Research publications

EGZO Tech

The content presented in this document, including those concerning our products, is intended for specialists working in medical industry – clinicians and health care professionals.

1

Introduction

The purpose of this document is to present research and publications regarding EGZOTech devices and their technologies. They were developed by EGZOTech employees or outsourced for development.

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List of publications

Assessment of Muscle Fatigue, Strength and Muscle Activation During Exercises with the Usage of Robot Luna EMG, Among Patients with Multiple Sclerosis

Krystyna Stańczyk[1], Anna Poświata[2], Anna Roksela[2], and Michał Mikulski[2]

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Abstract. Objective measurement of fatigability in patients with neurological diseases remains a problem rarely described in the research. The quick and easy assessment of muscle fatigue among patients with multiple sclerosis (MS) is a needed tool, which could be implemented as a standard test among those patients, to better plan and conduct physiotherapy. New devices, such as Luna EMG, allows to create precise environment, to carry out objective assessment and providing data based on strength and electromyography (EMG) measurement, especially median frequency (MDF), which is the standard parameter to indicate fatigue. The experiment was performed among 25 MS patients. Subjects were asked to perform 5 minutes isokinetic exercise of elbow flexion and extension and 2 minutes of isokinetic exercise of the same joint, with a 2 min break between. RMS value, median of frequency and its slope during exercise, was assessed for biceps and triceps brachii. The mean strength of both muscles were measured at the same time, accompanied by the automated counting of repetition. The correlation concerning triceps brachii has been found, between the amount of repetition in first exercise, with the slope of frequency in the first exercise (5 minutes isokinetic exercise). The same correlation for triceps brachii has been found for the second isokinetic exercise (2 minutes isokinetic exercise). For biceps brachii different correlation has occurred. The correlation between amount of repetition in 5 minutes isokinetic exercise and the slope in second (2 minutes) exercise has been noted. The mean strength during flexion for 5 minutes exercise was 11.20 Nm and 9.5 for extension. During 2 minutes exercise the mean values were 11.53 Nm and 10.18 Nm respectively. Assessment of MS patients performed with the usage of newest devices allows us to observe muscle fatigue, strength, muscle activation and relations between them among patients with MS. This quick test, accompanied by functional assessment can be a base for patient objective evaluation and a good foundation for planning and controlling training, in terms of muscle fatigue, applied force, muscle activation and coordination.

Keywords: sclerosis multiplex (MS), fatigue, exercise, sEMG

3.1. Luna EMG

3.1.1. Assessment of Muscle Fatigue, Strength and Muscle Activation During Exercises with the Usage of Robot Luna EMG, Among Patients with Multiple Sclerosis.

Goal:

The main goal of the study was to create and test a special protocol, using innovative device, such as Luna EMG, to assess fatigue and other related factors among patients with multiple sclerosis.

Conclusion:

Technologies can provide valid, reliable and sensitive assessment tools that, when used alongside clinical measures, can inform clinical decision-making and provide richer data on patient outcomes. There is now a clear need for guidelines for clinicians and researchers to optimize technology-based assessment and application of clinical measures and procedures.

Cit.:

Stańczyk, K., Poświata, A., Roksela, A., Mikulski, M. (2019). *Assessment of Muscle Fatigue, Strength and Muscle Activation During Exercises with the Usage of Robot Luna EMG, Among Patients with Multiple Sclerosis.* In: Pietka, E., Badura, P., Kawa, J., Wieclawek, W. (eds) *Information Technology in Biomedicine. ITIB 2019. Advances in Intelligent Systems and Computing, vol 1011. Springer, Cham.*

https://link.springer.com/chapter/10.1007/978-3-030-23762-2_11

3

List of publications

medicina

MDPI

Article

The Influence of EMG-Triggered Robotic Movement on Walking, Muscle Force and Spasticity after an Ischemic Stroke

Patrycja Lewandowska-Sroka [1], Rafał Stabrawa [1], Dominika Kozak [2,*], Anna Poświata [2], Barbara Łysoń-Uklańska [3], Katarzyna Bienias [3], Anna Roksela [4], Marcin Kliś [4] and Michał Mikulski [2]

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Abstract: *Background and Objectives*: Application of the EMG-driven robotic training in everyday therapeutic processes is a modern and innovative form of neurorehabilitation among patients after stroke. Active participation of the patient contributes to significantly higher activation of the sensorimotor network during active motor control rather than during passive movement. The study objective was to determine the effect of electromyographic triggering (EMG-triggered) robotic rehabilitation device treatment on walking, muscle force, and spasticity after an ischemic stroke. *Materials and Methods*: A total of 60 participants with impaired motor function and gait after subacute stroke were included in the study. Each patient was randomly assigned to an intervention or control group (IG or CG). All patients, except standard therapy, underwent 1 additional session of therapy per day, 5 days a week for 6 weeks. IG had 30 min of training on the robot, while CG received exercises on the lower limb rotor. The subjects were assessed with Timed Up and Go Test (TUG), Ashworth scale, knee range of motion (ROM), Lovett Scale, and tight circumference at baseline and at weeks 2, 4, and 6. *Results*: For seven parameters, the values credibly increased between consecutive measurements, and for the Ashworth scale, they credibly decreased. The biggest changes were observed for the measurements made with Lovett scale. The average thigh circumference as measured 5 and 15 cm above the knee increased credibly more in the robot condition, as compared to control condition. Additionally, the decrease in Ashworth values over time, although statistically credible in both groups, was credibly higher in the robot condition. *Conclusion*: The inclusion of the EMG-triggered neurorehabilitation robot in the patient's daily rehabilitation plan has a positive effect on outcomes of the treatment. Both proposed rehabilitation protocols significantly improved patients' condition regarding all measured outcomes, but the spasticity and thigh circumference improved significantly better in the robotic group in comparison to controls.

Keywords: stroke; rehabilitation; EMG-triggered; rehabilitation robot; spasticity; mobility; gait

check for updates

Citation: Lewandowska-Sroka, P.; Stabrawa, R.; Kozak, D.; Poświata, A.; Łysoń-Uklańska, B.; Bienias, K.; Roksela, A.; Kliś, M.; Mikulski, M. The Influence of EMG-Triggered Robotic Movement on Walking, Muscle Force and Spasticity after an Ischemic Stroke. *Medicina* **2021**, *57*, 227. https://doi.org/10.3390/medicina57030227

Academic Editor: Francisco Purroy

Received: 13 January 2021
Accepted: 25 February 2021
Published: 2 March 2021

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1. Introduction

Stroke is currently one of the most important health problems in the adult population worldwide, for both medical and social reasons. Almost one third of deaths in the world are caused by strokes [1]. Motor skills are one of the most important areas affected by stroke. Patients may experience a variety of disabilities in different body parts and different hemispheres can be affected. The most common impairments of the early stages of stroke are weakness and paresis, which may lead to a learned nonuse of limbs. Sensory impairments, chronic pain, and immobility of the patient in the early stages after stroke

3.1.2. The Influence of EMG-Triggered Robotic Movement on Walking, Muscle Force and Spasticity after an Ischemic Stroke.

Goal:

The aim of the study was to determine the effect of electromyographic triggering (EMG-triggered) robotic rehabilitation device treatment on walking, muscle force, and spasticity after an ischemic stroke.

