fizjoterapia polska

POLISH JOURNAL OF PHYSIOTHERAPY

OFICJALNE PISMO POLSKIEGO TOWARZYSTWA FIZJOTERAPII

THE OFFICIAL JOURNAL OF THE POLISH SOCIETY OF PHYSIOTHERAPY

NR 3/2020 (20) KWARTALNIK ISSN 1642-0136

Physiotherapeutic procedure in a patient after the first artificial heart implantation in Poland – SynCardia Total Artificial Heart (TAH)

Postępowanie fizjoterapeutyczne u pacjenta po pierwszej w Polsce implantacji sztucznego serca – SynCardia Total Artificial Heart (TAH)

The effect of hippotherapy on children with autism – physical and psychological factors

Wpływ hipoterapii na wybrane czynniki fizyczne i psychiczne u dzieci z autyzmem

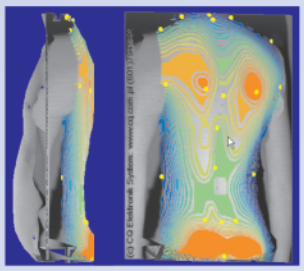
CQ Elektronik System

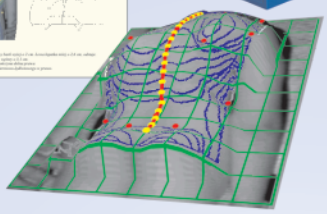
Nowoczesna diagnostyka
Terapia rehabilitacyjna

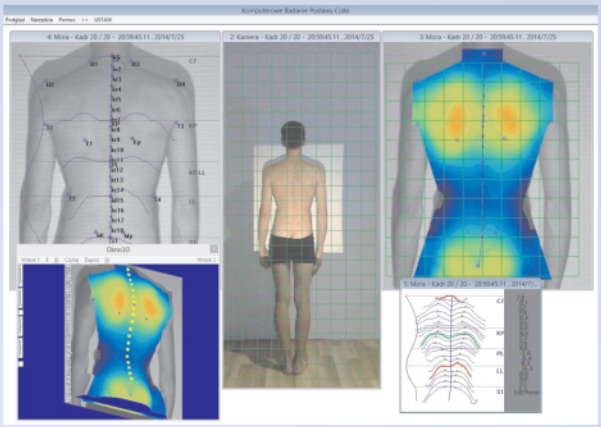
www.cq.com.pl

ZESTAW APARATURY DO LABORATORIUM KOMPUTEROWEJ DIAGNOSTYKI I KOREKCJI POSTAWY CIAŁA

SYSTEM MORA 4G



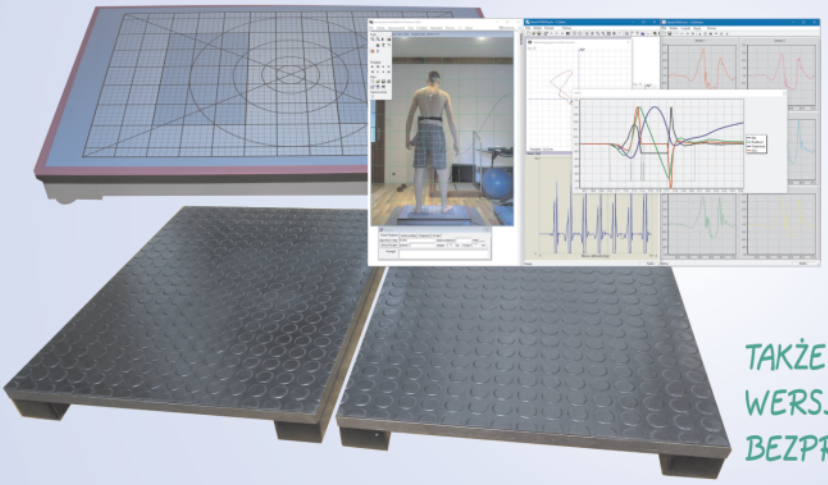


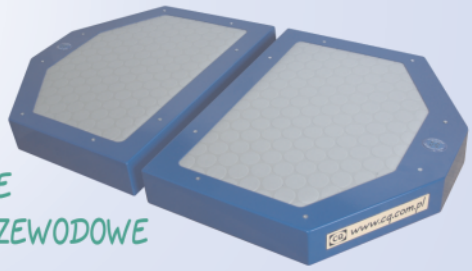


Fotogrametria przestrzenna 3D
Druga kamera całosylwetkowa

Platformy CQ-Stab2P

stabilograficzne i DYNAMOMETRYCZNE
jedno i DWUPŁYTOWE
z analizą wyskoku dla SPORTOWCÓW

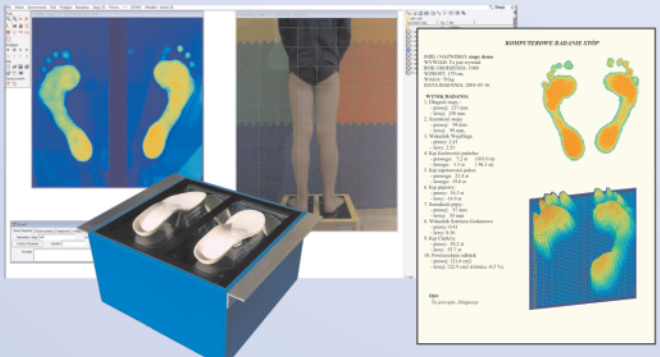


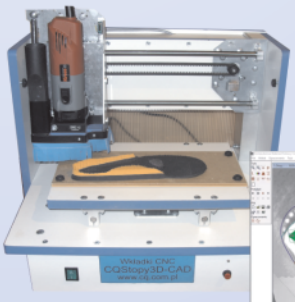


TAKŻE
WERSJE
BEZPRZEWODOWE

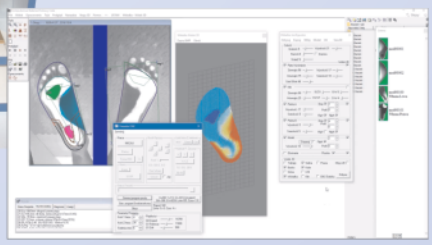
PROMOCJA DLA ZAKŁADÓW ORTOPEDYCZNYCH WYKONUJĄCYCH WKŁADKI

CQ-Stopy3D CAD-CNC





Eksport projektu STL
dla drukarek 3D



Bezpośrednie, szybkie, skanowanie przestrzenne (3D) stóp
System komputerowego wykonywania indywidualnych wkładek
Dokładna diagnostyka stóp i koślawości/szpotawości kolan i pięt

KOMPUTEROWE FREZOWANIE WKŁADEK
NA MIEJSCU, NA MIARĘ, NA CZAS !

PROJEKTUJEMY RÓWNIEŻ NA INDYWIDUALNE ZAMÓWIENIA
W OFERCIE · KOMPUTEROWE BADANIE POSTAWY · RUCHU · TREMORU · SIŁY · BALANSU · TRENINGU

Polski PRODUCENT * ul.Wiśniowa 15 * Czernica * tel.(71)3180104 * (601)794162

MATIO®

MATIO sp. z o.o.

to sprawdzony od 7 lat dystrybutor
urządzeń do drenażu dróg oddechowych
amerykańskiej firmy Hillrom

Hill-Rom

The Vest®
Airway Clearance System
model 205

MetaNeb™

do drenażu i nebulizacji dla pacjentów w warunkach szpitalnych

MATIO sp. z o.o., ul. Celna 6, 30-507 Kraków, tel./fax (+4812) 296 41 47,
tel. kom. 511 832 040, e-mail:matio_med@mukowiscydoza.pl, www.matio-med.pl

ultrasonografy.pl

NOWY WYMIAR FIZJOTERAPII

KOLOR DOPPLER - MAPY PRZEPŁYWÓW KRWI - CFM

DOFINANSOWANIE KURSU
- PROSIMY O KONTAKT

od 1993 ECHOSON

81 886 36 13 info@echoson.pl www.echoson.pl

ROSETTA ESWT

jedyny aparat do fali uderzeniowej bez kosztów eksploatacji!

