fizjoterapia polska

POLISH JOURNAL OF PHYSIOTHERAPY

OFICJALNE PISMO POLSKIEGO TOWARZYSTWA FIZJOTERAPII

THE OFFICIAL JOURNAL OF THE POLISH SOCIETY OF PHYSIOTHERAPY

NR 2/2017 (17) KWARTALNIK ISSN 1642-0136

Wpływ terapii z wykorzystaniem nowoczesnych technologii na aktywność i wytrzymałość dzieci z mózgowym porażeniem dziecięcym

The impact of technology-based therapy on activity level and endurance of children with cerebral palsy

Wpływ przebytego udaru mózgu na moc i prędkość skracania się mięśni

The impact of stroke on the power and shortening velocity of the muscles

TROMED TRAINING
program szkoleniowy

REHABILITACJA KARDIOLOGICZNA W PRAKTYCE

Szkolenie skierowane do osób zajmujących się problematyką rehabilitacji kardiologicznej, podzielone na dwa moduły.

Moduł I obejmuje zasady rehabilitacji kardiologicznej, metody diagnostyczne i terapeutyczne oraz rolę fizjoterapeuty w procesie rehabilitacji.

Moduł II omawia zagadnienia Kompleksowej Rehabilitacji Kardiologicznej u chorych po ostrym zespole wieńcowym, po zabiegach kardiochirurgicznych, po wszczepieniach kardiostymulatora oraz u chorych z chorobami współistniejącymi.

SCHORZENIA STAWU BARKOWEGO - REHABILITACJA Z WYKORZYSTANIEM ELEMENTÓW TERAPII MANUALNEJ

Szkolenie skierowane do fizjoterapeutów oraz studentów fizjoterapii, obejmujące zagadnienia z anatomii i fizjologii obręczy barkowej, podstaw artro i osteokinematyki, charakterystyki wybranych urazów i uszkodzeń w obrębie obręczy barkowej, profilaktyki schorzeń barku, diagnostyki pourazowej barku oraz praktycznego zastosowania technik manualnych w rehabilitacji

DIAGNOSTYKA I LECZENIE MANUALNE W DYSFUNKCJACH STAWU KOLANOWEGO

Szkolenie skierowane do fizjoterapeutów oraz studentów fizjoterapii, obejmujące zagadnienia z anatomii stawu kolanowego, biomechaniki struktur wewnątrzstawowych, charakterystyki wybranych uszkodzeń w stawie kolanowym, diagnostyki pourazowej stawu kolanowegooraz praktycznego zastosowania technik manualnych w rehabilitacji.

PODSTAWY NEUROMOBILIZACJI NERWÓW OBWODOWYCH - DIAGNOSTYKA I PRAKTYCZNE ZASTOSOWANIE W FIZJOTERAPII

Szkolenie podzielone na dwie części. Zajęcia teoretyczne obejmują zagadnienia dotyczące budowy komórek nerwowych, anatomii i fizjologii obwodowego układu nerwowego i rdzenia kręgowego, pozycji napięciowych i pozycji początkowych testów napięciowych w kończynach oraz kręgosłupie. Zajęcia praktyczne obejmują wykonanie neuromobilizacji dla nerwów obwodowych i opony twardej oraz przykładowe wykorzystania neuromobilizacji w jednostkach chorobowych.

TERAPIA PACJENTÓW Z OBRZĘKIEM LIMFATYCZNYM

Szkolenie podzielone na zajęcia teoretyczne z zakresu anatomii i fizjologii gruczołu piersiowego oraz układu chłonnego, objawów raka piersi, leczenia chirurgicznego, rehabilitacji przed i pooperacyjnej oraz profilaktyki przeciwobrzękowej. Zajęcia praktyczne mają na celu zapoznanie z metodami stosowanymi w terapii przeciwobrzękowej, praktycznym wykorzystaniem materiałów do kompresjoterapii oraz omówieniem zaopatrzenia ortopedycznego stosowanego u pacjentek po mastektomii.

FIZJOTERAPIA W ONKOLOGII - ZASADY POSTĘPOWANIA W WYBRANYCH PRZYPADKACH KLINICZNYCH

Szkolenie obejmuje zagadnienia dotyczące epidemiologii nowotworów i czynników ryzyka, diagnostyki, leczenia oraz następstw leczenia nowotworów (leczenie układowe, chirurgiczne, chemioterapia, radioterapia), podstaw terapii pacjentów leczonych w chorobach nowotworowych piersi, płuc, przewodu pokarmowego, okolicy głowy i szyi, układu moczowo-płciowego, układu nerwowego. Część praktyczna to ćwiczenia oraz metody fizjoterapeutyczne w jednostkach chorobowych.

LOGOPEDIA W FIZJOTERAPII

Szkolenie obejmuje następujące zagadnienia teoretyczne: założenia, zakres działań i uprawnienia terapii logopedycznej, narzędzia diagnozy logopedycznej, grupy pacjentów objętych terapią logopedyczną (dzieci z opóźnionym rozwojem mowy i dorośli, m.in. pacjenci z afazją, SM, chorobą Parkinsona), zaburzenia mowy a globalne zaburzenia rozwoju psychoruchowego, dysfunkcje układu ruchowego narządu żucia, wspólne obszary działania fizjoterapeuty i logopedy.

Część praktyczna obejmuje studium przypadku: ćwiczenia - kształtowanie umiejętności świadomego i prawidłowego operowania oddechem.

INFORMACJE I ZAPISY

TROMED Zaopatrzenie Medyczne
93-309 Łódź, ul. Grażyny 2/4 (wejście Rzgowska 169/171)
tel. 42 684 32 02, 501 893 590
e-mail: szkolenia@tromed.pl

TROMED TRAINING
program szkoleniowy

PODSTAWY NEUROREHABILITACJI - UDAR MÓZGU - MODUŁ 1

Szkolenie obejmuje zajęcia teoretyczne omawiające mechanizm udaru mózgu i jego następstwa kliniczne, diagnostyki dla potrzeb fizjoterapii, rokowań, mechanizmów zdrowienia, plastyczności układu nerwowego oraz aktualne zaleceniach dotyczące fizjoterapii pacjentów po udarze mózgu. Zajęcia praktyczne to przykłady terapii pacjentów w okresie wczesnej i wtórnej rehabilitacji, propozycje rozwiązywania problemów strukturalnych i funkcjonalnych oraz wykorzystanie metody Bobathów w rehabilitacji pacjentów po udarze mózgu.