Conclusion:

Using EMG triggered therapy in rehabilitation of stroke patients provides a possibility to learn how to use these preserved pathways. After a treatment, a patient is able to better control the muscle tone. This accelerates the motor function recovery, which allows for regaining the functional efficiency after a stroke.

Cit.:

Lewandowska-Sroka, Patrycja, Rafał Stabrawa, Dominika Kozak, Anna Poświata, Barbara Łysoń-Uklańska, Katarzyna Bienias, Anna Roksela, Marcin Kliś, and Michał Mikulski. *The influence of EMG-triggered robotic movement on walking, muscle force and spasticity after an ischemic stroke. Medicina 57, no. 3 (2021): 227*

https://www.mdpi.com/1648-9144/57/3/227

3

List of publications

diagnostics

MDPI

Article

The Relationship between the Static and Dynamic Balance of the Body, the Influence of Eyesight and Muscle Tension in the Cervical Spine in CAA Patients—A Pilot Study

Anna Olczak [1,2,*], Aleksandra Truszczyńska-Baszak [3] and Katarzyna Gniadek-Olejniczak [1]

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Abstract: Cerebral amyloid angiopathy (CAA) is one form of disease of the small vessels of the brain and can cause frequent cerebral hemorrhages as well as other types of stroke. The aim of the study was to analyze the static and dynamic balance of the body and changes in the tension of selected muscles of the cervical spine in patients with CAA after stroke, depending on visual control or its absence, compared to healthy volunteers. Eight stroke patients and eight healthy subjects were examined. The functional Unterberger test and the Biodex SD platform were used to test the dynamic equilibrium, on which the static equilibrium was also assessed. Muscle tension was tested with the Luna EMG device. In static tests, the LC muscle (longus colli) was significantly more active with and without visual control ($p = 0.016$; $p = 0.002$), and in dynamic tests, significantly higher results for MOS ($p = 0.046$) were noted. The comparison of the groups led to the conclusion that the more functional deficits, the more difficult it is to keep balance, also with eye control.

Keywords: stroke; CAA (Cerebral Amyloid Angiopathy); balance; muscle tension; vision

check for updates

Citation: Olczak, A.; Truszczyńska-Baszak, A.; Gniadek-Olejniczak, K. The Relationship between the Static and Dynamic Balance of the Body, the Influence of Eyesight and Muscle Tension in the Cervical Spine in CAA Patients—A Pilot Study. *Diagnostics* **2021**, *11*, 2036. https://doi.org/10.3390/diagnostics11112036

Academic Editors: Raffaele Nardone and Federico Piceri

Received: 30 September 2021
Accepted: 1 November 2021
Published: 3 November 2021

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1. Introduction

Cerebral amyloid angiopathy (CAA) is one of the forms of diseases of the small vessels of the brain. It causes the deposition of β-amyloid protein in the wall of arterioles, capillaries and venous vessels located in the cerebral cortex and the soft dura. The prevalence of CAA is very age dependent. From 2.3 percent in patients aged 65 to 74 years, from 12.1 percent in patients aged 85 and over [1]. Cerebral amyloid angiopathy is asymptomatic or with symptoms such as intracerebral hemorrhage, cognitive impairment or dementia [2,3]. Similar to Alzheimer's disease, it is a degenerative disease of the group of diseases called amyloidopathy. It is a disease of old age and is the second most common (after atherosclerosis) cause of recurrent cerebral haemorrhages [4–18]. CAA is relatively most common in the occipital, frontal, temporal and parietal lobes. The cerebellum is most rarely involved, and it is practically absent in the basal ganglia, thalamus, white matter and brainstem. CAA is characterized by a variable course and a chronically progressive disease process [19,20].

In our work, we present a group of stroke patients diagnosed with CAA. Stroke as well as other neurological conditions such as Alzheimer's disease, Parkinson's disease and syndrome, peripheral neuropathies, epilepsy, migraine, multiple sclerosis, etc., are disorders related to imbalance. It should also be remembered that aging has a large effect on the equilibrium system [7,21,22].

Balance disorders are one of the most common problems in adults (affecting 20–30% of the population) [23–25]. Of this, women and people from the geriatric group report the problem twice as often [26,27].

3.1.3. The Relationship between the Static and Dynamic Balance of the Body, the Influence of Eyesight and Muscle Tension in the Cervical Spine in CAA Patients—A Pilot Study.

Goal:

The aim of the study was to assess the ability to maintain static and dynamic balance of the body and the distribution of muscle tension in the cervical spine, depending on the eye control, in CAA patients and healthy volunteers.

Conclusion:

The Luna EMG rehabilitation device was used to assess muscle tone. Eyesight plays an important role in controlling the balance. especially in healthy. The more functional deficits the more difficult it is to restore balance also with eye control.

Cit.:

Olczak, A.; Truszczyńska-Baszak, A.; Gniadek-Olejniczak, K. *The Relationship between the Static and Dynamic Balance of the Body, the Influence of Eyesight and Muscle Tension in the Cervical Spine in CAA Patients—A Pilot Study. Diagnostics 2021, 11, 2036.*

https://www.mdpi.com/2075-4418/11/11/2036

3

List of publications

Journal of Clinical Medicine

MDPI

Article

Influence of the Passive Stabilization of the Trunk and Upper Limb on Selected Parameters of the Hand Motor Coordination, Grip Strength and Muscle Tension, in Post-Stroke Patients

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Abstract: Objective: Assessment of the influence of a stable trunk and the affected upper limb (dominant or non-dominant) on the parameters of the wrist and hand motor coordination, grip strength and muscle tension in patients in the subacute post-stroke stage compared to healthy subjects. Design: An observational study. Setting: Stroke Rehabilitation Department. Subjects: Thirty-four subjects after ischemic cerebral stroke and control group-32 subjects without neurological deficits, age and body mass/ height matched were included. Main measures: The tone of the multifidus, transverse abdominal and supraspinatus muscles were assessed by Luna EMG device. A HandTutor device were used to measure motor coordination parameters (e.g., range of movement, frequency of movement), and a manual dynamometer for measuring the strength of a hand grip. Subjects were examined in two positions: sitting without back support (non-stabilized) and lying with stabilization of the trunk and the upper limb. Results: Passive stabilization of the trunk and the upper extremity caused a significant improvement in motor coordination of the fingers ($p < 0.001$) and the wrist ($p < 0.001$) in patients after stroke. Improved motor coordination of the upper extremity was associated with an increased tone of the supraspinatus muscle. Conclusions: Passive stabilization of the trunk and the upper limb improved the hand and wrist coordination in patients following a stroke. Placing patients in a supine position with the stability of the affected upper limb during rehabilitation exercises may help them to access latent movement patterns lost due to neurological impairment after a stroke.