- efekty terapeutyczne nawet po pierwszym zabiegu
- terapia nieinwazyjna, w wielu przypadkach zapobiega interwencji chirurgicznej
- leczenie obejmuje zwykle 3-5 zabiegów w tygodniowych odstępach
- krótkie, kilkuminutowe sesje terapeutyczne

Wskazania do stosowania:

- ostroga piętowa
- kolano skoczka
- biodro trzaskające
- zespół bolesnego barku
- łokieć tenisisty
- punkty spustowe
- hallux - paluch koślawy

Dowiedz się więcej na stronie: **www.rosetta-eswt.pl**

Skontaktuj się z nami, by przetestować aparat za darmo w swoim gabinecie:

bardomed | **721 12 13 14** biuro@bardomed.pl www.bardomed.pl

Zawód Fizjoterapeuty dobrze chroniony

Poczuj się bezpiecznie

INTER Fizjoterapeuci
Dedykowany Pakiet Ubezpieczeń

Zaufaj rozwiązaniom sprawdzonym w branży medycznej.
Wykup dedykowany pakiet ubezpieczeń INTER Fizjoterapeuci, który zapewni Ci:

- ochronę finansową na wypadek roszczeń pacjentów – NOWE UBEZPIECZENIE OBOWIĄZKOWE OC
- ubezpieczenie wynajmowanego sprzętu fizjoterapeutycznego
- profesjonalną pomoc radców prawnych i zwrot kosztów obsługi prawnej
- odszkodowanie w przypadku fizycznej agresji pacjenta
- ochronę finansową związaną z naruszeniem praw pacjenta
- odszkodowanie w przypadku nieszczęśliwego wypadku

Nasza oferta była konsultowana ze stowarzyszeniami zrzeszającymi fizjoterapeutów tak, aby najskuteczniej chronić i wspierać Ciebie oraz Twoich pacjentów.

Skontaktuj się ze swoim agentem i skorzystaj z wyjątkowej oferty!

Towarzystwo Ubezpieczeń INTER Polska S.A.
Al. Jerozolimskie 142 B
02-305 Warszawa

www.interpolska.pl

inter UBEZPIECZENIA

RoboGait

Technomex

RoboGait to system do terapii chodu z asystą robota stosowany na każdym etapie rehabilitacji u pacjentów z niedowładem lub porażeniem kończyn dolnych w szczególności u pacjentów z urazami mózgu, rdzenia kręgowego, po przebytych udarach mózgu oraz ze schorzeniami ortopedycznymi.

Zobacz ten produkt na stronie:
neuroreedukacja.pl/robogait

Dowiedz się więcej:
32 40 10 350 wew. 57

Cechy kluczowe

- Uniwersalna orteza dla pacjentów dorosłych i pediatrycznych
- Regulacja siły wspomagania pacjenta
- Regulowany uchwyt na miednicę pozwalający na pracę zarówno z pełną stabilizacją miednicy, jak i z jej pełnym uwolnieniem
- Dynamiczne odciążenie pacjenta (od 0 do 100 kg - możliwość regulacji bez przerywania treningu)
- Biofeedback zapewniający funkcjonalne środowisko, zwiększające motywację wykonywanych ćwiczeń
- Narzędzia oceny oraz raporty

T_ 32 40 10 350 wew. 57
M_ bts@technomex.pl
W_ technomex.pl

A_ PHU Technomex Sp. z o.o.
ul. Szparagowa 15,
44-141 Gliwice, Poland

facebook.com/technomex
instagram.com/technomexpl
youtube.com/phutechnomex

KALMED
Iwona Renz, Poznań

ARTROMOT®
WYŁĄCZNY PRZEDSTAWICIEL
WWW.KALMED.COM.PL

DJO GLOBAL

SPRZEDAŻ I WYPOŻYCZALNIA ZMOTORYZOWANYCH SZYN CPM ARTROMOT®

Nowoczesna rehabilitacja CPM stawu kolanowego, biodrowego, łokciowego, barkowego, skokowego, nadgarstka oraz stawów palców dłoni i kciuka.

ARTROMOT-K1

ARTROMOT-SP3

ARTROMOT-S3

ARTROMOT-E2

ARTROMOT-H

ARTROMOT-F

Najnowsze konstrukcje ARTROMOT zapewniają ruch bierny stawów w zgodzie z koncepcją PNF (Proprioceptive Neuromuscular Facilitation).

ARTROSTIM FOCUS PLUS

KALMED Iwona Renz
ul. Wilczak 3
61-623 Poznań
www.kalmed.com.pl

tel. 61 828 06 86
faks 61 828 06 87
kom. 601 64 02 23, 601 647 877
kalmed@kalmed.com.pl

Serwis i całodobowa pomoc techniczna:
tel. 501 483 637
service@kalmed.com.pl

ultrasonografy.pl

NOWY WYMIAR FIZJOTERAPII

KOLOR DOPPLER - MAPY PRZEPŁYWÓW KRWI - CFM

DOFINANSOWANIE KURSU
- PROSIMY O KONTAKT

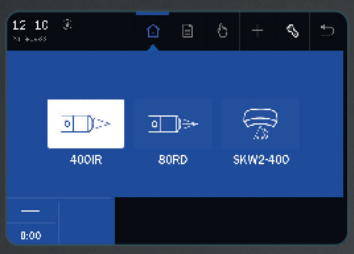
od 1993 ECHOSON

81 886 36 13 info@echoson.pl www.echoson.pl

PhysioGo.Lite Laser

ergonomiczny aparat do laseroterapii biostymulacyjnej

- wbudowana ilustrowana encyklopedia zabiegowa
- 175 programów dla popularnych jednostek chorobowych
- równoczesne podpięcie trzech akcesoriów
- dotykowy panel sterowania
- praca w trybach: manualnym i programowym
- pełne statystyki zabiegowe
- możliwość zasilania akumulatorowego



wsparcie merytoryczne
www.fizjotechnologia.com

ASTAR.

producent nowoczesnej aparatury fizykoterapeutycznej

ul. Świt 33
43-382 Bielsko-Biała
tel. +48 33 829 24 40

www.astar.pl

mindray
healthcare within reach

DP-50 exp

Z50/Z60

M6

ULTRASONOGRAFIA
W FIZJOTERAPII

DC-30

DC-40 full HD

Mindray Medical Poland Sp. z o. o.
ul. Cybernetyki 9, 02-677 Warszawa, Polska

info-pl@mindray.com MindrayPoland mindray.com/pl

Dr. Comfort®

NAGRODA POLSKIEGO TOWARZYSTWA REHABILITACJI

ACCEPTED
AMERICAN PODIATRIC MEDICAL ASSOCIATION

APROBATA AMERYKAŃSKIEGO MEDYCZNEGO STOWARZYSZENIA PODIATRYCZNEGO

CE WYRÓB MEDYCZNY

Nowy wymiar wygody dla stóp z problemami

Obuwie profilaktyczno-zdrowotne o atrakcyjnym wzornictwie i modnym wyglądzie

Miękki, wyściełany kołnierz cholewki
Minimalizuje podrażnienia

Wyściełany język
Zmniejsza tarcie i ulepsza dopasowanie

Stabilny, wzmocniony i wyściełany zapiętek
Zapewnia silniejsze wsparcie łuku podłużnego stopy

Lekka konstrukcja
Zmniejsza codzienne zmęczenie

Zwiększona szerokość i głębokość w obrębie palców i przodostopia
Minimalizuje ucisk i zapobiega urazom

Antypoślizgowa, wytrzymała podeszwa o lekkiej konstrukcji
Zwiększa przyczepność, amortyzuje i odciąża stopy

Ochronna przestrzeń na palce - brak szwów w rejonie przodostopia
Minimalizuje możliwość zranień

Wysoka jakość materiałów - naturalne skóry, oddychające siatki i Lycra
Dostosowują się do stopy, utrzymują je w suchości i zapobiegają przegrzewaniu