PODSTAWY NEUROREHABILITACJI - UDAR MÓZGU - MODUŁ 2

Szkolenie obejmuje warsztaty praktyczne z zakresu diagnostyki funkcjonalnej pacjentów, podstawowych problemów strukturalnych i funkcjonalnych oraz propozycje terapii: reedukacji funkcji kończyny górnej i dolnej oraz wybranych strategii rehabilitacji. Omawiane jest również zagadnienie dysfagii, w tym objawy zaburzeń połykania, testy i ocena zaburzeń, zasady bezpiecznego karmienia, strategie terapeutyczne, ćwiczenia miofunkcyjne oraz specjalne techniki ułatwiające połykanie.

SCHORZENIA NARZĄDÓW RUCHU U DZIECI I MŁODZIEŻY - ZASADY I KRYTERIA LECZENIA ORTOPEDYCZNEGO

Szkolenie obejmuje zagadnienia wad postawy u dzieci i młodzieży, wad wrodzonych narządów ruchu, wczesnego wykrywania nabytych schorzeń narządów ruchu, naukę badania ortopedycznego oraz zbierania wywiadu oraz praktyczne wskazówki oraz koncepcje w stosowaniu ortez i aparatów ortopedycznych.

Szkolenie skierowane do lekarzy ortopedów, pediatrów, lekarzy rodzinnych, lekarzy rehabilitacji medycznej, fizjoterapeutów oraz średniego personelu medycznego.

WSPÓŁCZESNE METODY LECZENIA WYBRANYCH DYSFUNKCJI STAWU SKOKOWEGO I STOPY

Szkolenie obejmuje zagadnienia z anatomii, biomechaniki stawu skokowego i stopy, metodyki badania stopy, postępowania w leczeniu urazów stawu skokowego i stopy, nabytych zniekształceniach stopy (przyczyny, objawy, sposoby postępowania) oraz pozostałych dysfunkcjach w obrębie stawu skokowego i stopy (entezopatie, przeciążenia, zapalenia, zespoły uciskowe nerwów, gangliony, zmiany zwyrodnieniowe, stopa cukrzycowa, stopa reumatoidalna).

CHOROBA ZWYRODNIENIOWA STAWÓW - ALGORYTM POSTĘPOWANIA DIAGNOSTYCZNO-TERAPEUTYCZNEGO

Szkolenie obejmuje następujące zagadnienia: choroba zwyrodnieniowa stawów - podstawowe pojęcia, algorytm postępowania diagnostyczno-terapeutycznego , nowoczesne metody leczenia w chorobie zwyrodnieniowej stawów, nauka prawidłowej oceny zaawansowania choroby zwyrodnieniowej w oparciu o wywiad, badania ortopedyczne i badania dodatkowe, zastosowanie ortez i aparatów ortopedycznych w chorobach zwyrodnieniowych.

Szkolenie skierowane do lekarzy ortopedów, pediatrów, lekarzy rodzinnych, lekarzy rehabilitacji medycznej, fizjoterapeutów oraz średniego personelu medycznego.

MOBILNOŚĆ I STABILNOŚĆ W SPORCIE I FIZJOTERAPII

Szkolenie obejmuje następujące zagadnienia: znaczenie treningu mobilności i stabilności w sporcie i fizjoterapii, definicja mobilności, przyczyny ograniczeń, strategie postępowania oraz techniki pracy nad zwiększeniem mobilności z użyciem przyborów, definicja stabilności, przyczyny zaburzeń, strategie postępowania oraz trening stabilności w sporcie i fizjoterapii - zajęcia praktyczne.

MÓZGOWE PORAŻENIE DZIECIĘCE - ALGORYTM POSTĘPOWANIA DIAGNOSTYCZNO-TERAPEUTYCZNEGO

Szkolenie obejmuje następujące zagadnienia: MPD - zespół symptomów, etapy leczenia, cele i wskazówki terapeutyczne, kwalifikacje pacjenta do danego etapu leczenia, nauka badania ortopedycznego w Mózgowym Porażeniu Dziecięcym, zastosowanie ortez i aparatów ortopedycznych w MPD.

Szkolenie skierowane do lekarzy ortopedów, pediatrów, lekarzy rodzinnych, lekarzy rehabilitacji medycznej, fizjoterapeutów oraz średniego personelu medycznego.

INFORMACJE I ZAPISY

TROMED Zaopatrzenie Medyczne
93-309 Łódź, ul. Grażyny 2/4 (wejście Rzgowska 169/171)
tel. 42 684 32 02, 501 893 590
e-mail: szkolenia@tromed.pl

Wpływu stymulacji sensomotorycznej stopy na stabilność posturalną, sprawność funkcjonalna i obciążenia kończyn dolnych u pacjenta w późnej fazie po udarze niedokrwiennym

Effect of sensorimotor foot stimulation on the body postural, function and load of the lower limb in patients in the late phase after stroke

Magdalena Goliwąs(A,B,C), Piotr Kocur(D,E), Marzena Wiernicka(D,E), Ewa Kamińska(D,E), Jacek Lewandowski(D,E,F)

Katedra Rehabilitacji Narządu Ruchu, AWF im. E. Piaseckiego w Poznaniu, Polska/
Depattment of Musculoskeletal System Rehabilitation, Eugeniusz Piasecki University School of Physical Education in Poznan, Poland

