own materials

Statistical methods

In order to assess the study results, the ANOVA analysis was performed for the TG and CG groups in the respective measurement periods. A post hoc test (Tukey's HSD test) was performed in order to assess the significance of differences in results between the groups. The level of significance was assumed as $p < 0.05000$.

Results

ANOVA TG (P) and CG groups in the respective measurement periods

Table 2. Measurement result 0 (prior to the test)

Variable	F	P
Score	0.003304	0.954622
Tasks Complete	0.833981	0.369847
Distance (m)	0.149902	0.701905
AverageSpeed (cm/s)	0.799421	0.379794
Proportion of Active Motion (%)	3.509993	0.072736
Energy (kCal)	0.089912	0.766768
Brunnstrom	7.824932	0.009771
Ashworth	0.647349	0.428648

Table 3. Post hoc test

Tukey's HSD test; Brunnstrom variable (Matrix 0). The marked differences are significant at $p < 0.05$

Group		{1} M=4,6071	{2} M=2,9615
K	{1}		0,009916
P	{2}	0,009916	

Before the therapy, the ANOVA variance analysis demonstrated one variable, Brunnstrom's hand recovery scale, different between the two groups.
The post hoc test determined the significance at 0.009; differentiating values: control group – 4.6; Tape group – 2.9.

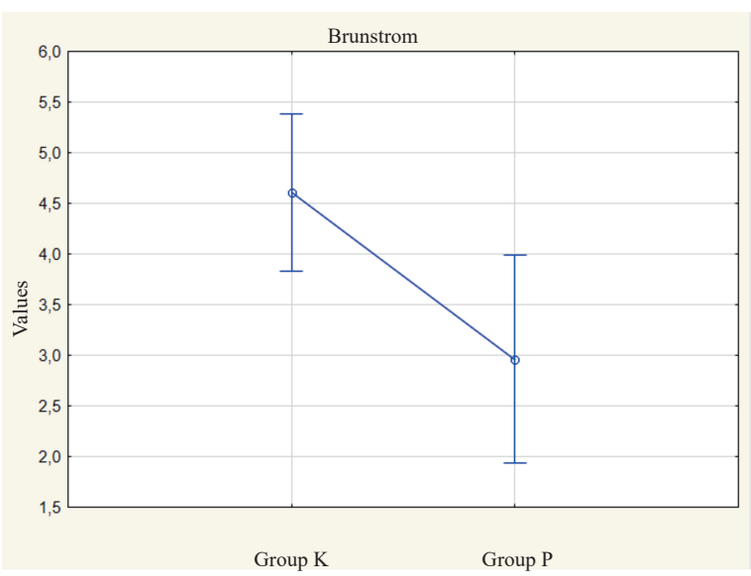

Fig. 4. Brunnstrom's hand recovery in the TG and CG groups

The results indicate that, before the test in the TG (P) group, the motor capacity of the palsied hand was much lower in the patients from the TG group than in those from the CG (K) group.

Table 4. Measurement result 1

Variable	F	P
Score	0.054543	0.817241
Tasks Complete	0.066343	0.798846
Distance (m)	0.045230	0.833306
AverageSpeed (cm/s)	0.000354	0.985135
Proportion of Active Motion (%)	9.153576	0.045226
Energy (kCal)	0.503434	0.484561

Table 5. Post hoc test

Tukey's HSD test; Proportion of Active Motion (%) variable (Matrix 1). The marked differences are significant at $p < 0.05$

Group		{1} M=48,771	{2} M=54,669
K	{1}		0,045226
P	{2}	0,045226	

In test 1., the ANOVA variance analysis determined one variable: Proportion of Active Motion that significantly differed between the groups.
The post hoc test determined the significance at 0.04; differentiating values: Control group – 48.77; Tape group – 54.67.