Trzy rozmiary szerokości

Podwyższona tęgość

Zwiększona przestrzeń na palce

WSKAZANIA
• haluksy • wkładki specjalistyczne • palce młotkowate, szponiaste • cukrzyca (stopa cukrzycowa) • reumatoidalne zapalenie stawów • bóle pięty i podeszwy stopy (zapalenie rozcięgna podeszwowego - ostroga piętowa) • płaskostopie (stopa poprzecznie płaska) • bóle pleców • wysokie podbicie • praca stojąca • nerwiak Mortona • obrzęk limfatyczny • opatrunki • ortezy i bandaże • obrzęki • modzele • protezy • odciski • urazy wpływające na ścięgna, mięśnie i kości (np. ścięgno Achillesa) • wrastające paznokcie

Wyłączny dystrybutor w Polsce:

KALMED
Iwona Renz, Poznań

ul. Wilczak 3
61-623 Poznań
tel. 61 828 06 86
fax. 61 828 06 87
kom. 601 640 223, 601 647 877
e-mail: kalmed@kalmed.com.pl
www.kalmed.com.pl

www.butydlazdrowia.pl **www.dr-comfort.pl**

MATIO sp. z o.o.

to sprawdzony od 7 lat dystrybutor
urządzeń do drenażu dróg oddechowych
amerykańskiej firmy Hillrom

Hill-Rom

The Vest
Airway Clearance System

model 105

do drenażu dla pacjentów w warunkach domowych

MATIO sp. z o.o., ul. Celna 6, 30-507 Kraków, tel./fax (+4812) 296 41 47,
tel. kom. 511 832 040, e-mail:matio_med@mukowiscydoza.pl, www.matio-med.pl

PRENUMERATA 2021

fizjoterapia polska

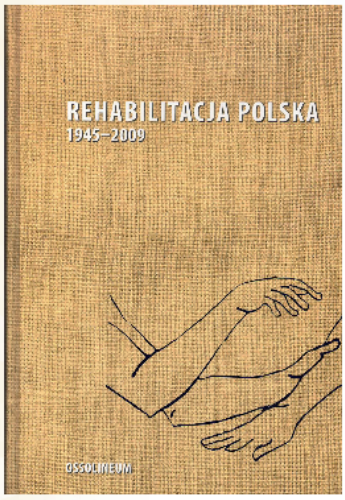
Zamówienia przyjmowane pod adresem e-mail:
prenumerata@fizjoterapiapolska.pl

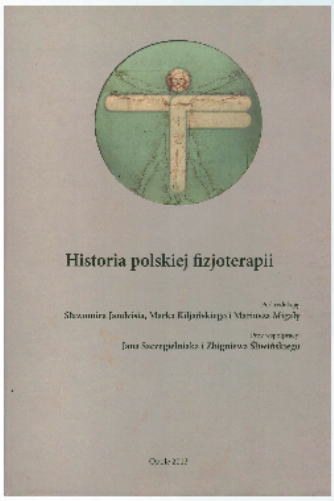
oraz w sklepie internetowym:
www.djstudio.shop.pl

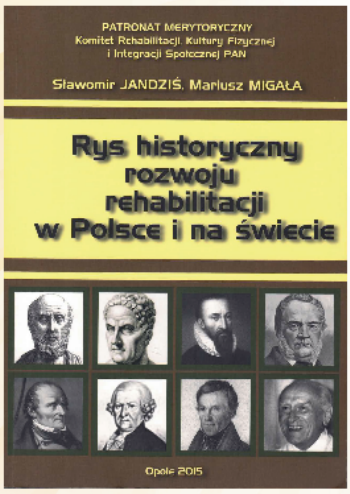
STUDIO

w sklepie dostępne także:

- ***archiwalne numery Fizjoterapii Polskiej w wersji papierowej***
- ***artykuły w wersji elektronicznej***
- ***książki poświęcone fizjoterapii***







ULTRASONOGRAFY

DLA FIZJOTERAPEUTÓW

HONDA 2200

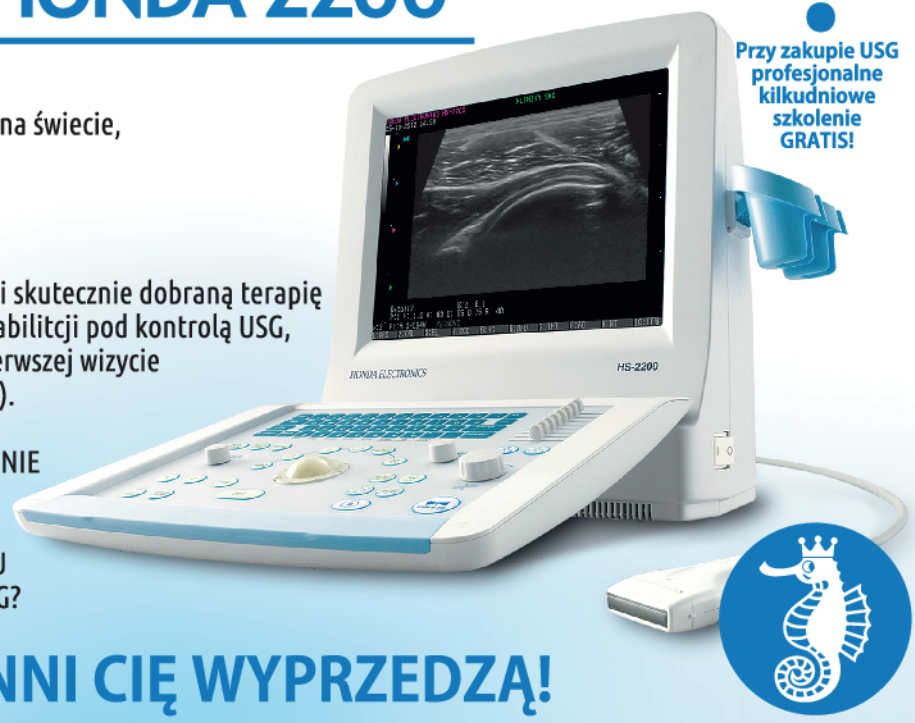
Przy zakupie USG profesjonalne kilkudniowe szkolenie GRATIS!

CHCESZ MIEĆ W GABINECIE?
- najlepszy, przenośny ultrasonograf b/w na świecie,
- nowoczesne 128-elem. głowice,
- 3 lata gwarancji i niską cenę!

CHCESZ MIEĆ?
- szybką i trafną diagnozę narządu ruchu i skutecznie dobraną terapię
- sonofeedback w leczeniu schorzeń i rehabilitcji pod kontrolą USG,
- wyselekcjonowanie pacjentów już na pierwszej wizycie (rehabilitacja czy skierowanie do szpitala).

CHCESZ IŚĆ NA PROFESJONALNE SZKOLENIE dla fizjoterapeutów kupując USG?

CHCESZ MIEĆ SUPER WARUNKI LEASINGU i uproszczoną procedurę przy zakupie USG?



NIE CZEKAJ, AŻ INNI CIĘ WYPRZEDZĄ!

Made in Japan

ULTRASONOGRAFIA W UROGINEKOLOGII !!!

CHCESZ?
- szybko diagnozować specyficzne i niespecyficzne bóle lędźwiowo-krzyżowe i zaburzenia uroginekologiczne,
- odczytywać, interpretować obrazy usg i leczyć podstawy pęcherza moczowego, mięśnie dna miednicy, mięśnie brzucha, rozejście kresy białej,
- poszerzyć zakres usług w swoim gabinecie i praktycznie wykorzystywać usg do terapii pacjentów w uroginekologii.

KUP ULTRASONOGRAF HONDA 2200 I IDŹ NA PROFESJONALNE SZKOLENIE !!!

My zapłacimy za kurs, damy najlepszy leasing, dostarczymy aparat, przeszkolimy! I otoczymy opieką gwarancyjną i pogwarancyjną!

Małgorzata Rapacz kom. 695 980 190

polrentgen®

www.polrentgen.pl

METRUM CRYOFLEX

PRODUCENT APARATURY MEDYCZNEJ

Partner Polskiego Związku Narciarskiego

1919 PZN

Kompleksowe rozwiązania dla fizjoterapii

Sprawdź naszą pełną ofertę na stronie metrum.com.pl i umów się na bezpłatne testy wybranego aparatu.