Keywords: cerebral stroke; hand rehabilitation; core stability; muscle tone; motor coordination

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Citation: Olczak, A.; Truszczyńska-Baszak, A. Influence of the Passive Stabilization of the Trunk and Upper Limb on Selected Parameters of the Hand Motor Coordination, Grip Strength and Muscle Tension, in Post-Stroke Patients. *J. Clin. Med.* **2021**, *10*, 2402. https://doi.org/10.3390/jcm10112402

Academic Editors: Tissa Wijeratne, Hugues Chabriat and Lindsay A. Farrer

Received: 23 March 2021
Accepted: 27 May 2021
Published: 29 May 2021

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1. Introduction

Up to 50% of patients report impaired upper limb and hand function following a stroke [1–3]. Unfortunately, functional restoration of the upper extremity requires a long-lasting physiotherapy and often fails to meet patients' expectations [4,5]. Thus, it is important to develop new therapies to improve the motor function of the upper extremity in stroke patients [6–11].

The stabilization of the human body is the basis for maintaining balance and makes it possible to perform selective, coordinated movements with parts of the body [12–17]. There are several elements to the body's stability: central stabilization, which concerns the proper tension and work of the deep muscles of the trunk, and a stable trunk [16–18]. According to Bobath's concept, a stable trunk is a counterbalance to the movements of all limbs [19,20]. It is very important that the trunk is stable and mobile at the same time, because only then can any selective movement be made [15,19,21]. In addition to arm and hand motor function deficits, trunk movement coordination disorders have been observed in patients with stroke [22]. In particular, movement of the lower limb is associated with contraction

3.1.4. Influence of the Passive Stabilization of the Trunk and Upper Limb on selected Parameters of the Hand Motor Coordination, Grip Strength and Muscle Tension, in Post-Stroke Patients.

Goal:

The aim of the study was to evaluate the influence of the stable position of the trunk and upper limb on the parameters of hand and wrist movement coordination, grip strength and muscle tension in subacute post-stroke patients compared to healthy subjects. The aim of the study was also to evaluate the parameters of the affected upper limb depending on whether the examined limb was dominant or non-dominant.

Conclusion:

Study found that passive stabilization of the shoulder in addition to the trunk during stroke rehabilitation is important to restore the correct movement pattern and regain function of the hand.

Cit.:

Olczak A, Truszczyńska-Baszak A. *Influence of the Passive Stabilization of the Trunk and Upper Limb on Selected Parameters of the Hand Motor Coordination, Grip Strength and Muscle Tension, in Post-Stroke Patients. J Clin Med. 2021 May 29;10(11):2402.*

https://www.mdpi.com/2077-0383/10/11/2402

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List of publications

International Journal of Environmental Research and Public Health

MDPI

Article

A Reliability of Active and Passive Knee Joint Position Sense Assessment Using the Luna EMG Rehabilitation Robot

Lukasz Oleksy [1,2,*], Aleksandra Królikowska [3], Anna Mika [4], Paweł Reichert [5], Monika Kentel [6], Maciej Kentel [6], Anna Poświata [7], Anna Roksela [8], Dominika Kozak [7], Katarzyna Bienias [7], Marcel Smoliński [8], Artur Stolarczyk [9] and Michał Mikulski [7]

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Citation: Oleksy, Ł.; Królikowska, A.; Mika, A.; Reichert, P.; Kentel, M.; Kentel, M.; Poświata, A.; Roksela, A.; Kozak, D.; Bienias, K.; et al. A Reliability of Active and Passive Knee Joint Position Sense Assessment Using the Luna EMG Rehabilitation Robot. *Int. J. Environ. Res. Public Health* **2022**, *19*, 15885. https://doi.org/10.3390/ijerph192315885

Academic Editors: Álvaro Campos Cavalcanti Maciel and Ricardo Oliveira Guerra

Received: 22 October 2022
Accepted: 25 November 2022
Published: 29 November 2022

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Abstract: Joint position sense (JPS) is the awareness of joint location in space, indicating accuracy and precision of the movement. Therefore, the aim of the present study is to determine the reliability of active and passive JPS assessment regarding the knee joint. This was carried out using the Luna EMG rehabilitation robot. Further analysis assessed whether the examination of only the dominant site is justified and if there are differences between sites. The study comprised 24 healthy male participants aged 24.13 ± 2.82 years, performing sports at a recreational level. Using the Luna EMG rehabilitation robot, JPS tests were performed for the right and left knees during flexion and extension in active and passive mode, in two separate sessions with a 1-week interval. Both knee flexion and extension in active and passive modes demonstrated high reliability (ICC = 0.866–0.982; SEM = 0.63–0.31). The mean JPS angle error did not differ significantly between the right and left lower limbs ($p < 0.05$); however, no between-limb correlation was noted ($r = 0.21–0.34$; $p > 0.05$). The Bland–Altman plots showed that the between-limb bias was minimal, with relatively wide limits of agreement. Therefore, it was concluded that the Luna EMG rehabilitation robot is a reliable tool for active and passive knee JPS assessment. In our study, JPS angle error did not differ significantly between left and right sides; however, the slight asymmetry was observed (visible in broad level of agreement exceeding 5° in Bland–Altman plots), what may suggest that in healthy subjects, e.g., active athletes, proprioception should always be assessed on both sides.

Keywords: biomedical monitoring; joint position sense; knee; patient monitoring; physiotherapy; proprioception; rehabilitation robotics; reliability; symmetry

1. Introduction

Proprioception of the knee plays a crucial role in maintaining joint stability and coordination during motion [1,2]. Joint position sense (JPS) is awareness of joint location in space, indicating the accuracy and precision of movement [3,4]. Proprioceptive sensory impairment may result from neurological disorders [5,6], chronic soft-tissue diseases [7,8], or neuropathic and orthopaedic conditions [9,10]. Joint position reproduction is the most

3.1.5. A Reliability of Active and Passive Knee Joint Position Sense Assessment using the Luna EMG Rehabilitation Robot.

Goal:

The aim of the study was to determine the reliability of active and passive JPS assessment in the knee joint using the Luna EMG rehabilitation robot. As the second aim, this study is the first to assess whether examining only the dominant limb is justified and if there are any between-limb differences in either active or passive modes.