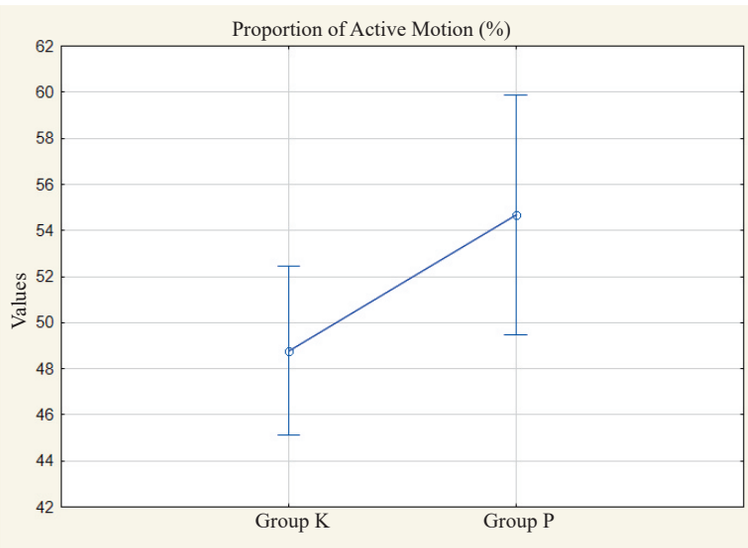

Fig. 5. Assessment of % of active movement in the TG and CG groups during the 1st test

The results indicate a significant improvement in % of active movement in the TG (P) group in comparison with the CG group.

Table 6. Measurement result 3

Variable	F	P
Score	0.000047	0.994593
Tasks Complete	0.005860	0.939592
Distance (m)	0.073658	0.788312
AverageSpeed (cm/s)	0.000565	0.981219
Proportion of Active Motion (%)	5.709405	0.024736
Energy (kCal)	0.703437	0.409579

Table 7. Post hoc test

Tukey's HSD test; Proportion of Active Motion (%) variable (Matrix 3). The marked differences are significant at $p < 0.05$

Group		{1} M=52,300	{2} M=57,277
K	{1}		0,024868
P	{2}	0,024868	

In test 3., the ANOVA variance analysis determined one variable: Proportion of Active Motion that significantly differed between the groups.

The post hoc test determined the significance at 0.02; differentiating values: Control group – 52.30; Tape group – 57.27.

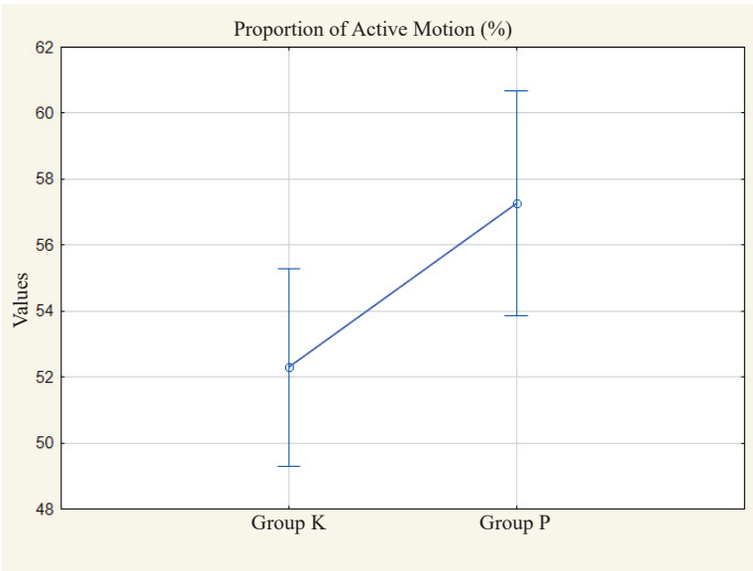

Fig.6. Assessment of % of active movement in the TG and CG groups during the 3rd test

The results indicate a significant improvement in % of active movement in the TG (P) group in comparison with the CG group.

Table 8. Measurement result 4

Variable	F	P
Score	0.020144	0.888272
Tasks Complete	0.015700	0.901289
Distance (m)	0.224417	0.639806
AverageSpeed (cm/s)	0.074584	0.787020
Proportion of Active Motion (%)	5.414230	0.028370
Energy (kCal)	0.816838	0.374733

Table 9. Post hoc test

Tukey's HSD test; Proportion of Active Motion (%) variable (Matrix 4). The marked differences are significant at $p < 0.05$

Group		{1} M=53,500	{2} M=57,338
K	{1}		0,028498
P	{2}	0,028498	

In test 4., the ANOVA variance analysis determined one variable: Proportion of Active Motion that significantly differed between the groups. The post hoc test determined the significance at 0.03; differentiating values: Control group – 53.50; Tape group – 57.34.
The results indicate another significant improvement in % of active movement in the TG (P) group in comparison with the CG group.
In tests No. 2, 5, 6, 7 and 8, the ANOVA variance analysis did not demonstrate any variables that would significantly differ between the groups.