Fala uderzeniowa

Laseroterapia

Diatermia

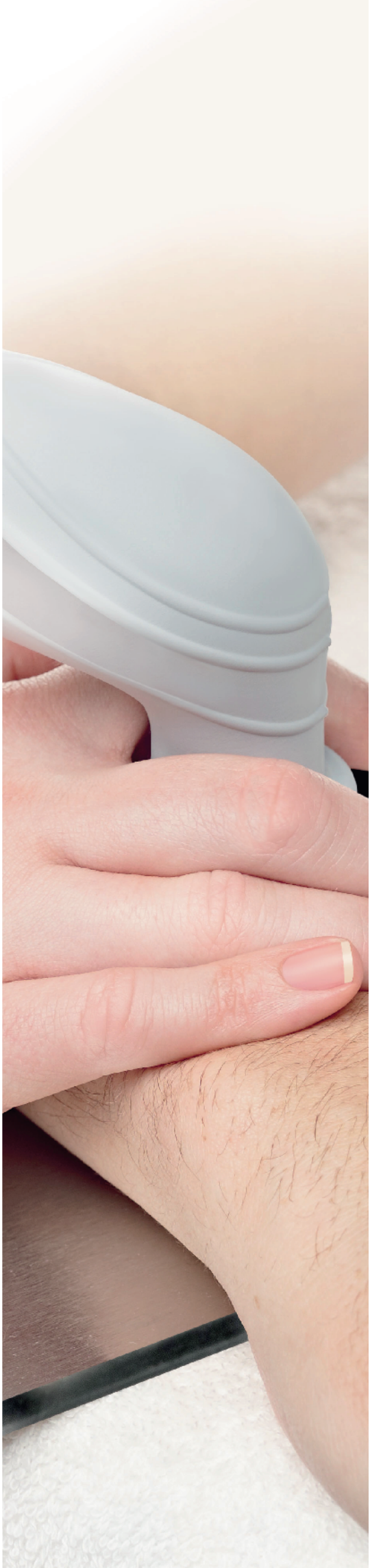
Ultradźwięki

Elektroterapia

LIPUS

Krioterapia CO_2 i N_2O

Masaż BOA



METRUM CRYOFLEX, ul. Zielna 29, 05-082 Blizne Łaszczyńskiego, +48 22 33 13 750, biuro@metrum.com.pl, metrum.com.pl

SIEMENS
Ingenuity for life

Zapytaj o finansowanie
Dzięki naszej współpracy z SIEMENS FINANCE masz możliwość uzyskania pożyczki medycznej w 15 minut bez wychodzenia z gabinetu. Umowa podpisywana SMS-em.

fizjoterapia polska
nr 3/2020 (20)

Effect of Electromyogram-Triggered Stimulation versus Alternating Electromyogram Stimulation on Hand Functions in Chronic Stroke Patients: A randomized controlled trial

Wpływ stymulacji wyzwalanej elektromiogramem w porównaniu do naprzemiennej stymulacji elektromiogramem na funkcje dłoni u pacjentów po udarze mózgu: Randomizowane badanie kontrolowane

Dany Alphonse Anwar Habib[1(A,B,D,E,F)], Abeer AboBakr El-Wishy[2(A,D,E,F)], Ebtessam Mohamed Fahmy[3(A,D,E,F)], Heba A. Bahey El Deen[4,5(C,D)], Shaimaa Shaheen Mohammed[3(C,E)], Abd El-Hamiedlbrahim El-Sayed Mohammad[6(A,B,E,F)]

[1]El-Khazendar General Hospital, Cairo, Egypt
[2]Faculty of Physical Therapy, Cairo University, Egypt
[3]Faculty of Medicine, Cairo University, Egypt
[4]Faculty of Applied Medical Sciences, Al-Jouf University, Qariyaat, Kingdom of Saudi Arabia
[5]Department of Physical Therapy for Surgery, Faculty of Physical Therapy, Misr University for Science and Technology, Giza, Egypt
[6]National Institute of Longevity Elderly Sciences NILES BENI-SUEF University, Egypt

Abstract

Aim. The purpose of this study is to compare between electromyogram-triggered stimulation versus alternating electromyogram stimulation on hand function in chronic stroke patients. Material and Methods. Forty five chronic stroke patients of both sexes were divided into 3 equal groups (A, B and C). Each group received the same designed physical therapy program for hand function training in addition to electromyogram-triggered stimulation for group A and alternating electromyogram stimulation for group B. Each patient was assessed before and after the two months of intervention protocol by box and block test to evaluate manual dexterity and by electromyography (EMG) threshold to evaluate peak muscle torque. Results. There was significant post-treatment increase in manual dexterity and peak muscle torque mean scores in all groups. The percentage of improvement was higher in group B compared to other groups. Conclusion. Adding alternating electromyogram stimulation or electromyogram-triggered stimulation to a designed physical therapy program for hand function training improves hand function and peak muscle torque in chronic stroke patients. Alternating electromyogram stimulation was more effective than electromyogram-triggered stimulation.

Key words:

Electromyogram-triggered stimulation, alternating electromyogram stimulation, rehabilitation; stroke, hand function

Streszczenie

Cel. Celem badania jest porównanie stymulacji wyzwalanej elektromiogramem z naprzemienną stymulacją elektromiogramem na funkcje ręki u pacjentów po udarze mózgu. Materiał i metody. Czterdziestu pięciu pacjentów obojga płci po udarze mózgu podzielono na 3 równe grupy (A, B i C). Każda grupa otrzymała ten sam opracowany program fizjoterapii do treningu funkcji rąk, ponadto do programu leczenia wprowadzono stymulację wyzwalaną elektromiogramem w grupie A i naprzemienną stymulację elektromiogramem w grupie B. Każdego pacjenta oceniono pod kątem sprawności manualnej przy użyciu testu block and box (przekładanie klocków z jednej komory pudła do drugiej w określonym czasie) i elektromiografii (EMG) w celu oceny maksymalnego momentu obrotowego mięśni przed i po dwóch miesiącach leczenia. Wyniki. We wszystkich grupach odnotowano znaczący wzrost sprawności manualnej i maksymalnego momentu obrotowego mięśni po leczeniu. Odsetek poprawy był wyższy w grupie B w porównaniu z innymi grupami. Wnioski. Wprowadzenie naprzemiennej stymulacji elektromiogramem lub stymulacji wyzwalanej elektromiogramem do zaprojektowanego programu fizjoterapii w celu treningu funkcji dłoni, poprawia funkcję dłoni i maksymalny moment obrotowy mięśni u pacjentów po udarze. Stymulacja naprzemienna elektromiogramem okazałą się bardziej skuteczna niż stymulacja wyzwalana elektromiogramem.

Słowa kluczowe:

Stymulacja wyzwalana elektromiogramem, stymulacja naprzemienna elektromiogramem, rehabilitacja; udar, funkcja dłoni

Abbreviations:
EMG: Electromyography, NMES: Neuromuscular electrical stimulation, EMG-NMS: Electromyography-triggered neuromuscular stimulation, LSD: Least significant difference

Introduction

Stroke is a leading cause of Physical disability in adult population [1]. Although most stroke survivors regain independent mobility, many fail to regain functional use of their impaired upper limb [2]. Arm paresis may be the most disabling impairment in stroke patients, considering its impact on the ability to perform activities of daily living [3]. In fact, finger extension is the most common motor deficit [4]. The grabbing, holding and handling of items is a routine task that remains impaired in 55 to 75% of patients three to six months after a stroke [5].

A systematic review that focused on techniques to stimulate upper extremity restoration indicated that upper limb task completion after stroke is positively altered by goal-specific sensorimotor input through exercising or using arm and hand daily [6]. Neuromuscular electrical stimulation (NMES) is a method used to improve upper limb function grasp efficiency after stroke [7].

Neuromuscular electrical stimulation is a commonly used therapy for stroke rehabilitation [8]. A meta-analysis by Yang et al [9] revealed that electrical stimulation effectively improves arm function in patients after stroke. Electrical stimulation assists in upper limb function restoration, including hand and arm movements, and cause neuro-plastic changes within the motor network [10, 11]. Practicing passive-active movement repetitively improved upper extremity motor function and motor cortex activation in stroke patients [12]. An evidence-based review indicated that rehabilitation strategies which integrate practicing of active repetitive movements might increase upper extremeity function after stroke [13].