Streszczenie

Istnieje kilka badań, które oceniają wpływ stymulacji stóp w po udarze mózgu. Badanie obejmowało ocenę skutków stymulacji sensomotorycznej stópy u chorych po udarze niedokrwiennym mózgu. Pacjenci zostali (> 1 rok po udarze) losowo przydzielono do grupy badanej (n = 20), i grupy kontrolnej (n = 17). W obu grupach przeprowadzono standardowy sześciotygodniowy program rehabilitacji. W grupie badanej, standardowy program rehabilitacji został uzupełniony treningiem stymulacji sensomotorycznej stopy. Analizą objęto: stabilność postawy, równowagę, funkcje motoryczne, napięcie mięśniowe, uczucie w kończynie dolnej. W obu grupach nie zaobserwowano zmian istotnych statystycznie w następujące parametry: obszaru COP i długość COP. Znaczące zmiany odnotowano w grupie badanej w próbie z i bez kontroli wzroku w parametrach oceniających obciążenie całkowite kończyny bezpośrednio i pośrednio objętych niedowładem. Index Symetrii w grupie badanej uległ obniżeniu o 13,2% w teście z kontrolą i o 15,1% bez kontroli wzroku. W grupie badanej zaobserwowano istotne zmiany w parametrach opisujących sprawność motoryczną i równowagę, a także w ocenie napięcia mięśniowego w obrębie stawu skokowego.

Słowa kluczowe:

stymulacja sensomotoryczna stopy, Fugl-Meyer Assessment Scale, Index Symetrii

Abstract

There are few studies which assess the impact of stimulation of the foot in after-stroke patients. The study involved an assessment of the effects of sensorimotor foot stimulation in patients after ischemic stroke. Patients (post-stroke duration > 1 year) were randomized to the experimental group (n = 20) and control group (n = 17). Both groups completed a standard six-week rehabilitation programme. In the experimental group, the standard rehabilitation programme was supplemented by sensorimotor foot stimulation training. The analysis included: postural stability, balance, motor function, muscle tone, sensation. In both groups have not significantly changed the following parameters: center of foot pressure (COP) area and COP length. Significant changes have been observed in the experimental group with and without visual control for the following parameters: total load of lower limb directly and indirectly covered by a stroke. Symmetry Index has shown a reduction ratio in the experimental group by 13.2% in the test with and by 15.1% without visual control. In the experimental group significant functional changes have been demonstrated in motor function and balance as well as in the assessment of muscle tone within the ankle. Sensorimotor foot stimulation with standard rehabilitation procedure is a better form of physiotherapy than use standard rehabilitation only.

Key words:

Sensorimotor foot stimulation, Fugl-Meyer Assessment Scale, Symmetry Index

Introduction

Stroke is one of the most common causes of early disability and it decreases the quality of life. In the first week after a stroke [1, 2] only about 12% of patients are independent in performing basic activities of daily living (ADL), such as: eating, bathing, grooming, and moving. As many as 25% up to 74% of patients have problems with those activities [3,4].

Hemiplegia, which is characterized by: muscle weakness and loss of motor skills in one half of the body, changes in sensory and cognitive functions, deterioration in motor coordination, may reduce the limit of patient's postural stability [5] and, consequently, increase the risk of falls by 23-50% in chronic phase patients [6]. As the patient’s functions deteriorate the costs of energy expenditure on daily activities ADL and the risk of social problems increase [5]. The majority of patients are not able to stand, to make small movements necessary to keep the balance and the load distribution between right and left foot is asymmetrical.

The insole plantar pressure distribution changes. There is a disproportion of pressure distribution between the limb directly affected by the paresis and the one indirectly affected. When a person is standing, their feet are, in most part, the only direct contact with the external environment and they are responsible for maintaining the balance. Sensory receptors, which in large numbers are located on the foot, through feedback transmit the information to the higher cognitive centers and thus affect the process of planning subsequent motor functions [7-10].

The basis for the after-stroke care is an interdisciplinary, comprehensive rehabilitation, the implementation of which is already significant in the first days after the stroke and continued very often in the chronic phase [11-14].

There are few studies which assess the impact of an active or passive stimulation of the foot in after-stroke patients [15].

Therefore, it is important to look for new methods of rehabilitation of such patients and assess their effects. Sensorimotor stimulation of the paretic foot is a proposal which develops physiotherapist’s techniques. The aim of the study was to assess the impact of sensorimotor foot stimulation on postural stability, functional efficiency and load distribution of the lower limbs in patients in a late phase after an ischemic stroke.

Subjects and methods

The study was carried out on a rehabilitation ward in Poznan, with the approval of the Bioethics Committee at the Poznań University of Medical Sciences. At the time of the study, between 2013-2015, there were 80 after-stroke patients in the facility. 38 patients who did not meet inclusion criteria for the study were rejected.

There were the following inclusion criteria: an ischemic stroke, which took place more 12 months ago; patients who can achieve and maintain an upright position for at least 30 seconds; agreement to participate in the study. There were the following exclusion criteria: a hemorrhagic stroke; an ischemic stroke with fewer than 12 months after the stroke; coexistence of other central nervous system disorders such: Parkinson's disease, Alzheimer's disease, multiple sclerosis; diabetes; disabling injuries associated with musculoskeletal system (fractures, sprains); wounds of soft tissue in the foot; inability to keep an upright position for at least 30 seconds; visible imbalances; in the past: falls; headaches and dizziness; patients reluctant to participate in the study.

Patients for the treatment group and the control group were selected randomly from the patients who met the inclusion criteria. The treatment group consisted of 23 patients and a control group of 19.

Functional assessment of every patient took place twice, in the first and last day of the stay at the rehabilitation ward. The assessment was done by one person (a physiotherapist). Assessment included: postural stability, balance, agility, tension and feeling in the lower limb directly affected by the stroke.

The assessment of the postural stability and load distribution on plantar surface of the foot was performed with the use of a treadmill FDM-TDL produced by Zebris with Win FDM-T software with Stance module. The pressure-measurement range is 1-100 N/cm^2 with a sampling of 100 Hz. The device saved such parameters as: the length of the center of foot pressure (COP), COP area, and load of the forefoot and hindfoot of the left and right lower limb, as well as the total load of the right and left foot. Each measurement was preceded by a calibration of the device. During the tests the patient was standing barefoot on the platform, the feet were rotated out at an angle of 14°, with heels 4 cm from each other parallel to the X axis. The patient achieved and maintained a standing position with arms lowered along the torso and head set in Frankfurt plane for 30 seconds [16-18].