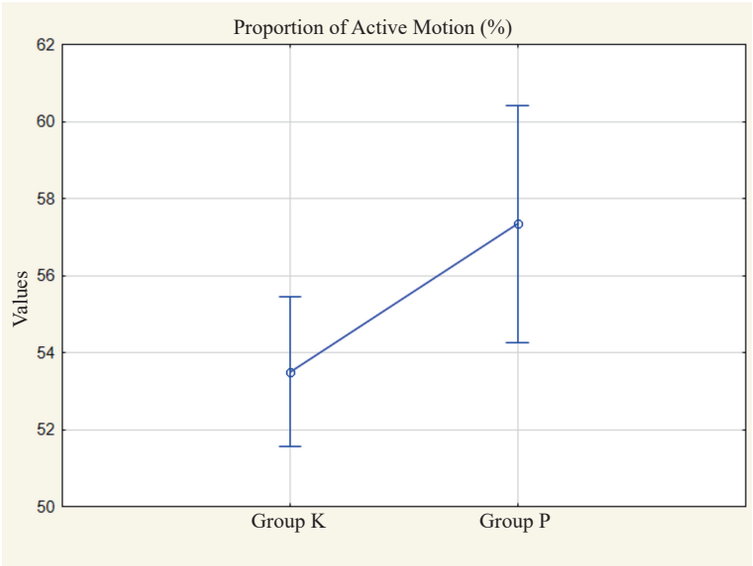

Fig. 7. Assessment of % of active movement in the TG and CG groups during the 4th test

Table 10. Measurement result 9

Variable	F	P
Score	0.020536	0.887198
Tasks Complete	0.000014	0.997086
Distance (m)	0.682248	0.416627
AverageSpeed (cm/s)	0.385555	0.540266
Proportion of Active Motion (%)	0.717059	0.405144
Energy (kCal)	1.190686	0.285596
Brunnstrom	7.121537	0.013180
Ashworth	1.120370	0.299959

Table 11. Post hoc test

Tukey's HSD test; Brunnstrom variable (Matrix 9). The marked differences are significant at $p < 0.05$

Grupa Group		{1} M=5,0000	{2} M=3,3077
K	{1}		0,013316
P	{2}	0,013316	

In test 9., the ANOVA variance analysis determined one Brunnstrom variable that significantly differed between the groups. The post hoc test determined the significance at 0.01; differentiating values: Control group – 5; Tape group – 3.3.

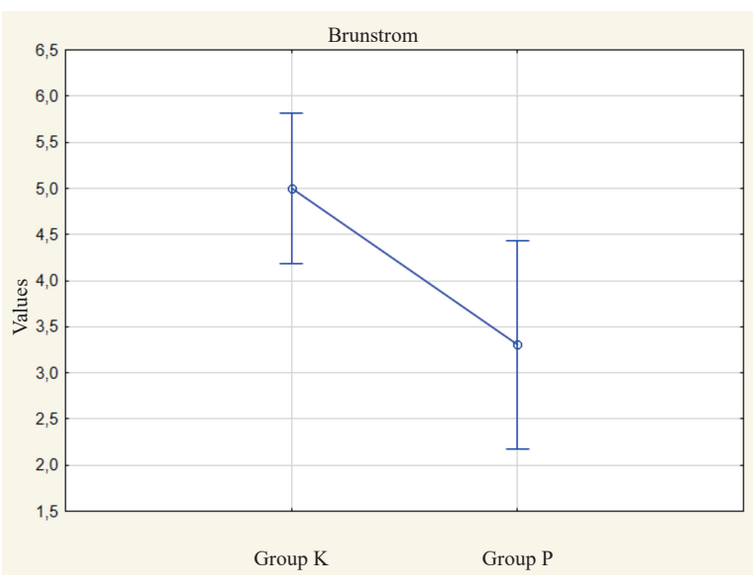

Fig. 8. Final Brunnstrom's hand recovery assessment in the TG and CG groups

The results indicate that, after the last test in the TG (P) group, the motor capacity of the palsied hand was lower than in the CG group. However, the analysis of results demonstrated that identical improvement was noted in comparison with the initial test (0.4 points at Brunnstrom's scale) in both groups.