Electromyography-triggered neuromuscular stimulation (EMG-NMS) is an intervention that combines three modalities: functional electrical stimulation, biofeedback, and exercise. With this combination, EMG-stimulation is capable of facilitating movement of the hemiparetic upper extremity with patterned, repetitive, and voluntarily initiated exercises [14]. Electromyogram-triggered functional electrical stimulation requires cognitive involvement by the motor cortex, where it involves a voluntary muscle contraction for a selected movement until the muscle action reaches a pre-determined threshold level, and then an assisting electrical stimulus begins [3, 15]. Several studies suggest that EMG-NMES may produce changes in cortical activation patterns and excitability in chronic stroke [16, 17, 18]. Adding EMG-NMES to conventional therapy programs improves short-term upper limb impairment and may be included in clinical practice to achieve greater gains on post-stroke upper limb impairment [19].

Another type of electrical stimulation is alternating EMG-stimulation. Alternating EMG-stimulation delivers neuromuscular electric stimulation and EMG in a repeated manner. An electric stimulation is delivered to the targeted muscle during the rest period so that stroke patient can understand what the muscle contraction should feel like. During the work period, contraction accomplished throughout the stimulation period (rest period) should be repeated volitionally by the patient to reach a pre-determined threshold target. A combination of stimulation and repeating action will reinforce the muscles and help relearn the normal reflexes. Alternating EMG-stimulation combines electrical stimulation, repeated limb movement, and biofeedback, where the patient during the work period will try to contract until he/she reaches a target EMG level [20].

Aim of the study

The purpose of this study was to compare the efficacy of alternating EMG-stimulation versus electromyography-triggered neuromuscular stimulation on hand function in chronic stroke patients.

Material and methods

Study design

This study was a randomized controlled clinical trial conducted at the Faculty of Physical Therapy, Cairo University. The study was approved by the local ethical committee of the Faculty of Physical Therapy, Cairo University (No: P.T.REC/012/001665). The study's aim and procedures were explained to the patients and a written consent was taken prior to participation.

Subjects

Forty five stroke patients (36 males and 9 females), aged between 50 and 65 years were recruited from the Outpatient Clinics, Faculty of Physical Therapy, Cairo University, Egypt. Patients were selected according to the following inclusion criteria: Chronic stroke patients with duration of illness ranging from 6 to 18 months from the stroke onset, grade two or more of muscle power for elbow and shoulder flexors on manual muscle testing grading scale, spasticity of the upper limb less than 1+ on the Modified Ashworth Scale, full passive range of motion of the wrist, thumb, index, and long finger metacarpophalangeal joints of the affected limb, a minimum level of hand function - (patients who were able to grasp and release a minimum of one block in the Box and Block Test), light touch test and position test for the upper limb of the Stroke Impairment Assessment Set = 0 (not affected), and Mini-Mental State Examination score > 21 (can understand simple verbal instructions).

Exclusion criteria were: Contractures and/or limitation in the range of motion for wrist joints, shoulder pain that might restrict movement, spasticity of the upper limb more than 1+ on the Modified Ashworth Scale, patients with contraindications for electrical stimulation (pacemakers or altered tissue sensation), comorbidities affecting upper limb function (e.g. osteoarthritis, carpal tunnel syndrome, previous hand surgeries… etc.), and pre-existing musculoskeletal disease significantly affecting physical function.

Randomization

The patients were randomly allocated at the first visit using an online random number calculator to one of three equal groups. Each group consisted of 15 patients (study group A received EMG-triggered stimulation coupled with the designed program for hand function training, study group B received alternating EMG stimulation coupled with the designed program for hand functions training, and control group C received the designed program for hand functions training only). Figure 1. illustrates patient flow chart.

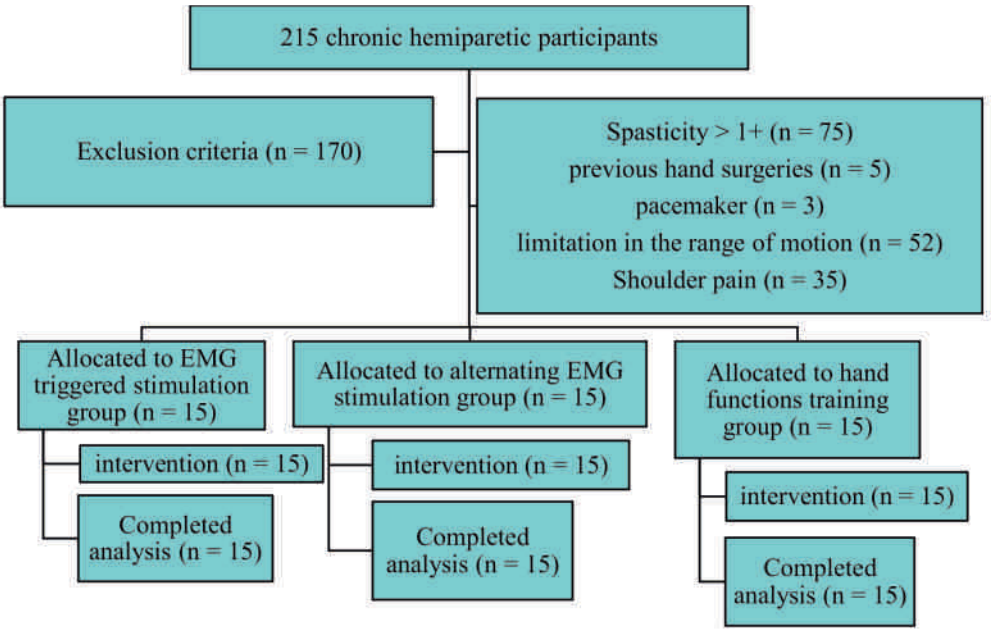


Figure 2. Plot of sample size calculation

Procedures

Outcome measurements were collected for all participants before the study and 2 months after the intervention protocol.

Instrumentation for evaluation only

Box and Block Test

It is a manual dexterity measuring tool for stroke patients which is valid and reliable. The test involves transferring square wooden blocks (2.54 cm) from one side to the other side of a square box (20.32 cm) by passing over a wooden partition (12.70 cm height). The patient can try the test for 15-second as a trial and after correction of errors in their performance; the patient start transferring blocks as many as he can for 1 minute allowed time. The number of blocks transferred in 1 minute is recorded. Lower scores represent higher hand function impairment [21, 22].

Instrumentation for evaluation and treatment

MyoTrac Infiniti device (T9800, Thought Technology Ltd. Montreal, Quebec, Canada): This device was used to assess peak muscle torque and to deliver alternating and EMG-triggered stimulation. Electromyography threshold is the EMG amplitude proportional to the peak muscle torque that can be exerted by the underlying muscle. During muscle contraction, electrodes attached to the skin surface detected the electrical activity generated in the muscle. For isometric and/or isotonic contractions with constant speed, the EMG signal magnitude is directly equivalent to the muscle strength [23].

Surface electrode detected electromyography signal from muscle contraction and an electrical stimulation is delivered in proportion to the integrated EMG signal. The other electrode was placed approximately one inch below the first active electrode. The ground electrode was attached three inches away from either active electrode anywhere on the forearm. Stimulation intensity (pulse amplitude) was adjusted to reach full joint movement, yet can be tolerated by the patient. Stimulation was delivered via a biphasic waveform, with a pulse duration (pulse width) of 300 µs. Pulse frequency (pulse rate) was adjusted to participant comfort but was kept between a range of 20 and 40 Hz. The duty cycle was set at 5 seconds on and 20 seconds off [24].

Designed physical therapy program for all groups (A, B and C)

Before each treatment session: The therapist performed general passive range of motion (ROM) activity for the affected arm, followed by short periods of gentle stretching to the wrist and finger flexors [25]. Each patient in all groups received a designed hand function training and a home program. For patients in group (A) they received EMG-triggered stimulation. The threshold that the patient was able to reach was automatically calculated and displayed. The patient continued to reach that target throughout the remainder of the session. Once the target threshold was reached, the device would stimulate the target muscle and then the patient was asked to perform the hand function training [26]. For patients in group (B) they received alternating EMG stimulation. The threshold that the patient was able to reach was automatically calculated and displayed. The patient continued to reach that target throughout the remainder of the session. During the work period, the MyoTrac Infiniti device delivered an electrical impulse to contract the targeted muscle. During the rest period, the patient voluntarily contracted the targeted muscle in a manner similar to what was felt in the previous work period, then he performed the hand function training [20]. For patients in control group C, electrodes were used with the stimulator unit as placebo.