There were 10 measurements made successively, the first 5 with eyes open, another 5 in the same position with eyes closed.

The balance was assessed by a Berg Balance Scale (BBS) test. The test assesses the ability to maintain a static and dynamic balance when performing 14 tasks such as: sitting, getting up, standing up, standing with eyes closed, standing on one leg, standing on a narrow basis, reaching forward, reaching for objects, twisting the torso, rotating the body. The patient can get 56 points, which proves a correct posture [19-23].

The efficiency of the lower limb was tested with Fugl-Meyer Assessment Scale (FMA), and more specifically its subscales testing lower limbs: Motor Function-Lower

Extremity. The neuromotor efficiency of the paretic limb was tested in a lying, sitting, and standing position. The patient's task was to make specific movements three times with a lower limb indirectly affected by the paresis and then the movement was repeated three times with the limb directly affected by the paresis. Only the movement of the directly affected limb was assessed. The best performance was rated on a scale of 0 to 2, where 0 represents no valid movement, 1 means the movement partially made correctly, 2 is full correct move. The test assessed their own muscle reflexes: a knee-jerk reflex and an ankle-jerk reflex. The study also assessed dysmetria, tremor and the speed with which a specific sequence of movements was made. The total of 34 points that can be achieved proves correct motor skills of the paretic limb [20, 24, 25].

A modified Ashworth scale was used to assess the state of muscle tone in the paretic limb. The 6-stage scale (0, 1, 1+, 2, 3, 4), where 0 is no increase in muscle tone and 4 the inability of making a move in the joint. The assessment of muscle tone is done by conducting passive motion in the joint, subjectively determining the resistance of the tested muscle at the time when its origin and insertion move away. In the present study the increased muscle tone was assessed in a position of lying down at the back, with all movements taking place in the hip and knee joints. In the ankle joint we tested dorsiflexion, plantar flexion, inversion and eversion. Then all the obtained assessment values of increased muscle tone for the entire limb were added for easier presentation on charts. The higher the point value, the greater the increased muscle tone in the lower limb [26].

Exteroceptive sensation was tested with a light touch using a swab in 7 points located on the foot (big toe, little toe, metatarsal bones (I and V), heel bone, medial and lateral margin of the foot). The patient was in a sitting position; feet were based on the ground. Each area on foot was scored on a scale of 0.1 (0-numbness, 1-normal sensation) [27].

A complete load of the lower limb indirectly and directly affected by paresis was used to analyze the Symmetry Index (SI). The average value of the five consecutive tests for the above parameters was calculated and then substituted into the above formula. The SI was assessed for the tests performed while standing on both feet with eyes open and closed. The SI) of the lower limbs was calculated; it is one of the most popular methods for assessing the percentage difference between the kinematic and kinetic parameters of both limbs. The most common formula used to study the symmetry is the one developed by Robinson (1987) [28]:

$$SI = 2\,\frac{X_R - X_L}{X_R + X_L} \times 100\%,$$

where:

X_R is the value of the specified parameter for the right limb,
X_L is the value of the specified parameter for the left limb.

For the purpose of this study the formula was modified in order to be used for after-stroke patients,

$$SI = 2 \frac{X_{P0} - X_{B0}}{X_{P0} + X_{B0}} \times 100\%,$$

where:

X_{PO} is the value of the specified parameter for the limb indirectly affected by paresis,

X_{BO} is the value of the specified parameter for the limb directly affected by paresis.

The positive values indicate a greater load on the side indirectly affected by paresis, and negative values indicate a greater load on the side directly affected by paresis.
All patients from the treatment and the control group underwent the process of rehabilitation which lasted six weeks. Rehabilitation began the second day of the stay on the ward and ended the day before the patient left for home. The rehabilitation program consisted of an individual therapy with a physiotherapist, kinesitherapy and physiotherapy treatments.

Individual therapy with a physiotherapist included therapy based on the NDT Bobath concept, PNF and other physiotherapy techniques. It lasted 30 minutes, five days a week.

Kinesitherapy took place 2 times a day and lasted 45 minutes, 6 days a week. Kinesitherapeutic methods included: non-weight bearing exercises, active exercises with resistance, the treadmill, the rotor for lower and upper limbs, cycloergometer, learning to walk and others.
Physiotherapy treatment ordered by a medical specialist were selected from the whole range of treatments: electrical treatments, hydrotherapy, phototherapy (number of treatments: 2).

Sensorimotor foot stimulation

The tested factor which differs the treatment group form the control group is the sensorimotor foot stimulation. Sensorimotor foot stimulation program consisted of 25 sessions, each lasting 20 minutes. Sensorimotor foot stimulation was performed during individual therapy sessions with the therapist in the treatment group. The remaining 10 minutes was devoted to typical individual work with a therapist like in the control group.

The main assumptions of the sensorimotor stimulation included:

● improving flexibility of the soft tissue around the ankle and foot by using techniques of slow long-term NDT Bobath elongation, restoring mobility in the ankle, in the metatarsal joints and interphalangeal joints using various types of manual techniques, among others: traction.

● facilitating and improving the sensation in the foot by stroking, kneading and irritating the surface of the entire foot with objects of different textures;

● learning and improving selective movements within the ankle joint through the use of stimuli: visual, auditory and sensory so that the patient makes an independent movement in the joint
● learning and improving symmetrical loading of the feet while standing up and standing with eyes open and closed.
● learning and improving symmetrical load of the feet while standing up and standing on the ground of different textures.

Daily therapeutic intervention plan included:
Day 1-3: improving the flexibility of the soft tissue around the ankle and foot, 4-9 day: facilitating and improving the sensation in the foot, 10-13 day: learning and improving selective movements within the ankle joint, 14-18 day: learning and improving symmetrical load of the feet while standing up and standing with eyes open and closed, 19-25 day: learning and improving the symmetrical load of the feet while standing up and standing on the ground of different textures.