Table 12. Anova: P1 and P2 (in the TG group before and after the test)

Variable	F	P
Score	6.10245	0.020673
Tasks Complete	7.62062	0.010649
Distance (m)	10.77050	0.003038
AverageSpeed (cm/s)	10.70560	0.003114
Proportion of Active Motion (%)	0.95456	0.337921
Energy (kCal)	6.47086	0.017526
Brunnstrom	0.25977	0.614746
Ashworth	1.26487	0.271414

Table 13. Post hoc test

Test RIR Tukeya; zmienna Score. Zaznaczone różnice są istotne z p < 0.05Tukey's HSD test; Score variable. The marked differences are significant at p < 0.05

Group	{1} M=847,71	{2} M=1247,5
P1 {1}		0,020811
P2 {2}	0,020811	

Results of the Anova test in the TG (P) and CG groups before and after therapy

ANOVA variance analysis for the Tape group demonstrated the variables that significantly differed between the period before and after the therapy: Score, Tasks Complete, Distance, AverageSpeed and Energy. The post hoc test determined the significance for the score variable at 0.02; differentiating values: before the therapy 847.71; after the therapy – 1247.5.

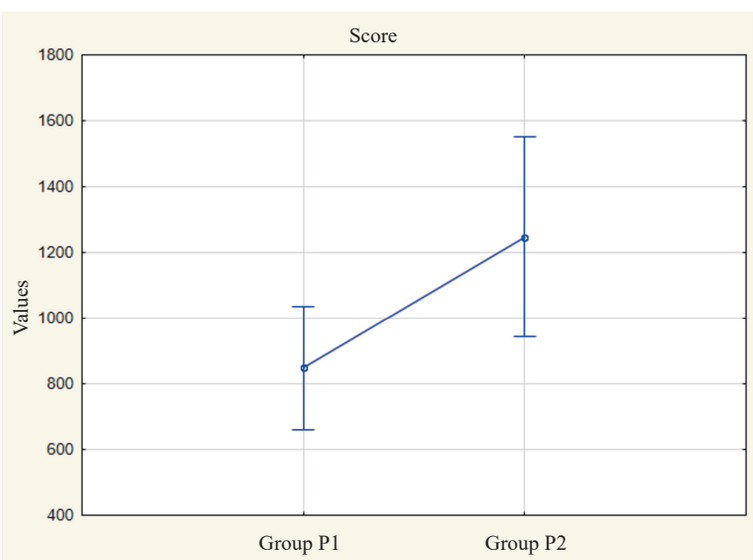

Fig.9. Assessment of the number of points in the TG group before and after the test

The results indicate a statistically significant increase in the number of points in the TG (P) group. The results were higher than the analogous results in the CG group.

Table 14. Post hoc test

Tukey's HSD test; Task Complete variable. The marked differences are significant at p < 0.05

Group	{1} M=211,79	{2} M=285,54
P1 {1}		0,010791
P2 {2}	0,010791	

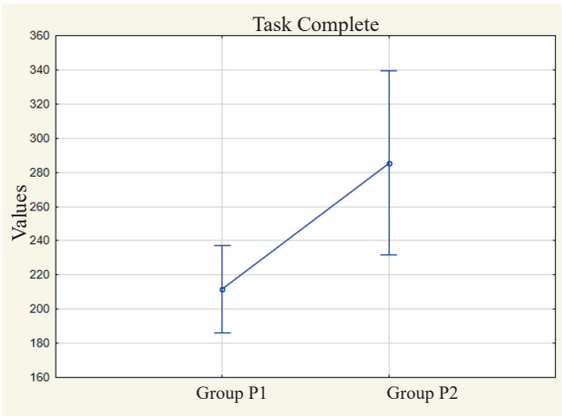

Fig. 10. Assessment of task performance (in points) in the TG group before and after the test

The post hoc test determined the significance for the task complete variable at 0.01; differentiating values: before the therapy 211.79; after the therapy – 285.5.
The results demonstrate a significant increase in the number of points in the TG (P) group.