Each treatment session continued for 30 minutes, 3 days/week for 8 weeks. Each hand function was repeated as much as possible throughout the treatment time. Treatment session was divided equally on the learning tasks with 60 second rest between each task [27]. Peak muscle torque (µv) and manual dexterity were assessed before the study and 8 weeks after the training program.

Hand functions training

This training consisted of different tasks of progressively increasing difficulty; difficulty of the training was increased every week, depending on the progress gained in the previous task. The patient could progress to the next task if he/she performed (completed) the task successfully without difficulty or without taking a long time (more than 60 seconds).

Hand function tasks include: grasping, gripping, pinching, button-pressing tasks, finger spreading with rubber band, and reaching computer mouse [28, 26].

Home program

Participants were shown by the physiotherapist how to practice functional tasks at home using the hemiplegic arm for 2 sessions of 30 minutes a day. These tasks included picking up a bath sponge and attempting to wash the opposite arm with it, picking up a small juice can and pouring the contents into a glass, picking up a cup and attempting to drink, holding a 4-ounce jar of coffee while unscrewing the lid with the unaffected hand, grasping and releasing a 2.5 cm block (cube), grasping and releasing a ball (7.5 cm in diameter), as well as practicing gross movements (such as hand to mouth, hand to top of head and hand to behind the head) [29].

Data analysis

Statistical analysis was conducted using statistical SPSS Package Program version 25 for Windows (SPSS, Inc., Chicago, IL). Descriptive statistics data included the mean and standard deviation for demographic data, action research arm test (unaffected), action research arm test (affected), and EMG variables. Paired t-test was used to compare pre- and post-treatment within each group for action research arm test (unaffected), action research arm test (affected), and EMG variables. One-way analysis of variance (ANOVA-test) was used to compare groups A, B, and C for demographic data, action research arm test (unaffected), action research arm test (affected), and EMG variables. Post-hoc least significant difference test was used to compare pairs of groups for post-treatment of the tested variables when significant differences were observed from the ANOVA test. All statistical analyses were significant at 0.05 level of probability ($P \leq 0.05$). There was no need to do intention to treat analysis because there was no patient withdrawal from the study.

Results

General and clinical characteristics of patients

Table 1. represents the mean values of general and clinical data in groups A, B and C. Statistical analysis revealed no significant differences ($P > 0.05$) in demographic data groups A, B and C.

Table 1. General and clinical characteristics between groups A, B and C (n = 15/ group)

Items		Group A	Group B	Group C	p-value
Age (Year)	Mean ± SD	57.87 ± 4.92	57.33 ± 4.11	57.93 ± 4.63	0.925
Weight (kg)	Mean ± SD	80.80 ± 15.52	76.47 ± 12.66	79.67 ± 7.43	0.611
Height (cm)	Mean ± SD	168.67 ± 6.99	165.13 ± 8.96	169.47 ± 6.64	0.263
Gender	Male	13 (87%)	11 (73%)	12 (80%)	0.659
	Female	2 (13%)	4 (27%)	3 (20%)	
Handedness	Right	15 (100%)	14 (93%)	15 (100%)	0.360
	Left	0 (0%)	1 (7%)	0 (0%)	
Duration of illness	Mean ± SD	10.07 ± 3.17	10.33 ± 2.74	10.93 ± 3.08	0.723
Mini-mental score	Mean ± SD	27.47 ± 0.91	27.47 ± 1.18	27.20 ± 0.94	0.713
Affected side	Right	9 (60%)	10 (67%)	12 (80%)	0.484
	Left	6 (40%)	5 (33%)	3 (20%)	
Muscle power					
Elbow flexion	Mean ± SD	4.13 ± 0.51	4.13 ± 0.51	4.00 ± 0.65	0.759
Elbow extension	Mean ± SD	3.27 ± 0.45	3.47 ± 0.51	3.47 ± 0.51	0.453
Shoulder flexion	Mean ± SD	3.53 ± 0.64	3.53 ± 0.64	3.40 ± 0.51	0.782
Muscle tone according to Modified Ashworth scale					
Shoulder	Zero	6 (40%)	5 (33%)	8 (53%)	0.858
	1	6 (40%)	7 (47%)	5 (33%)	
	1+	3 (20%)	3 (20%)	2 (14%)	
Elbow	Zero	6 (40%)	7 (46%)	7 (47%)	0.951
	1	6 (40%)	4 (27%)	5 (33%)	
	1+	3 (20%)	4 (27%)	3 (20%)	
Wrist	Zero	8 (53%)	8 (53%)	8 (53%)	0.984
	1	3 (20%)	3 (20%)	4 (27%)	
	1+	4 (27%)	4 (27%)	3 (20%)	

SD: standard deviation, %: percentage, P-value: probability value, P > 0.05 non-significant

Results of box and block test (unaffected side)
Table 2. represents the mean values of box and block test (unaffected side) in groups A, B, and C.

Table 2. Comparison of mean values of box and block test within and between groups

Score of box and block test	Group A	Group B	Group C	p-value
Pre-treatment (Mean ± SD)	57.93 ± 8.38	58.33 ± 6.54	54.40 ± 6.81	0.278
Post-treatment (Mean ± SD)	58.80 ± 7.74	59.40 ± 6.47	54.49 ± 6.36	0.256
Mean difference	0.87	1.07	0.09	
Improvement%	1.50%	1.83%	0.17%	
P-value	0.617	0.753	0.981	

SD: standard deviation, %: percentage, P-value: probability value

Results of box and block test (affected side)
Table 3. and Figure 2. represent the mean values of box and block test (affected side) in groups A, B, and C. Statistical analysis by paired t-test revealed that there were significant pre- and post- treatment differences within all groups with percentage of improvement equal to 61.57, 74.81, and 21.91%, respectively (P = 0.0001). So, the alternating group (group B) improved box and block test (affected side) compared to EMG-triggered and control groups. Statistical analysis by ANOVA test revealed no significant difference before treatment (P = 0.973), while there was significant post-treatment difference (P = 0.011) among groups A, B, and C. Post-hoc LSD (least significant difference) test revealed significant post-treatment differences between group A versus group C (P = 0.040), and group B versus group C (P = 0.003), but no significant difference between group A versus group B (P = 0.333). Mean differences between groups showed that group B recorded the highest post-treatment results at the box and block test (affected side) as shown in Table 4.

Table 3. Comparison of mean values of box and block test within and between groups

Score of box and block test	Group A	Group B	Group C	p-value
Pre-treatment (Mean ± SD)	26.80 ± 16.01	27.67 ± 13.23	26.52 ± 12.36	0.973
Post-treatment (Mean ± SD)	43.30 ± 10.90	48.37 ± 14.48	32.33 ± 16.59	0.011*
Mean difference	16.50	20.70	5.81	
Improvement%	61.57%	74.81%	21.91%	
P-value	0.0001*	0.0001*	0.003*	

*SD: standard deviation, %: percentage, P-value: probability value, * significant (P < 0.05)*

Table 4. LSD-Post-hoc test for comparison of post treatment mean value of box and block test between groups A, B, and C

	Group A vs. Group B		Group A vs. Group C		Group B vs. Group C	
	Difference	P-value	Difference	P-value	Difference	P-value
Post-box and block (affected)	5.07	0.333	10.97	0.040*	16.05	0.003*