Statistical methods
The results were verified statistically using traditional measures of statistical dispersion. All tested features were quantitative variables. Most of the analyzed variables had normal distributions. U Mann-Whitney test was used when comparing the treatment group with the control group, which checked whether the values of samples collected from two different groups are equally large. Wilcoxon test was used to compare the data within one group before and after the test, to investigate whether there was a statistically significant change. The results of the analyzed scales depending on the sample eyes open/eyes closed were also analyzed with the use of Wilcoxon's test.
The statistical analysis was performed using STATISTICA and PQStat ver. 1.6. The level of significance was set at $p < 0.05$, and the level of high significance at $p < 0.0001$.

Results
All patients enrolled in the study (n = 42) underwent the process of rehabilitation. 3 patients from the treatment group and 2 patients from the control group were excluded from the final analysis of the results as their stays were shortened to 3 weeks. The treatment group included 20 and the control group 17 patients after an ischemic stroke. Table 1 shows characteristics of the patients.
Patients in both groups before the rehabilitation process did not differ among themselves in terms of the number of years that passed after the stroke, their age, weight, height and BMI. The groups did not differ in terms of the parameters describing the patient, i.e.: the length of the COP, COP area, the proportion of the load of the lower limbs, the SI index, BBS test, tension in the lower limb, and sensing capability.
There were no differences between groups in the number of completed medical procedures. The number of procedures performed during individual therapies did not differ between the groups. General rehabilitation and physiotherapy exercises differed significantly in terms of the number of

Table 1.The general characteristics of subjects

Variable	Experimental group n = 20	Control group n = 17
Gender (W/M)	8/12	
Age (years)	61.4 ±8.0	65.8 ±9.2
Height (m)	1.7 ±0.1	1.7 ±0.1
Weight (kg)	76.4 ±11.3	76.2 ±9.2
BMI (kg/m^2)	26.3 ±2.4	26.9 ±2.6
Stroke sites (right/left)	10/10	9/8
Duration (year)	3.5 ±2.3	3.9 ±2.5
Total number of treatments for n=1	234/11.7	188/11.1
Individual exercises for n=1	2.7	2.2
General physiotherapy for n=1	5.2	5.1*
Physical therapy treatments for n=1	3.9	2.2*
	8/9	

*- statistical difference between the groups

performed procedures. While in the control group general rehabilitation exercises were more often used, in the treatment group physiotherapy exercises were more frequent.

Table 2 shows all reported values of the measured parameters describing the balance and efficiency of the lower limbs in the first and second period of the study. Examined the importance of differences that emerged between the periods of the tests in the treatment group and the control group. Functional assessment conducted on the basis of BBS ($p = 0.0358$), FMA ($p < 0.0001$), Ashworth rating scale assessing increased muscle tension showed that patients in the treatment group and the control group improved significantly ($p=0.0068$). However, the change in results between the first and second period of the test was more important for the treatment group which used sensorimotor foot stimulation. Only the results of the test assessing sensing capabilities did not change. There were no changes observed in both groups after the rehabilitation process.

Table 2. Parameters measured before and after 6 weeks of rehabilitation

Zmienna Variable		Grupa badana/Experimental group			n = 20		
		przed before	po after	zmiana change	przed before	po after	zmiana change
BBS		40.7 ±12.9	46.5 ±10.3	*	40.3 ±13.2	43.4 ±12.1	*
FMA		17.7 ±6.8	23.4 ±6.1	*	22.1 ±6.2	24.4 ±6.4	*
Ashworth Scale		12.4 ±8.1	7.7 ±6.7	ns	12.5 ±8.4	10.4 ±6.9	*
COP area (mm^2)	AO	177.1 ±122.6	166.3 ±111.5	ns	128.1 ±75.2	126.9 ±78.1	ns
	AC	306.2 ±363.6	273.1 ±284.8	ns	228.8 ±140.8	209.0 ±118.7	ns
COP lenght (mm)	AO	755.7 ±164.2	780.6 ±193.1	ns	636.9 ±130.7	683.9 ±78.1	ns
	AC	998.0 ±362.2	989.0 ±344.1	*	827.0 ±215.4	824.8 ±210.4	ns
Load on the directly affected extremity stroke (% - N/cm^2)	AO	39.3 ±11.7	42.8 ±10.1	*	38.6 ±8.3	38.8 ±8.7	ns
	AC	39.6 ±12.0	42.6 ±10.7	*	38.6 ±9.3	39.6 ±9.4	ns
Load on the indirectly affected lower extremity stroke (% - N/cm^2)	AO	60.8 ±11.7	57.3 ±10.2	*	1.4 ±8.3	60.9 ±6.3	ns
	AC	60.4 ±12.0	57.4 ±10.7	*	61.4 ±9.4	60.4 ±9.4	ns
Difference between load on the directly and indirectly affected lower extremity stroke (% - N/cm^2)	AO	21.5 ±23.5	14.6 ±20.3	*	22.1 ±16.5	22.1 ±17.4	ns
	AC	20.8 ±24.0	14.8 ±21.5	*	18.2 ±23.5	15.6 ±23.6	ns
SI	AO	48.5 ±40.9	35.4 ±34.9	*	41.4 ±34.0	39.3 ±33.6	ns
	AC	51.8 ±36.2	36.7 ±36.5	*	41.1 ±36.3	34.4 ±37.0	*

FMA – test Fugle-Meyer Assessment Scale
BBS – test Berg Balance Scale
COP – center of foot pressure
AO – test with eyes opened
AC – test wykonany z oczami zamkniętymi;
ns – /changes are not statistically significant
*Statistically significant differences for $p \leq 0.05$

In tests with both eyes open and closed, in terms of the COP length and COP area describing postural stability, there were no significant differences between the groups after the rehabilitation process.

Observation of parameters describing the distribution of the load between the limb directly and indirectly affected by paresis indicates a significant change after 6 weeks of rehabilitation only in the treatment group, in a test with both eyes open and closed.