Table 15. Post hoc test

Tukey's HSD test; Distance (m) variable. The marked differences are significant at p < 0.05

Grupa Group	{1} M=53,357	{2} M=79,077
P1 {1}		0,003181
P2 {2}	0,003181	

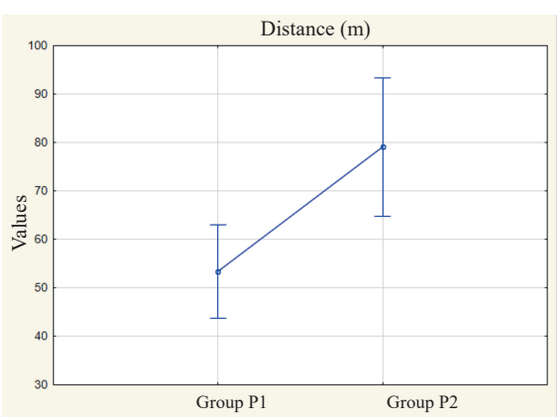

Fig.11. Assessment of the distance covered in the TG group before and after the test

The post hoc test determined the significance for the distance variable at 0.003; differentiating values: before the therapy 53.36; after the therapy – 79.07.
The results demonstrate a significant increase in the distance covered in group TG (P). The result was better than that of the CG group after the therapy.

Table 16. Post hoc test

Tukey's HSD test; Average Speed (cm/s) variable. The marked differences are significant at p < 0.05

Group	{1} M=9,6500	{2} M=13,631
P1 {1}		0,003256
P2 {2}	0,003256	

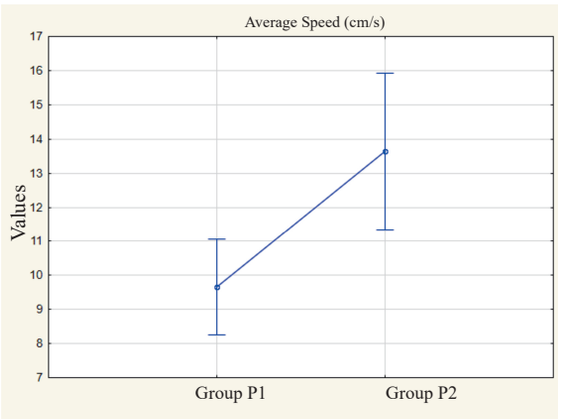

Fig.12. Assessment of movement speed in the TG group before and after the test

The post hoc test determined the significance for the average speed variable at 0.003; differentiating values: before the therapy 9.65; after the therapy – 13.63.
The assessment of results demonstrates an increase in the speed of movement in the TG (P) group.

Table 17. Post hoc test

Tukey's HSD test; Energy (kCal) variable. The marked differences are significant at p < 0.05

Group	{1} M=3,7929	{2} M=5,6000
P1 {1}		0,017664
P2 {2}	0,017664	

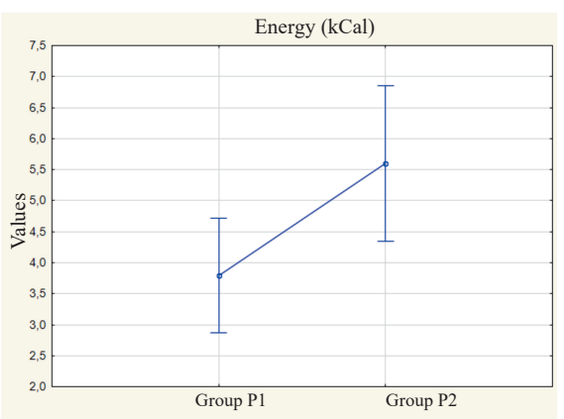

Fig.13. Assessment of the energy expenditure in the TG group before and after the test

The post hoc test determined the significance for the energy variable at 0.02; differentiating values: before the therapy 3.8; after the therapy – 5.6.
The results demonstrate an increase in the energy expenditure in the TG (P) group as a result of dynamic taping.