*SD: standard deviation, P-value: probability value, * significant (P < 0.05)*

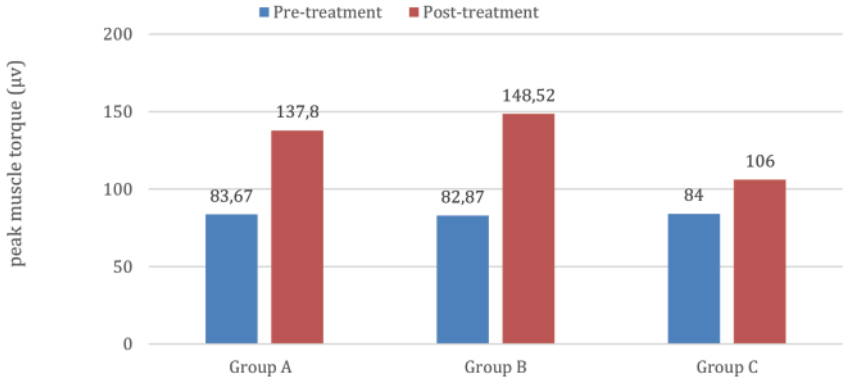


Figure 2. Comparison of mean values of box and block test within and between groups

Peak muscle torque (µv)

Table 5. and Figure 3. represent the mean values of peak muscle torque in groups A, B, and C. Statistical analysis by paired t-test revealed significant differences pre- and post- peak muscle torque within all groups with improvement percentage of 64.69, 79.22, and 26.19%, respectively (P = 0.0001). So, the alternating group (group B) improved peak muscle torque compared to EMG-triggered and control groups. Statistical analysis by ANOVA test revealed no significant difference before treatment (P = 0.973), while there was significant post-treatment difference (P = 0.011) among groups A, B, and C. Post-hoc LSD test revealed significant post-treatment differences between group A versus group C (P = 0.038), and group B versus group C (P = 0.007), but no significant difference between group A versus group B (P = 0.475). Mean differences between groups showed that group B recorded the highest post-treatment results at the peak muscle torque values as shown in Table 6.

Table 5. Comparison of mean values of peak muscle torque within and between groups

Score of peak muscle torque (µv)	Group A	Group B	Group C	p-value
Pre-treatment (Mean ± SD)	83.67 ± 31.73	82.87 ± 19.84	84.00 ± 33.47	0.998
Post-treatment (Mean ± SD)	137.80 ± 21.61	148.52 ± 39.99	106.00 ± 43.89	0.018*
Mean difference	54.13	65.65	22.00	
Improvement%	64.69%	79.22%	26.19%	
P-value	0.0001*	0.0001*	0.0001*	

*SD: standard deviation, %: percentage, P-value: probability value, * significant (P < 0.05)*

Table 4. LSD-Post-hoc test for comparison of post treatment mean value of box and block test between groups A, B, and C

	Group A vs. Group B		Group A vs. Group C		Group B vs. Group C	
	Difference	P-value	Difference	P-value	Difference	P-value
Post- peak muscle torque	10.72	0.475	31.80	0.038*	42.52	0.007*

*SD: standard deviation, P-value: probability value, * significant (P < 0.05)*

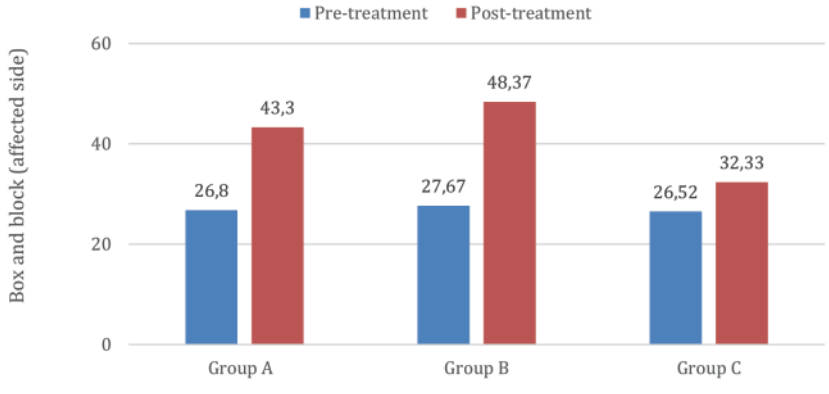


Figure 3. Comparison of mean values of peak muscle torque (µv) within and between groups

Discussion

Studies indicated that upper limb hemiparesis motor control is promoted through repetitive movement therapy mediated by surface neuromuscular electrical stimulation [24].

Data analysis revealed significant improvement in manual dexterity and peak muscle torque within each group after the treatment. The percentage of improvement was more significant in alternating electromyogram stimulation group compared to electromyogram-triggered and control groups.

Increments in the box and block test score and peak muscle torque for the EMG-NMES group agreed with the findings of Cauraugh et al [25] who reported that electromyography-triggered neuromuscular electrical stimulation group moved significantly more blocks in the box and block test, and displayed a higher isometric force impulse in force generation tasks (sustained muscular contraction) compared to the control group after the rehabilitation treatment. Kimberley et al [16] also recommended electromyography-triggered neuromuscular electrical stimulation to improve functional measures of motor performance. Assessment of arm using box and block test, Jebsen Taylor Hand Function Test, isometric finger extension strength, and self-rated motor activity log were all improved after the treatment program. Shin et al [17] also stated that electromyography-triggered neuromuscular electrical stimula-

tion showed significant improvement in four functional tests (box and block, accuracy index, strength, and the on/offset time of muscle contraction), after its application to wrist extensor of the hemiparetic hand in stroke patients. Hara et al [30] found that root mean square of target muscle EMG were significantly increased after combining electromyography with functional electric stimulation, which also improved active range of motion, spasticity, and hand performance. Moreover, Amasyali & Yaliman [15] found that EMG-stimulation was effective in improving upper limb function in stroke patients after comparing electromyography-triggered neuromuscular stimulation to mirror therapy. Fugl-Meyer motor scale, grip force, wrist extension range, and box and block test results improved after intervention.

The results of this study revealed that alternating electromyogram stimulation group had significant improvement in hand dexterity and peak muscle torque. To the best of our knowledge, no previous studies have been conducted on alternating electromyogram stimulation, and this is the first study in Egypt to apply electromyogram-triggered stimulation in stroke patients. The idea of alternating EMG-stimulation is based on "Before Task Performance" (Modeling Feedback). Modeling refers to the method of reproducing actions that another person has performed. Such demonstrations are powerful sources of information, given to the patient before the task performance, that provide the observer with the pattern and goal of the movement as well as information about the way such movements are coordinated and related to one another. Such information is difficult to put into words yet can be demonstrated easily through modeling feedback [31]. Delivering proprioceptive prescriptive information of hand movement with passive practice leads to significant improvement in active reproduction of this new motor skill [32]. Purely passive movement stimulates some brain areas that are also active during volitional movement. Passive training can also promote long term neural plasticity in both motor and sensory cortices of healthy subjects [33].

Improvement of hand dexterity and peak muscle torque after electromyogram-triggered stimulation and alternating electromyogram stimulation may be explained in view of active participation from the patient, as the patient is asked to extend the hand actively. Active participation leads to positive results compared to passive electric stimulation. Initiating motor actions voluntarily is known to be more effective in strengthening the muscles. Moreover, electromyogram-triggered stimulation and alternating electromyogram stimulation require cognitive involvement of the motor cortex [3]. Functional magnetic resonance imaging studies have shown that adding the cognitive component to active NMES exerts a positive effect on neuroplasticity [34].

A possible explanation that alternating electromyogram stimulation had the highest percentage of improvement after the treatment is that it introduces both the advantages of passive training (Modeling Feedback), provided by neuromuscular electrical stimulation, and augmented feedback (provided by EMG feedback), as the patient is asked to actively reach a targeted EMG biofeedback level after the passive movement.

Conclusion

Adding alternating electromyogram stimulation or electromyogram-triggered stimulation to a designed physical therapy program for hand function training improves hand function and peak muscle torque in chronic stroke patients. Alternating electromyogram stimulation was more effective than electromyogram-triggered stimulation.

Limitations of the study

The use of alternating electromyogram stimulation or electromyogram-triggered stimulation in addition to a designed physical therapy program for hand function training was effective in improving hand function in chronic stroke patients. Yet, there was no further follow-up taking place after the assessment, and this is considered a limitation that could be investigated in other research. Also, no sample size calculation was done because there have been previously no studies conducted on alternating electromyogram stimulation.