Conclusion:

Luna EMG rehabilitation robot is a reliable tool for JPS assessment in both knee flexion and extension, in active and passive modes as well on the right as on the left sides.

Cit.:

Oleksy, Ł.; Królikowska, A.; Mika, A.; Reichert, P.; Kentel, M.; Kentel, M.; Poświata, A.; Roksela, A.; Kozak, D.; Bienias, K.; et al. *A Reliability of Active and Passive Knee Joint Position Sense Assessment Using the Luna EMG Rehabilitation Robot. Int. J. Environ. Res. Public Health 2022, 19, 15885.*

https://www.mdpi.com/1660-4601/19/23/15885

3

List of publications

3.1.6. Importance of core stability for coordinated movement of the human body in stroke rehabilitation.

Goal:

The aim of the study was to examine the effect of core stability on parameters of coordinated movement of the trunk and lower extremities in post-stroke rehabilitation.

Conclusion:

Muscle tensions were generally lower in post-stroke patients compared to those with lower back pain syndrome but active abdominal tension muscles caused the increase of core stability and alter the trunk movement path, and improves gait and range of movement. Core stability training during stroke rehabilitation may help patients to achieve a higher level of coordinated movement.

Cit.:

Anna Olczak (2022) *Importance of core stability for coordinated movement of the human body in stroke rehabilitation, Neurological Research, 44:1, 7-13*

https://www.tandfonline.com/doi/abs/10.1080/01616412.2021.1950952?journalCode=yner20

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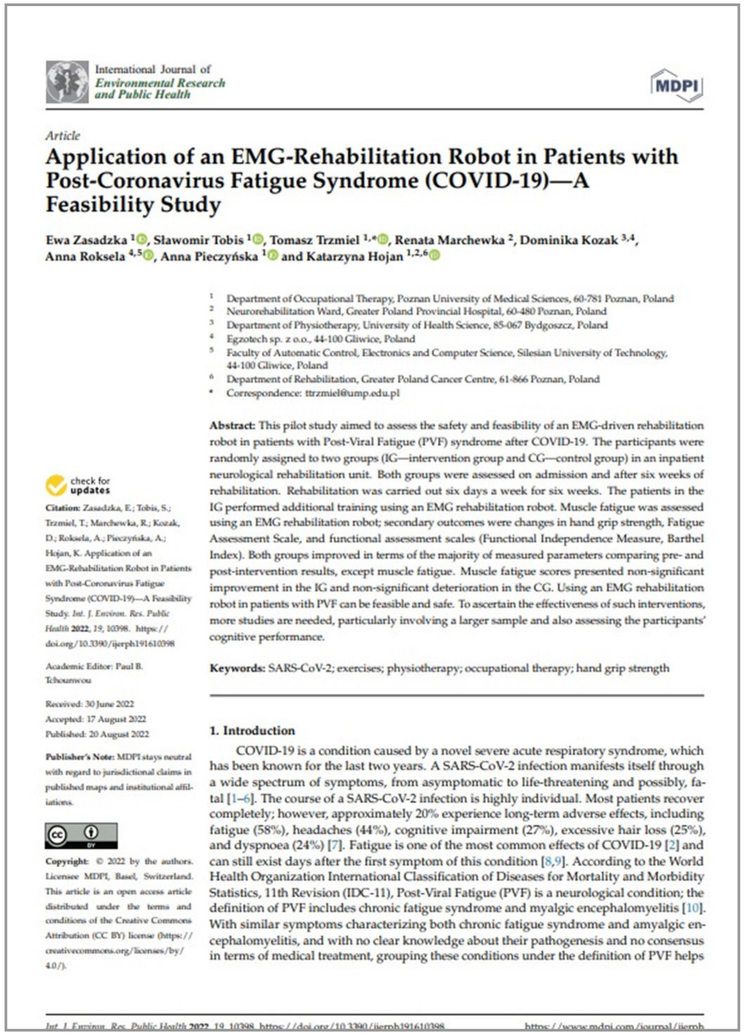
List of publications



International Journal of Environmental Research and Public Health

MDPI

Article

Application of an EMG-Rehabilitation Robot in Patients with Post-Coronavirus Fatigue Syndrome (COVID-19)—A Feasibility Study

Ewa Zasadzka [1], Sławomir Tobis [1], Tomasz Trzmiel [1,*], Renata Marchewka [2], Dominika Kozak [3,4], Anna Roksela [4,5], Anna Pieczyńska [1] and Katarzyna Hojan [1,2,6]

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Abstract: This pilot study aimed to assess the safety and feasibility of an EMG-driven rehabilitation robot in patients with Post-Viral Fatigue (PVF) syndrome after COVID-19. The participants were randomly assigned to two groups (IG—intervention group and CG—control group) in an inpatient neurological rehabilitation unit. Both groups were assessed on admission and after six weeks of rehabilitation. Rehabilitation was carried out six days a week for six weeks. The patients in the IG performed additional training using an EMG rehabilitation robot. Muscle fatigue was assessed using an EMG rehabilitation robot; secondary outcomes were changes in hand grip strength, Fatigue Assessment Scale, and functional assessment scales (Functional Independence Measure, Barthel Index). Both groups improved in terms of the majority of measured parameters comparing pre- and post-intervention results, except muscle fatigue. Muscle fatigue scores presented non-significant improvement in the IG and non-significant deterioration in the CG. Using an EMG rehabilitation robot in patients with PVF can be feasible and safe. To ascertain the effectiveness of such interventions, more studies are needed, particularly involving a larger sample and also assessing the participants' cognitive performance.

Keywords: SARS-CoV-2; exercises; physiotherapy; occupational therapy; hand grip strength

check for updates

Citation: Zasadzka, E.; Tobis, S.; Trzmiel, T.; Marchewka, R.; Kozak, D.; Roksela, A.; Pieczyńska, A.; Hojan, K. Application of an EMG-Rehabilitation Robot in Patients with Post-Coronavirus Fatigue Syndrome (COVID-19)—A Feasibility Study. *Int. J. Environ. Res. Public Health* **2022**, *19*, 10398. https://doi.org/10.3390/ijerph191610398

Academic Editor: Paul B. Tchounwou

Received: 30 June 2022
Accepted: 17 August 2022
Published: 20 August 2022

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1. Introduction

COVID-19 is a condition caused by a novel severe acute respiratory syndrome, which has been known for the last two years. A SARS-CoV-2 infection manifests itself through a wide spectrum of symptoms, from asymptomatic to life-threatening and possibly, fatal [1–6]. The course of a SARS-CoV-2 infection is highly individual. Most patients recover completely; however, approximately 20% experience long-term adverse effects, including fatigue (58%), headaches (44%), cognitive impairment (27%), excessive hair loss (25%), and dyspnoea (24%) [7]. Fatigue is one of the most common effects of COVID-19 [2] and can still exist days after the first symptom of this condition [8,9]. According to the World Health Organization International Classification of Diseases for Mortality and Morbidity Statistics, 11th Revision (IDC-11), Post-Viral Fatigue (PVF) is a neurological condition; the definition of PVF includes chronic fatigue syndrome and myalgic encephalomyelitis [10]. With similar symptoms characterizing both chronic fatigue syndrome and amyalgic encephalomyelitis, and with no clear knowledge about their pathogenesis and no consensus in terms of medical treatment, grouping these conditions under the definition of PVF helps

3.1.7. Application of an EMG-Rehabilitation Robot in Patients with Post-Coronavirus Fatigue Syndrome (COVID-19)—A Feasibility Study.