Results of the ANOVA test in the control group before and after the test

Table 18. Results of the ANOVA K1 and K2 test (in the CG group before and after the test)

Variable	F	P
Score	8.64304	0.006806
Tasks Complete	17.16174	0.000322
Distance (m)	5.17048	0.031467
AverageSpeed (cm/s)	4.45804	0.044505
Proportion of Active Motion (%)	5.45329	0.027521
Energy (kCal)	3.17056	0.086666
Brunnstrom	0.56644	0.458438
Ashworth	1.20818	0.281767

ANOVA variance analysis for the control group demonstrated the variables that significantly differed between the period before and after the therapy: Score, Tasks Complete, Distance, AverageSpeed and Proportion of Active Motion.

Table 19. Post hoc test

Tukey's HSD test; Score variable. The marked differences are significant at p < 0.05

Group	{1} M=828,57	{2} M=1223,4
K1 {1}		0,006958
K2 {2}	0,006958	

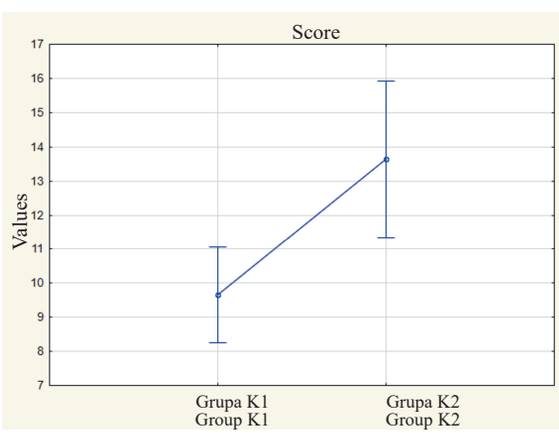

Fig.14. Assessment of the number of points in the CG group before and after the test

The post hoc test determined the significance for the score variable at 0.006; differentiating values: before the therapy – 828.6; after the therapy – 1223.4.
The results demonstrate a significant increase in the number of points in the CG group.

Table 20. Post hoc test

Tukey's HSD test; Tasks Complete variable. The marked differences are significant at p < 0.05

Group		{1} M=191,86	{2} M=285,43
K1	{1}		0,000452
K2	{2}	0,000452	

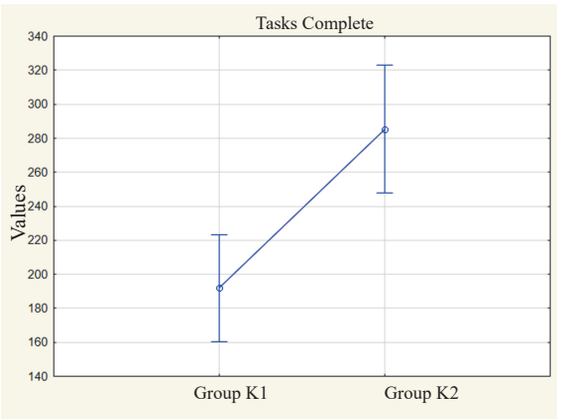

Fig. 15. Assessment of task performance (in points) in the CG group before and after the test

The post hoc test determined the significance for the task complete variable at 0.004; differentiating values: before the therapy – 191.86; after the therapy – 285.43.
The task result in the CG group improved significantly after the test.

Table 21. Post hoc test

Tukey's HSD test; Distance (m) variable. The marked differences are significant at p < 0.05

Group		{1} M=56,214	{2} M=72,500
K1	{1}		0,031589
K2	{2}	0,031589	

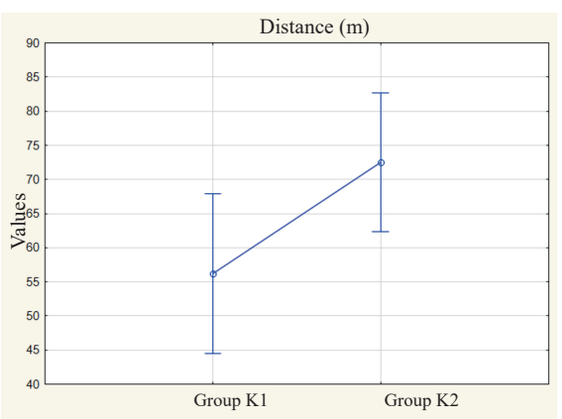

Fig.16. Assessment of the distance covered in the TG group before and after the test

The post hoc test determined the significance for the distance variable at 0.03; differentiating values: before the therapy – 56.21; after the therapy – 72.50.
On the last test day in the CG group, the distance covered result was significantly higher.