Adres do korespondencji / Corresponding author

Dany Alphonse Anwar Habib

E-mail: danyalphonse@gmail.com

Acknowledgements

I would like to offer special thanks to Dr. Ebtessam Khatab, who, although no longer with us, continues to inspire by her example and dedication to the students she served over the course of her career.

Piśmiennictwo/ References

1. Cheng SJ, Chen PH, Chen LA, et al. Stroke During Pregnancy and Puerperium: Clinical Perspectives. Taiwan J Obstet Gynecol. 2010; 49(4): 395-400.
2. Barreca S, Wolf SL, Fasoli S, et al. Treatment interventions for the paretic upper limb of stroke survivors: a critical review. Neurorehabil Neural Repair. 2003; 17: 220-226.
3. Kim Y. The effects of EMG-triggered functional electrical stimulation on upper extremity function in stroke patients. Phys Ther Rehabil Sci. 2013; 2(1): 1-6.
4. Connelly L, Jia Y, Toro ML, et al. Pneumatic Glove and Immersive Virtual Reality Environment for Hand Rehabilitative Training after Stroke. IEEE Engineering in Medicine and Biology Society. 2010; 18(5): 551-559.

5. Sharma P, Sutaria JM, and Zambare P. Effects of Neuromuscular Electrical Stimulation (NMES) on Hand Function in Stroke Patients. Indian Journal of Physiotherapy & Occupational Therapy. 2015; 9 (3): 43-48.
6. Hatem SM, Saussez G, Faille MD, et al. Rehabilitation of Motor Function after Stroke: A Multiple Systematic Review Focused on Techniques to Stimulate Upper Extremity Recovery. Front Hum Neurosci. 2016; 10: 442.
7. Molteni F, Rossini M, Gasperini G, et al. Wearable Hand Neuroprosthesis for Hand Rehabilitation after Stroke: Preliminary Results of the retrainer S2 Randomized Controlled Trial. Biosystems & Biorobotics. 2018; 21: 3-7.
8. Takeda K, Tanino G, and Miyasaka H. Review of devices used in neuromuscular electrical stimulation for stroke rehabilitation. Med Devices (Auckl). 2017; 10: 207-213.
9. Yang JD, Liao CD, Huang SW, et al. Effectiveness of electrical stimulation therapy in improving arm function after stroke: a systematic review and a meta-analysis of randomized controlled trials. Clin Rehabil. 2019; 33(8): 1286-1297.
10. Mrachacz-Kersting N, Jiang N, Stevenson AJT, et al. Efficient neuroplasticity induction in chronic stroke patients by an associative brain-computer interface. J Neurophysiol. 2016; 115: 1410-1421.
11. Biasiucci A, Leeb R, Iturrate I, et al. Brain-actuated functional electrical stimulation elicits lasting arm motor recovery after stroke. Nat Commun. 2018; 9: 2421.
12. Lindberg P, Schmitz C, Forssberg H, et al. Effects of passive-active movement training on upper limb motor function and cortical activation in chronic patients with stroke: a pilot study. J Rehabil Med. 2004; 36: 117-123.
13. French B, Thomas LH, Coupe J, et al. Repetitive task training for improving functional ability after stroke. Cochrane Database of Systematic Reviews 2016, Issue 11. Art. No.: CD006073.
14. Fritz SL, Chiu YP, Malcolm MP, et al. Feasibility of Electromyography-Triggered Neuromuscular Stimulation as an Adjunct to Constraint-Induced Movement Therapy. Physical Therapy. 2005; 85: 428-442.
15. Amasyali SY and Yaliman A. Comparison of the effects of mirror therapy and electromyography-triggered neuromuscular stimulation on hand functions in stroke patients: a pilot study. International Journal of Rehabilitation Research. 2016; 39: 302-307.
16. Kimberley TJ, Lewis SM, Auerbach EJ, et al. Electrical stimulation driving functional improvements and cortical changes in subjects with stroke. Exp Brain Res. 2004; 154(4): 450-460.
17. Shin HK, Cho SH, Jeon HS, et al. Cortical effect and functional recovery by the electromyography-triggered neuromuscular stimulation in chronic stroke patients. Neurosci Lett. 2008; 442: 174-179.
18. Kwakkel G, Winters C, van Wegen EE, et al. Effects of Unilateral Upper Limb Training in Two Distinct Prognostic Groups Early After Stroke: The Explicit-Stroke Randomized Clinical Trial. Neurorehabilitation and Neural Repair. 2016; 30(9): 804-816.
19. Monte-Silva K, Piscitelli D, Norouzi-Gheidari N, et al. Electromyogram-Related Neuromuscular Electrical Stimulation for Restoring Wrist and Hand Movement in Poststroke Hemiplegia: A Systematic Review and Meta-Analysis. Neurorehabil Neural Repair. 2019; 33(2): 96-111.
20. Thought Technology. MyoTrac Infiniti System: User Guide. Quebec, Canada. (2016).
21. Ranjan A, Raj Le, Kumar D, et al. Reliability of Box and Block Test for manual dexterity in patients with rheumatoid arthritis: a pilot study. International Journal of Rheumatic Diseases. 2016; 19: 1272-1277.
22. Ekstrand E, Lexell J, and Christina Brogårdh. Test−Retest Reliability and Convergent Validity of Three Manual Dexterity Measures in Persons with Chronic Stroke. PM R. 2016; 8(10): 935-943.
23. Li H, Zhao G, Zhou Y, et al. Relationship of EMG/SMG features and muscle strength level: an exploratory study on tibialis anterior muscles during plantar-flexion among hemiplegia patients. BioMedical Engineering OnLine. 2014; 13: 5.
24. Wilson RD, Page SJ, Delahanty M, et al. Upper-Limb Recovery after Stroke: A Randomized Controlled Trial Comparing EMG-Triggered, Cyclic, and Sensory Electrical Stimulation. Neurorehabilitation and Neural Repair. 2016; 30(10): 978-987.
25. Cauraugh J, Light K, Kim S, et al. Chronic Motor Dysfunction after Stroke Recovering Wrist and Finger Extension by Electromyography-Triggered Neuromuscular Stimulation. Stroke. 2000; 31: 1360-1364.
26. Kim SH, Park JH, Jung MY, et al. Effects of Task-Oriented Training as an Added Treatment to Electromyogram-Triggered Neuromuscular Stimulation on Upper Extremity Function in Chronic Stroke Patients. Occup. Ther. 2016; 23: 165-174.
27. Bellew JW, Michlovitz SL, and Nolan TP. Michlovitz's Modalities for Therapeutic Intervention. Clinical application. 6th ed. Philadelphia: F. A. Davis; 2016. p 417.
28. Kumar C and Gupta N. A Comparison between Task Oriented and Client-Centred Task-Oriented Approaches to Improve Upper Limb Functioning in People with Sub-Acute Stroke. J Nov Physiother. 2015; 5(5): 276-285.
29. Mann G, Taylor P, and Lane R. Accelerometer-Triggered Electrical Stimulation for Reach and Grasp in Chronic Stroke Patients: A Pilot Study. Neurorehabil Neural Repair. 2011; 25(8): 774-780.
30. Hara Y, Ogawa S, Tsujiuchi K, et al. A home-based rehabilitation program for the hemiplegic upper extremity by power-assisted functional electrical stimulation. Disabil Rehabil. 2008; 30: 296-304.
31. Muratori LM, Lamberg EM, Quinn L, et al. Applying principles of motor learning and control to upper extremity rehabilitation. J Hand Ther. 2013; 26(2): 94-103.
32. Beets IAM, Mace M, Meesen RLJ, et al. Active versus passive training of a complex bimanual task: Is prescriptive proprioceptive information sufficient for inducing motor learning? PLoS One. 2012; 7(5): 1-11.
33. Kahn LE, Zygman ML, Rymer WZ, et al. Robot-assisted reaching exercise promotes arm movement recovery in chronic hemiparetic stroke: a randomized controlled pilot study. Journal of NeuroEngineering and Rehabilitation. 2006; 3:12.
34. Boyaci A, Topuz O, Alkana H, et al. Comparison of the effectiveness of active and passive neuromuscular electrical stimulation of hemiplegic upper extremities: a randomized, controlled trial. International Journal of Rehabilitation Research. 2013; 36: 315-22.