Goal:

The aim of the study was to assess the safety and feasibility of the use of an EMG-Rehabilitation Robot in exercises performed by Post-COVID patients with PVF.

Conclusion:

The study demonstrated that implementing an EMG robot-rehabilitation protocol in PVF patients is feasible and safe. In this pilot study, the feasibility of the concept of using the EMG—rehabilitation robot in exercises for patients with PVF syndrome was verified positively.

Cit.:

Zasadzka E, Tobis S, Trzmiel T, Marchewka R, Kozak D, Roksela A, Pieczyńska A, Hojan K. *Application of an EMG-Rehabilitation Robot in Patients with Post-Coronavirus Fatigue Syndrome (COVID-19)-A Feasibility Study. Int J Environ Res Public Health. 2022 Aug 20;19(16):10398.*

https://www.mdpi.com/1660-4601/19/16/10398

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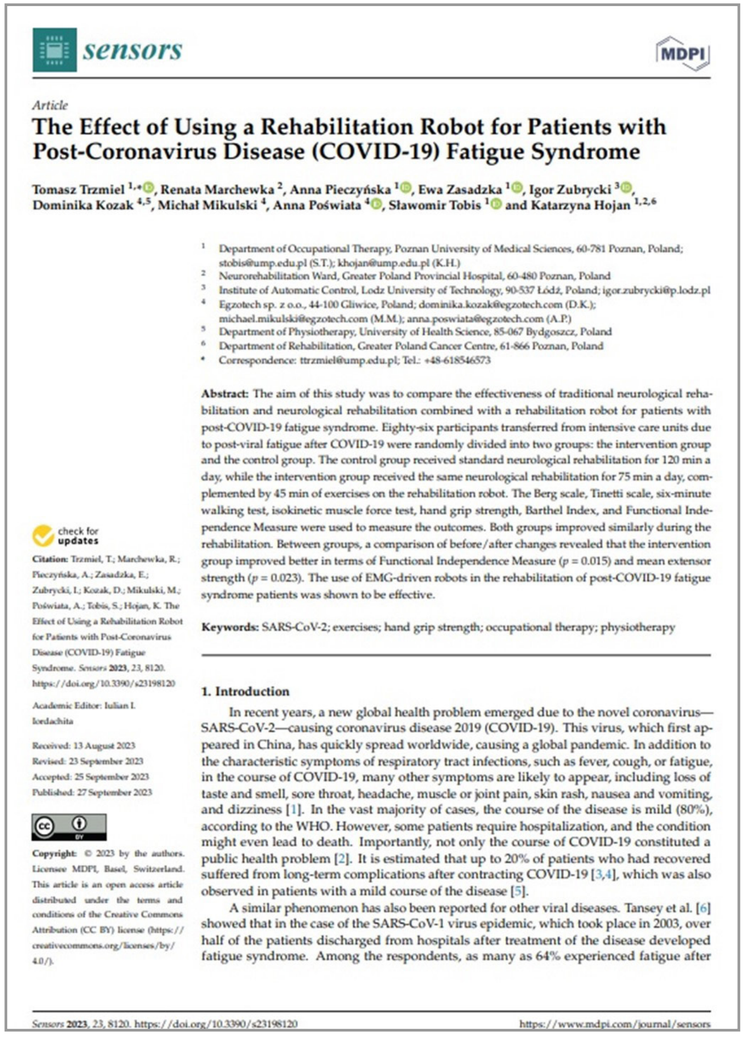
List of publications



sensors

MDPI

Article

The Effect of Using a Rehabilitation Robot for Patients with Post-Coronavirus Disease (COVID-19) Fatigue Syndrome

Tomasz Trzmiel [1,*], Renata Marchewka [2], Anna Pieczyńska [1], Ewa Zasadzka [1], Igor Zubrycki [3], Dominika Kozak [4,5], Michał Mikulski [4], Anna Poświata [4], Sławomir Tobis [1] and Katarzyna Hojan [1,2,6]

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Abstract: The aim of this study was to compare the effectiveness of traditional neurological rehabilitation and neurological rehabilitation combined with a rehabilitation robot for patients with post-COVID-19 fatigue syndrome. Eighty-six participants transferred from intensive care units due to post-viral fatigue after COVID-19 were randomly divided into two groups: the intervention group and the control group. The control group received standard neurological rehabilitation for 120 min a day, while the intervention group received the same neurological rehabilitation for 75 min a day, complemented by 45 min of exercises on the rehabilitation robot. The Berg scale, Tinetti scale, six-minute walking test, isokinetic muscle force test, hand grip strength, Barthel Index, and Functional Independence Measure were used to measure the outcomes. Both groups improved similarly during the rehabilitation. Between groups, a comparison of before/after changes revealed that the intervention group improved better in terms of Functional Independence Measure ($p = 0.015$) and mean extensor strength ($p = 0.023$). The use of EMG-driven robots in the rehabilitation of post-COVID-19 fatigue syndrome patients was shown to be effective.

Keywords: SARS-CoV-2; exercises; hand grip strength; occupational therapy; physiotherapy

check for updates

Citation: Trzmiel, T.; Marchewka, R.; Pieczyńska, A.; Zasadzka, E.; Zubrycki, I.; Kozak, D.; Mikulski, M.; Poświata, A.; Tobis, S.; Hojan, K. The Effect of Using a Rehabilitation Robot for Patients with Post-Coronavirus Disease (COVID-19) Fatigue Syndrome. *Sensors* **2023**, *23*, 8120. https://doi.org/10.3390/s23198120

Academic Editor: Iulian I. Iordachita

Received: 13 August 2023
Revised: 23 September 2023
Accepted: 25 September 2023
Published: 27 September 2023

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1. Introduction

In recent years, a new global health problem emerged due to the novel coronavirus—SARS-CoV-2—causing coronavirus disease 2019 (COVID-19). This virus, which first appeared in China, has quickly spread worldwide, causing a global pandemic. In addition to the characteristic symptoms of respiratory tract infections, such as fever, cough, or fatigue, in the course of COVID-19, many other symptoms are likely to appear, including loss of taste and smell, sore throat, headache, muscle or joint pain, skin rash, nausea and vomiting, and dizziness [1]. In the vast majority of cases, the course of the disease is mild (80%), according to the WHO. However, some patients require hospitalization, and the condition might even lead to death. Importantly, not only the course of COVID-19 constituted a public health problem [2]. It is estimated that up to 20% of patients who had recovered suffered from long-term complications after contracting COVID-19 [3,4], which was also observed in patients with a mild course of the disease [5].