Table 22. Post hoc test

Group		Tukey's HSD test; Average Speed (cm/s) variable. The marked differences are significant at p < 0.05	
		{1} M=10,586	{2} M=12,843
K1	{1}		0,044622
K2	{2}	0,044622	

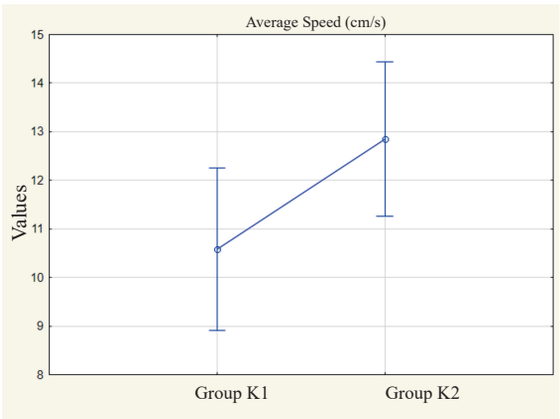

Fig.17. Assessment of task performance in the TG group before and after the test

The post hoc test determined the significance for the average speed variable at 0.04; differentiating values: before the therapy – 10.58; after the therapy – 12.84.
In the CG group, the final speed result was significantly higher than the initial result.

Table 23. Post hoc test

Group		Tukey's HSD test; Proportion of Active Motion (%) variable. The marked differences are significant at p < 0.05	
		{1} M=46,093	{2} M=55,679
K1	{1}		0,027648
K2	{2}	0,027648	

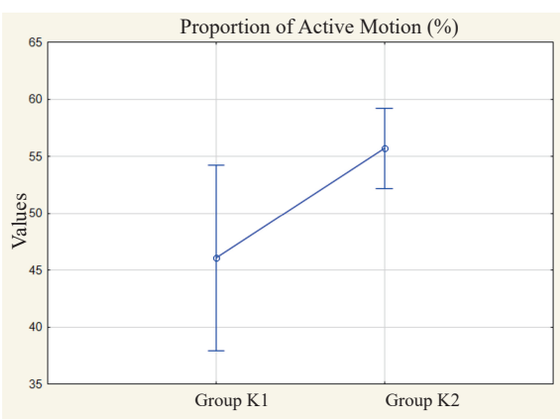

Fig. 18. Percentage assessment of active movement in the CG group before and after the test

The post hoc test determined the significance for the Proportion of Active Motion at 0.03; differentiating values: before the therapy – 46.09; after the therapy – 55.68.
The results of the CG group indicate a significant percentage improvement in active movement between the final and initial tests.

Discussion

Neurophysiological methods of physical therapy are used for treating patients after cerebral stroke (PNF, Bobath). Dynamic taping and neuro physical therapy using a smart robot are innovative methods of treatment. The positive effects of DT and robots in neuro physical therapy were proven in numerous studies.

Caimmi M. et al. examined the results of physical therapy with a rehabilitation robot (RCH) in improving the mobility of upper limbs in patients at the chronic stage after cerebral stroke. The test assessed the performance of the functional test of hand to mouth (HTM) coordination. The test included 10 patients with hemiparesis of the upper limbs, with mild to moderate intensity. The patients were subjected to 12 therapeutic sessions (3 per week) with a robot. Each session took 20 minutes o RCH and HtM; the movements were fully supported, but the patients were asked to attempt to actively participate. The basic result measure was the Fugl-Meyer Assessment (FMA); The muscle tone assessment based on modified Ashworth Scale was of secondary significance. All the patients, except for one, demonstrated a functional improvement (section FMA A-D, average increase 7.2 +/- 3.9 points, $P < 0.008$).With the analysis of results, the authors demonstrated that physical therapy with a neurological robot is an effective rehabilitation intervention in patients in the chronic phase of the stroke. It was emphasized that the results were very promising taking into account the short period of therapeutic intervention (1 month) and the long period since the stroke (27 +/- 20 months) [2].