There was also a difference in the SI before and after the rehabilitation process. SI decreased by 13.3% (a test with eyes open) and 15.1% (a test with eyes closed) in the treatment group and these changes were statistically significant. In the control group the changes were not statistically significant for the differences between the test periods SI changed by 2,9% (a test with eyes open) and 6.8% (a test with eyes closed).

Discussion

There are few studies that show the effects of passive and active sensory training in after-stroke patients. The main limitation of the studies presented in the literature is the small number of subjects and heterogeneity of the group [15] and therefore the goal of the study is to assess the impact of sensorimotor stimulation of the foot directly affected by paresis on postural stability in patients who suffered from an ischemic stroke (at least 12 months after the stroke). In addition, the study also analysed the impact of sensorimotor foot stimulation on the parameters assessed subjectively, that is balance – with the use of BBS test, agility of the lower limb – with the use of FMA and muscle tension.

Our patients were aged 51-80 years old and in comparison with the studies of other authors the group was homogeneous. For comparison, the patients of Geiger et al. [19] were aged 30-77 years old, the patients of Srivastava et al. [22] 22-65 years, while the group of Tyson et al. [29] included 28 people aged 28-82 years. The most similar data in terms of age of patients was reported in the study conducted by Harris et al. [21].

Comparing the time that elapsed after the stroke, multiple authors have a rather broad spectrum of days and years to qualify patients for treatment groups. Studies included patients 1 year to 10 years after an ischemic stroke. In the group of Harris et al. [21] there were patients 1 year to 24 years after the neurological event. Geiger et al. [19] examined patients between 15-538 days after the stroke, and at the same time the author compared the impact of the balance training in acute-phase patients and chronic-phase patients.

Analyzing dimorphic differences of the subjects, we did not find any studies that would correlate the selected sensory or motor training with the sex of after-stroke patients. The published studies describe the status of both women and men in the groups, yet there are no separate conclusions for women and men after a stroke. They are studies conducted on homogeneous, in terms of sex, groups and they include healthy people. Illing et al. [30] observed that the way in which sensory and postural systems work depends on age; their group included only healthy men. Men aged 60-70 are physically less stable and are more likely to fall than younger men. Similarly Maciaszek et al. [31] assessed a group of men, aged 60 and older, who reported no pain and were characterized by good health. The author proved that Tai Chi training has a positive impact on postural stability and the strength of the lower limbs in a homogenous, in terms of sex, group. Differences stemming from sex and postural stability are a very important aspect and a frequent subject of studies concerning children or young people [32, 33].

The situation looks similar when dividing patients according to the side affected by hemiplegia. Very rarely do we see a separate analysis for left side and right side hemiplegia when the impact of the proposed therapeutic method is discussed. You can find numerous studies that separately assess and analyze the improvement of the efficiency of the lower [26] and the upper limb [34].

Posturographic platforms are the most common tools for quantitative evaluation of the efficiency of the balance [23,35-37]. The most commonly measured parameters are: the area of the COP, COP lenght, size and frequency of the COP displacement in the sagittal plane and the movements in the frontal plane [23, 31, 38-41]. The measurements are performed when the patient is standing on both feet, on one foot, with eyes closed and open [42]. The measurement can also be recorded with the visual-motor feedback [43]. The surface on which the patient is standing can be solid, soft, elastic [35, 44]. In our studies the patient was standing on both feet on solid ground, with eyes open and closed. The test lasted 30 seconds and it is the time which usually occurs in the studies describing after-stroke patients. The measurements were recorded with Zebris device. The variety of posturographic platforms which are used to diagnose patients with damaged central nervous system, e.g.: NeuroCom Balance Master [19], Biodex Balance Master [22], but also for conducting the balance training, make it very difficult to compare the results between researchers.

When analyzing the parameter of the total load of the lower limb directly and indirectly affected by paresis before the rehabilitation process, there were no significant differences during tests with eyes closed and eyes open. Significant changes were observed in the treatment group during the second period of tests after the rehabilitation process. The value of the total load parameter of the limb indirectly affected by paresis decreased, and that of the directly affected one increased. In the control group the values did not exceed the level of materiality threshold. The above presented comparison indicates that the proposed sensorimotor foot therapy had a positive effect on the proportions of the total load of the lower limb in the treatment group compared with the standard physiotherapy procedures in the control group. Earlier, similar results were obtained in a smaller study group of the pilot studies. Very similar results were achieved by Sunqkarat et al. [45] who stimulated the patient's foot with an insole, while Lynch et al. [27] did not observe any improvement after sensorimotor training which consisted in stimulating selected points on the foot.

The analysis of the postural stability, using Zebris system, showed that all patients when standing put more weight on the lower limb indirectly affected by stroke. This assessment differs significantly from the one coming from the studies conducted by Forghani et al. [46]. The author used a visual assessment of the feet, and the results indicate a symmetrical placement of the feet in most patients.

In order to assess the patient's motor function, the FMA scale was selected to assesses the functional capacity of the after-stroke patient. When compared with Brunnstrom, Rankin and Motor Assessment Scales, we observe that FMA test is distinguished by accuracy. It is often used in clinical trials [25, 47-50]. In our study, the analysis of FMA test results showed a higher growth in points in patients who underwent the sensorimotor foot stimulation. The study conducted by Sanford et al. [25] showed that the FMA test is a reliable measurement tool used in after-stroke patients who undergo rehabilitation.

At the same time a decrease in the number of points in the assessment of muscle tone in the lower limb was observed, which probably means that there was a reduction of muscle tone in the active structures of the lower limb joints. The next stage of study tested the patient's balance with the use of BBS which, as stated in scientific literature, is the most common tool for measuring changes taking place in the functions responsible for keeping the balance [27, 51-54]. There were no differences between groups in the first period of tests. The analysis of the second period of study showed an increase in the number of points in the treatment group which underwent standard rehabilitation combined with sensorimotor foot stimulation. Belgen et al. [55] observed that a small number of points increases the risk of falls, therefore it is important to use therapeutic methods which in a maximum way increase the patient's ability to keep the balance. Introducing a targeted therapy in the form of visual feedback [22, 23, 54] and combining standard forms of rehabilitation, for example, with changeable, thermal intervention, as shown by Chen et al. [53, 56], improves patient's functions and balance. It is important to remember about new technologies thanks to which patients can undergo rehabilitation process even for 24 hours a day improving their quality of life [57].