A similar phenomenon has also been reported for other viral diseases. Tansey et al. [6] showed that in the case of the SARS-CoV-1 virus epidemic, which took place in 2003, over half of the patients discharged from hospitals after treatment of the disease developed fatigue syndrome. Among the respondents, as many as 64% experienced fatigue after

3.1.8. The Effect of Using a Rehabilitation Robot for Patients with Post-Coronavirus Disease (COVID-19) Fatigue Syndrome.

Goal:

The aim of this study was to compare the effectiveness of traditional neurological rehabilitation against neurological rehabilitation combined with a rehabilitation robot for patients with post-COVID-19 fatigue syndrome.

Conclusion:

In light of the results of the present study, implementing EMG-driven robots in the rehabilitation of post-COVID-19 fatigue syndrome patients is effective. Substituting a part of traditional rehabilitation with robotic rehabilitation did not negatively alter rehabilitation outcomes. Our results indicate that the implementation of robotic rehabilitation for patients with post-coronavirus fatigue syndrome in rehabilitation programs can be supported.

Cit.:

Trzmiel, T.; Marchewka, R.; Pieczyńska, A.; Zasadzka, E.; Zubrycki, I.; Kozak, D.; Mikulski, M.; Poświata, A.; Tobis, S.; Hojan, K. *The Effect of Using a Rehabilitation Robot for Patients with Post-Coronavirus Disease (COVID-19) Fatigue Syndrome. Sensors 2023, 23, 8120.*

https://www.mdpi.com/1424-8220/23/19/8120

3

List of publications

Evaluation of Neurological Disorders in Isokinetic Dynamometry and Surface Electromyography Activity of Biceps and Triceps Muscles

Anna Roksela[1,2][0000-0002-5286-4586], Anna Poświata[2], Jarosław Śmieja[3][0000-0002-6120-4424], Dominika Kozak[2][0000-0001-8741-4166], Katarzyna Bienias[2], Jakub Ślaga[4], and Michał Mikulski[2]

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Abstract. Diagnosing neurological disorders and tracking rehabilitation progress requires objective, quantitative measures. Isokinetic exercises are commonly employed to evaluate muscle strength and activity. However, repetitive, quantitative assessment of the tests performed during these exercises can be difficult, especially for patients with neurological disorders. Usually, either dynamometric or sEMG measurements are used. This study is concerned with the evaluation of the applicability and reliability of these two measurement techniques, based on analysis of elbow flexion and extension supported by the Luna EMG rehabilitation robot, aimed at the evaluation of the activity of the biceps and triceps muscles. Dynamometric and surface electromyography measurements are compared with respect to their repeatability between sessions and days, and their ability to differentiate impaired limbs from healthy ones.

Keywords: rehabilitation robotics, neurological disorders, electromyography, dynamometry, isokinetic tests

1 Introduction

Stroke is ranked as the second leading cause of death worldwide, however, the high morbidity also results in 50 % of survivors suffering from chronic disability [1]. One of the most important areas affected by stroke is motor skills. Precise, sensitive muscle strength and activity testing methods are needed to evaluate muscle functioning in patients with neurological disorders. Biomedical engineering provides valid, reliable, and sensitive evaluation tools that, when used alongside clinical measures, can support clinical decision-making and supply richer

3.1.9. Evaluation of Neurological Disorders in Isokinetic Dynamometry and Surface Electromyography Activity of Biceps and Triceps Muscles.

Goal:

Study is concerned with the evaluation of the applicability and reliability of these two measurement techniques, based on analysis of elbow flexion and extension supported by the Luna EMG rehabilitation robot, aimed at the evaluation of the activity of the biceps and triceps muscles.

Conclusion:

Study has highlighted the promise and challenges of using the isokinetic dynamometry and surface electromyography test to evaluate muscle strength and activity. Isokinetic testing with a rehabilitation robot, facilitating both types of measurements is recommended to provide outcome measures for the progress evaluation of neurological disorders, valuable for clinicians.

Cit.:

Roksela, A.; Poświata, A.; Śmieja, J.; Kozak, D.; Bienias, K.; Ślaga, J.; Mikulski, M. *Evaluation of Neurological Disorders in Isokinetic Dynamometry and Surface Electromyography Activity of Biceps and Triceps Muscles.* In: Strumiłło, P., Klepaczko, A., Strzelecki, M., Bociąga, D. (eds) *The Latest Developments and Challenges in Biomedical Engineering. PCBEE 2023. Lecture Notes in Networks and Systems, vol 746. Springer, Cham. https://doi.org/10.1007/978-3-031-38430-1_25*

https://link.springer.com/chapter/10.1007/978-3-031-38430-1_25#citeas

3

List of publications

AKADEMIA WYCHOWANIA FIZYCZNEGO IM. BRONISŁAWA CZECHA
W KRAKOWIE

WYDZIAŁ REHABILITACJI RUCHOWEJ

Iwona Sihinkiewicz

DT-415

ROZPRAWA DOKTORSKA

Opracowana w Instytucie Rehabilitacji Klinicznej
na Wydziale Rehabilitacji Ruchowej
Akademii Wychowania Fizycznego w Krakowie

Wpływ treningu z wykorzystaniem robota Luna EMG na aktywność mięśniową, równowagę i wybrane parametry chodu pacjentów po udarze niedokrwiennym mózgu

Promotor: prof. dr hab. Joanna Golec

Promotor pomocniczy: dr Rafał Stabrawa

Kraków, 2023

3.1.10. The impact of training with the Luna EMG usage on muscle activity, balance and selected gait parameters of patients after ischemic stroke.

Goal:

The aim of the study was to assess the impact of affected lower limb training using the Luna EMG on muscle activity, balance and gait speed of patients after ischemic stroke.

Conclusion:

The addition of the affected lower limb training using reactive electromyography, with the Luna EMG, to the commonly used rehabilitation program, allows to obtain significant functional improvement in patients after ischemic stroke. The usage of innovative technology in the commonly used rehabilitation program for patients after ischemic stroke allows to achieve effective therapy, with less physical burden on the physiotherapist.