In a similar study, Rosati G. et al. demonstrated the beneficial effects of using a robot in complementary neurorehabilitation of the upper limb in patients after cerebral stroke. The study covered 24 patients, divided into two equal groups – treatment group (TG) and control group (KO). Both groups underwent conventional physical therapy, and a neurological robot was additionally used in the TG group. The effects of the therapy were assessed using standard functional tests, such as, among others, the Medical Research Council and Fugl-Meyer assessments. The study results demonstrated better motor effects in the group where a robot was used in the process of neurorehabilitation. The authors emphasized the positive attitude of patients to the robot, and lack of adverse effects of the therapy [3].

Masier S. et al. assessed the effects of sensorimotor training using a robot in patients after cerebral stroke. The randomized study included 20 patients with hemiparesis after ischemic stroke, who were subject to standard physical therapy. The studied group was additionally subjected to sensorimotor training using a neurorobot (4 hours/week/4 weeks). The test result analysis demonstrated an improvement in both groups, but the group training with a robot demonstrated a greater motor improvement and a greater improvement of upper limb dexterity. It should be emphasized that the effects of rehabilitation were stable over the period of a three-month observation. No adverse reactions were noted during the therapy with a robot. The study results allowed the authors to demonstrate that the use of a robot may effectively supplement the standard rehabilitation after cerebral stroke, providing new therapeutic strategies for neurological rehabilitation [4].

The available literature lacks information on assessment of the effects of dynamic taping using an intelligent neurological robot in patients after cerebral stroke with hemiparesis. However, the authors see the possibility of assessing the effects of dynamic taping in patients after Colles' fracture [5] or after complex physical therapy after a hand surgery using a Hand-Tutor device [6].

The purpose of own study was to assess the effects of dynamic taping in the physical therapy of upper limbs in the patients after cerebral stroke with paresis. The Fourier M2 neurological robot was used to provide an objective assessment of the upper limb. The Brunnstrom's hand recovery assessment and Ashworth scale of spasticity were applied additionally [1]. The study covered 28 patients after ischemic cerebral stroke with hemiparesis who consented to participate in the study and met the inclusion criteria. The patients were randomly divided into 2 groups and then subjected to the same physical therapy using a multi-sensory stimulation program using a robot, while dynamic taping was additionally applied in the TG group. The tape applications were supposed to normalize the muscle tone of the myofascial system of the forearm, hand and arm of the paretic upper limb. The study assessed quantifiable indices calculated by a robot, such as the distance a hand has to cover to perform the test, the number of calories burned or the task duration, patient's own activity in percentage terms, the points achieved after the task. The assessment also covered hand dexterity based on Brunnstrom's functional scale and muscle tone based on the Ashworth scale. The assessment before the test of the group with dynamic taping, it was demonstrated that the motor capacity of the paretic hand was significantly lower in comparison with the patients from the CG group.

The study demonstrated statistically relevant effects on the 1st, 3rd and 4th day of the study in the form of a percentage improvement in active movement in the TG group as a result of application of dynamic taping.

The assessment of the remaining study results demonstrated both the effects of dynamic taping and the effects of the therapy with the use of a neurological robot in patients after cerebral stroke with hemiparesis. The assessment of those effects showed the therapy effects were comparable in both groups. As the initial hand dexterity in the TG group was significantly smaller, this additionally emphasises the assessment of dynamic taping in the process of neurological physical therapy. The study demonstrate the significant usefulness of the smart robot for the diagnostic process, therapy and assessment of the effects of treatment of upper limbs in patients with hemiparesis resulting from ischemic cerebral stroke.

Conclusions

1. The study demonstrated statistically relevant effects on the 1st, 3rd and 4th day of the study in the form of a percentage improvement in active movement in the TG group as a result of application of dynamic taping.
2. The assessment of the remaining study results demonstrated both the effects of dynamic taping and the effects of the therapy with the use of a neurological robot in patients after cerebral stroke with hemiparesis. The

assessment of those effects showed the therapy effects were comparable in both groups. As the initial hand dexterity in the TG group was significantly smaller, this additionally emphasises the assessment of dynamic taping in the process of neurological physical therapy.
3. The Fourier M2 smart robot is s useful and objective tool for diagnostics, therapy and assessment of the effects of physical therapy in patients after cerebral stroke with upper limb dysfunction.
4. The test results have to be interpreted carefully due to the small number of tests, but they may be conducive for further tests.

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