Conclusions

Sensorimotor foot stimulation in association with classic improvement of therapeutic (physiotherapy, physical therapy) improves the ability to maintain balance, improves the functional lower extremity paretic, and reduces the load asymmetry of the lower limbs.

In addition, it was observed that combining new elements with the basic procedure that improves gives better therapeutic effects even in patients in the late period after a stroke.

Corresponding author

Magdalena Goliwąs

email: mgoliwas@awf.poznan.pl

References

1. Wade D, Hewer R: Functional abilities after stroke: measurement, natural history and prognosis. J Rehabil Res Dev, 1987, 50: 177-182.
2. Miller E, Murray L, Richards L, et al.: Comprehensive overview of nursing and interdisciplinary rehabilitation care of the stroke patient: a scientific statement from the American Heart Association. Stroke, 2010, 41: 2402-2448.
3. Veerbeek JM, Wegen E, Peppen R, et al.: What is the evidence of physical therapy post stroke? A systematic review and meta-analysis. Plos One, 2014, 9 (2): 1-33.
4. Gok H, Apltekin N, Geler-Kulcu D, et al.: Efficacy of treatment with a kinesthetic ability training device on balance and mobility after stroke: a randomized controlled study. Clin Rehabil, 2008, 22: 922-930.
5. Januario F, Campos I, Amaral C: Rehabilitation of postural stability in ataxic/hemiplegic patient after stroke. Disabil Rehabil, 2010, 32 (21): 1775-1779.
6. Horak FB, Wrisley DM, Frank J: The balance evolution system test (BESTest) to differentiate balance deficits. Phys Ther, 2009, 89 (5): 484-498.
7. Duysens J, Trippel M, Horstmann GA, et al.: Gatingand reversal of reflexes in ankle muscles during human walking. Exp Brain Res, 1990, 82: 351-358.
8. Van Wezel BMH, Ottenhoff FAM, Duysens J: Dynamic control of locomotion-specific information in tactile cutaneous reflexes from the foot during human walking. J Neurol Sci, 1997, 17: 3804-3814.
9. Zehr EP, Komiyama T, Stein RB: Cutaneous reflexes during human gait: electromyography and kinematic responses to electrical stimulation. J Neurophysiology, 1997, 77: 3311-3325.
10. Christensen LOD, Morita H, Petersen N, et al.: Evidence suggesting that a transcortical reflex pathway contributes to cutaneous reflexes in the tibialis anterior muscle during walking in man. Exp Brain Res, 1999, 124: 59-68.
11. Lennon S, Bassile M: The rules physiotherapy in neurology. In: Physiotherapy in neurological rehabilitation. Wrocław: Elsevier Urban & Partner, 2009: 35-225.
12. Dewey HM, Sherry LJ, Collier JM: Stroke rehabilitation 2007: what should it be? Inter J Stroke, 2007; 2: 191-200.
13. Veerbeek JM, Wegen E, Peppen R, et al.: What is the evidence of physical therapy post stroke? A systematic review and meta-analysis. Plos One, 2014, 9 (2): 1-33.
14. Horgan NF, O'Regan M, Cunningham CJ, et al.: Recovery after stroke: a 1-year profile. Disabil Rehabil, 2009; 31:831–839.
15. Schabrun SE, Hillier S: Evidence for the retraining of sensation after stroke: a systematic review. Clin Rehabil, 2009, 23: 27-39.
16. Kavounoudias A, Roll R, Roll JP: The plantar sole is a dynamometric map for human balance control. Neuro Raport, 1998, 9: 3247-3252.
17. Niam S, Cheung W, Sullivan PE, et al.: Balance and physical impairments after stroke. Arch Phys Med Rehabil, 1999, 80: 1227-1233.
18. Inglis TJ, Kennedy PM, Wells C, et al.: The role of cutaneous receptors in the foot. Sensomotor Central of Mavement and Postural Editied by SC Ganderia, U. Proske, DG Stuart 2002; 508, 111-117.
19. Geiger RA, Allen JB, O'Keefe J, et al.: Balance and mobility following stroke: effects of physical therapy interventions with and without biofeedback/forceplate training. Phys Ther, 2001, 81 (4): 995-1005.
20. Garland SJ, Willems DA, Ivanova TD, et al.: Recovery of standing balance and functional mobility after stroke. Arch Phys Med Rehabil, 2003, 84: 218-227.
21. Harris JE, Eng JJ, Marigold DS, et al.: Relationship of balance and mobility to fall incidence in people with chronic stroke. Phys Ther, 2005, 2 (85): 150-158.
22. Srivastava A, Taly AB, Gupta A, et al.: Post-stroke balance training: Role of force platform with visual feedback technique. J Neuro Sci 289, 2009: 89-93
23. Pacześniak-Jost A, Samojedna-Kobosz A, Skrzypiec M, et al.: Wykorzystanie platformy pdm do oceny równowagi-badanie powtarzalności wyników. Young Sport Sci of Ukraine, 2011, 3:184-194.
24. Drużbicki M, Pacześniak-Jost A, Kwolek A: Clinical methods used in neurological rehabilitation. Overview of the Medical University of Rzeszow, 2007, 3: 268-274.
25. Sanford J, Moreiand J, Swanson LR, et al.: Reliability of the Fugl-Meyer Assessment for testing motor performance in patients following stroke. Phys Ther, 2013, 73: 447-454.
26. Rudwik E, Eliasson S, Akner G: The effect of exercise of the affected foot in stroke patients-a randomized controlled pilot trial. Clin Rehabil, 2006, 20: 645-655.
27. Lynch AE, Hillier SL, Stiller K, et al.: Sensory retraining of the lower limb after acute stroke: a randomized controlled pilot trial. Arch Phys Med Rehabil, 2007, 88: 1101-1107.
28. Wit A. The normative values to assess asymmetry of gait and posture standing for human. Warsaw: AWF Warsaw; 2012, 38-125.