Cit.:

Sihinkiewicz I. *The impact of training with the Luna EMG usage on muscle activity, balance and selected gait parameters of patients after ischemic stroke [doctoral dissertation].* Kraków: Bronisław Czech University of Physical Education in Kraków; 2023. Supervisor: Prof. Joanna Golec, PhD. Assistant Supervisor: Dr. Rafał Stabrawa.

https://bip.awf.krakow.pl/attachments/article/1771/Sihinkiewicz%20poprawione.pdf

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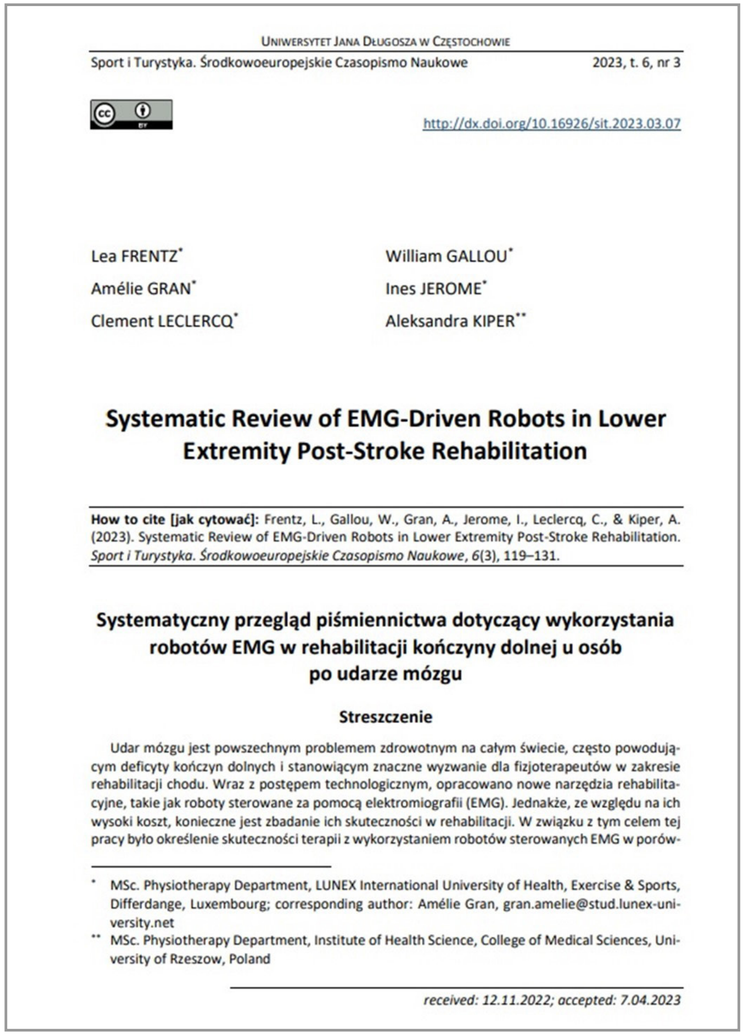
List of publications



UNIWERSYTET JANA DŁUGOSZA W CZĘSTOCHOWIE
Sport i Turystyka. Środkowoeuropejskie Czasopismo Naukowe 2023, t. 6, nr 3

http://dx.doi.org/10.16926/sit.2023.03.07

Lea FRENTZ* William GALLOU*
Amélie GRAN* Ines JEROME*
Clement LECLERCQ* Aleksandra KIPER**

Systematic Review of EMG-Driven Robots in Lower Extremity Post-Stroke Rehabilitation

How to cite [jak cytować]: Frentz, L., Gallou, W., Gran, A., Jerome, I., Leclercq, C., & Kiper, A. (2023). Systematic Review of EMG-Driven Robots in Lower Extremity Post-Stroke Rehabilitation. *Sport i Turystyka. Środkowoeuropejskie Czasopismo Naukowe*, *6*(3), 119–131.

Systematyczny przegląd piśmiennictwa dotyczący wykorzystania robotów EMG w rehabilitacji kończyny dolnej u osób po udarze mózgu

Streszczenie

Udar mózgu jest powszechnym problemem zdrowotnym na całym świecie, często powodującym deficyty kończyn dolnych i stanowiącym znaczne wyzwanie dla fizjoterapeutów w zakresie rehabilitacji chodu. Wraz z postępem technologicznym, opracowano nowe narzędzia rehabilitacyjne, takie jak roboty sterowane za pomocą elektromiografii (EMG). Jednakże, ze względu na ich wysoki koszt, konieczne jest zbadanie ich skuteczności w rehabilitacji. W związku z tym celem tej pracy było określenie skuteczności terapii z wykorzystaniem robotów sterowanych EMG w porów-

* MSc. Physiotherapy Department, LUNEX International University of Health, Exercise & Sports, Differdange, Luxembourg; corresponding author: Amélie Gran, gran.amelie@stud.lunex-university.net
** MSc. Physiotherapy Department, Institute of Health Science, College of Medical Sciences, University of Rzeszow, Poland

received: 12.11.2022; accepted: 7.04.2023

3.1.11. Systematic Review of EMG-Driven Robots in Lower Extremity Post-Stroke Rehabilitation.

Goal:

The aim of this review was to investigate the current literature on the effectiveness of EMG-driven robots for gait management in the physiotherapy treatment of stroke patients. The research question was: "In adult poststroke hemiparetic patients, what is the effect of EMG-driven robots on gait rehabilitation compared to conventional physiotherapy training (CPT)?".

Conclusion:

In summary, no relevant conclusion can be drawn about the effectiveness of EMG-driven robots alone for post-stroke patients' gait in comparison with conventional physiotherapy training, but it seems that a mixed approach combining both of them could be the most beneficial.

Cit.:

Frentz, L, Gallou, W, Gran, A, Jerome, I, Leclercq, C, Kiper, A. *Systematic Review of EMG-Driven Robots in Lower Extremity Post-Stroke Rehabilitation. Sport i Turystyka. Środkowoeuropejskie Czasopismo Naukowe, 6(3), 119–131. (2023).*