29. Tyson SF, Sadeghi-Demneh E, Nester ChJ: The effects of transcutaneous electrical nerve stimulation on strength, proprioception, balance and mobility in people with stroke: a randomized controlled cross-over trial. Clin Rehab, 2013, 27 (9): 785-761
30. Illing S, Choy NL, Nitz J, et al.: Sensory system function and postural stability in men aged 30-80 years. The Aging Male, 2010, 13 (3): 202-210.
31. Maciaszek J, Osiński W: The effects of Tai Chi on body balance in elderly people – a review of studies from the early 21st century. Amer J Chinese Med, 2010, 38 (2): 219-229.
32. Sobera M: Characteristics of the process of maintaining the balance of the body in children aged 2-7 years. Monograph, 97. Wroclaw: Publishing house AWF Wroclaw, 2010.
33. Milosis DC, Siatras TA: Six differences in young gymnasts postural steadiness. Perceptual and Motor Skills, 2012, 114 (1): 319-328.
34. Celnik P, Hummel F, Harris-Love M, et al.: Somatosensory stimulation enhances the effects of training function hand tasks in patients with chronic stroke. Arch Phys Med Rehabil, 2007, 88: 1369-1376.
35. Mraz M, Piestrak P: The comparison the frequency of changes stabilograms between healthy subjects and with diseases of the central nervous system. Fizjoterapia, 1995, 3 (1): 18-20.
36. Ocetowicz T, Skalski A, Grodzicki T: The balance study using the balance platform - an assessment of reproducibility of the method. Gerontology Poland, 2006, 14 (1):144-148.
37. Lynn SK, Padilla RA, Tsang KKW: Differences in static-and dynamic-balance task performance after 4 weeks of intrinsic-foot-muscle training: the short-foot exercise versus the towel-curl exercise. J Sport Rehabil, 2012, 21: 327-333.
38. Deschamps K, Matricali GA, Roosen P, et al.: Classification of Forefoot Plantar Pressure Distribution in Persons with Diabetes: A Novel Perspective for the Mechanical Management of Diabetic Foot? PLoS One, 2013, 8 (11): e79924.
39. Błaszczyk JW, Bacik B, Juras G:Clinical assessment of postural stability. J Mech Med Bio, 2003, 3 (2): 135-144.
40. Bernard-Demanze L, Vuillerme N, Berger L, et al.: Magnitude and duration of the effects of plantar sole massages on the upright stance control mechanisms of healthy individuals. Inter SportMed J, 2006, 7 (2): 154-169.
41. Meyer PF, Oddsson LIE,De Luca CJ: The role of plantar cutaneous sensation in unperturbed stance. Experi Brain Res, 2004, 156: 505-512.
42. Mraz M, Nowacka U, Skrzek A, et al.: Postural stability females aged 8-22 years in terms of research posturographic. Fizjoterapia, 2010, 18 (2): 35-43.
43. Bujang R, Abdul Wahat NH, Umat C. Postural stability in adult cochlear implat recipients. J Med Sci, 2013, 2: 86-94.
44. Goliwas M, Kocur P, Furmaniuk L, et al.: Effects of sensorimotor foot training on the symmetry of weight distribution on the lower extremities in patients in the late phase after stroke. J Phys Ther Sci, 2015,82: 2925-2930.
45. Sunqkarat S, Fisher BE, Kovindha A: Efficacy of on insole shoe wedge and augmented pressure sensor for gait training in individuals with stroke: a randomized controlled trial. Clin Rehabil, 2011, 25: 360-369.
46. Forghany S, Tyson S, Nester Ch, et al.: Foot posture after stroke: frequency, nature and clinical significance. Clin Rehabil, 2011, 25 (11): 1050-1055.
47. Gok H, Apltekin N, Geler-Kulcu D, et al.: Efficacy of treatment with a kinesthetic ability training device on balance and mobility after stroke: a randomized controlled study. Clin Rehab, 2008, 22: 922-930.
48. Mikołajewska E. Klinimetria in physiotherapy patients after stroke. Sztuka leczenia, 2011, 3-4: 77-94.
49. Sullivan KJ, Tilson JK, Cen SY, et al.: Fugl-Meyer Assessment of sensorimotor function after stroke. Standarized training procedure for clinical practice and clinical trials. Stroke, 2011, 42: 427-432.
50. Caglar NS, Akin T, Aytekin E, et al.: Pain syndromes in hemiplegic patients and their effects on rehabilitation results. J Phy Ther Sci, 2016, 28: 731-734.
51. Oliveira R, Borges G: A clinical correlation using Fugl-Meyer Assessment Scale, Berg Balance Scale and Barthel Index. Arquivos de Neuro-Psiquiatria, 2006, 64 (3-B): 731-735.
52. Kostiukow A, Rostkowska E, Samborski W: Study on the balance. Yearbook of the Pomeranian Medical University in Szczecin, 2009, 55 (3): 102-109.
53. Chen JCH, Shaw FZ: Progress in sensorimotor rehabilitative physical therapy programs for stroke patients. Wor J Clin Cases, 2014, 2 (8): 316-326.
54. Ko YJ, Ha HG, Bae YH, et al.: Effect of space balance 3D training using visual feedback on balance and mobility in acute stroke patients. J Phys Ther Sci, 2015, 27: 1593-1596.
55. Belgen B, Beninato M, Sullivan PE, et al.: The association of balance Capacity and falls self-efficacy with history of falling in community-dwelling people with chronic stroke. Arch Phys Med & Rehabil, 2006, 87 (4): 554-561.
56. Chen JCh, Lin ChH, Wie YCh, et al.: Facilitation of motor and balance recovery by thermal intervention for the paretic lower limb of acute stroke: a single-blind randomized clinical trial. Clin Rehabil, 2011, 25 (9): 823-832.
57. White J, Janssen H, Jordan L, et al.: Tablet technology during stroke recovery: a survivor's perspective. Disabil Rehabil, 2015, 37 (13): 1186-1192.