https://czasopisma.ujd.edu.pl/index.php/sport/article/view/1897

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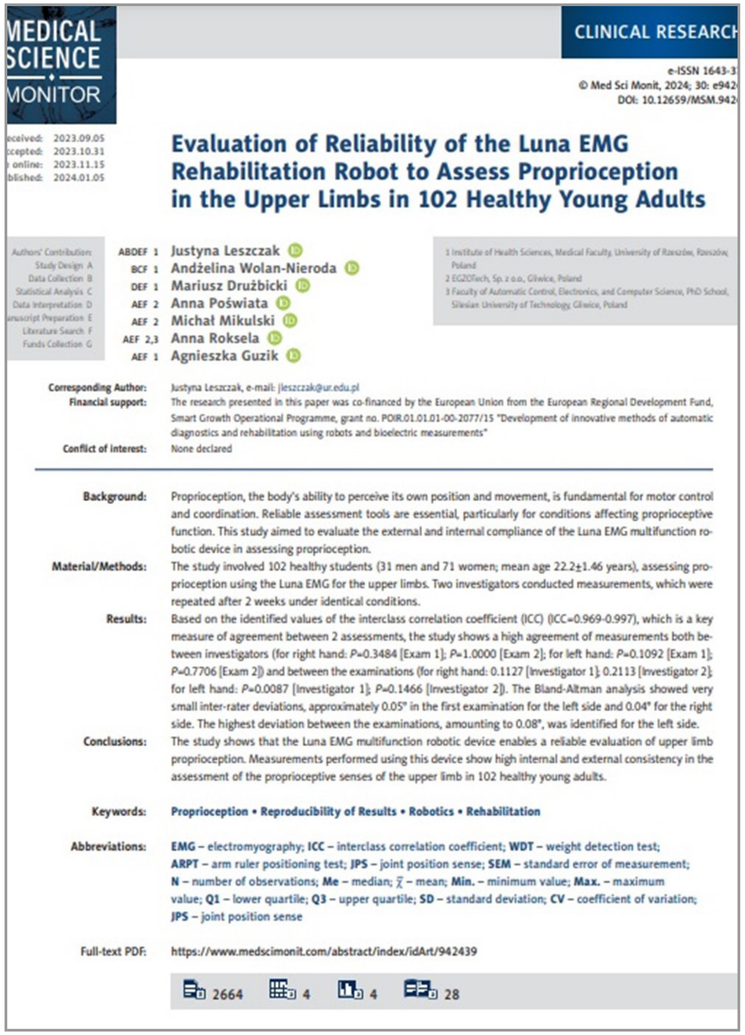
List of publications



MEDICAL SCIENCE MONITOR

CLINICAL RESEARCH

e-ISSN 1643-3
© Med Sci Monit, 2024; 30: e942
DOI: 10.12659/MSM.942

Received: 2023.09.05
Accepted: 2023.10.31
Online: 2023.11.15
Published: 2024.01.05

Evaluation of Reliability of the Luna EMG Rehabilitation Robot to Assess Proprioception in the Upper Limbs in 102 Healthy Young Adults

Authors' Contribution: Study Design A, Data Collection B, Statistical Analysis C, Data Interpretation D, Manuscript Preparation E, Literature Search F, Funds Collection G

ABDEF 1 Justyna Leszczak
BCF 1 Andżelina Wolan-Nieroda
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AEF 2 Michał Mikulski
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Corresponding Author: Justyna Leszczak, e-mail: jleszczak@ur.edu.pl
Financial support: The research presented in this paper was co-financed by the European Union from the European Regional Development Fund, Smart Growth Operational Programme, grant no. POIR.01.01.01-00-2077/15 "Development of innovative methods of automatic diagnostics and rehabilitation using robots and bioelectric measurements"

Conflict of interest: None declared

Background: Proprioception, the body's ability to perceive its own position and movement, is fundamental for motor control and coordination. Reliable assessment tools are essential, particularly for conditions affecting proprioceptive function. This study aimed to evaluate the external and internal compliance of the Luna EMG multifunction robotic device in assessing proprioception.

Material/Methods: The study involved 102 healthy students (31 men and 71 women; mean age 22.2±1.46 years), assessing proprioception using the Luna EMG for the upper limbs. Two investigators conducted measurements, which were repeated after 2 weeks under identical conditions.

Results: Based on the identified values of the interclass correlation coefficient (ICC) (ICC=0.969-0.997), which is a key measure of agreement between 2 assessments, the study shows a high agreement of measurements both between investigators (for right hand: *P*=0.3484 [Exam 1]; *P*=1.0000 [Exam 2]; for left hand: *P*=0.1092 [Exam 1]; *P*=0.7706 [Exam 2]) and between the examinations (for right hand: 0.1127 [Investigator 1]; 0.2113 [Investigator 2]; for left hand: *P*=0.0087 [Investigator 1]; *P*=0.1466 [Investigator 2]). The Bland-Altman analysis showed very small inter-rater deviations, approximately 0.05° in the first examination for the left side and 0.04° for the right side. The highest deviation between the examinations, amounting to 0.08°, was identified for the left side.

Conclusions: The study shows that the Luna EMG multifunction robotic device enables a reliable evaluation of upper limb proprioception. Measurements performed using this device show high internal and external consistency in the assessment of the proprioceptive senses of the upper limb in 102 healthy young adults.

Keywords: Proprioception • Reproducibility of Results • Robotics • Rehabilitation

Abbreviations: **EMG** – electromyography; **ICC** – interclass correlation coefficient; **WDT** – weight detection test; **ARPT** – arm ruler positioning test; **JPS** – joint position sense; **SEM** – standard error of measurement; **N** – number of observations; **Me** – median; $\bar{x}$ – mean; **Min.** – minimum value; **Max.** – maximum value; **Q1** – lower quartile; **Q3** – upper quartile; **SD** – standard deviation; **CV** – coefficient of variation; **JPS** – joint position sense

Full-text PDF: https://www.medscimonit.com/abstract/index/idArt/942439

2664 4 4 28

3.1.12. Evaluation of Reliability of the Luna EMG Rehabilitation Robot to Assess Proprioception in the Upper Limbs in 102 Healthy Young Adults.

Goal:

The study aimed to examine external and internal compliance (ie, inter- and intrarater reliability) of the Luna EMG multifunction robotic device as a tool to assess upper-limb proprioception.

Conclusion:

The Luna EMG multifunction robotic device is a reliable tool in the evaluation of upper-limb proprioception. Measurements made with the Luna EMG show high internal and external consistency in assessment of the proprioceptive senses of the upper limbs in a group of 102 healthy young adults.

Cit.:

Leszczak, J.; Wolan-Nieroda, A.; Drużbicki, M.; Poświata, A.; Mikulski M.; Roksela, A.; Guzik A. *Evaluation of Reliability of the Luna EMG Rehabilitation Robot to Assess Proprioception in the Upper Limbs in 102 Healthy Young Adults. Med Sci Monit, 2024; 30: e942439.*

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10775584/

3

List of publications

Wydawnictwo UR 2024
ISSN 2544-1361 (online)

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2024

Assessment of external and internal compliance of the Luna EMG robot as a tool for assessing upper limb proprioception in people after stroke

Leszczak Justyna[1], Pniak Bogumiła[1,2], Poświata Anna[3], Roksela Anna[3,4], Mikulski Michał[3], Drużbicki Mariusz[1], Guzik Agnieszka[1]

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[2]Szpital Uzdrowiskowo-Rehabilitacyjny „Excelsior" w Iwoniczu Zdroju
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[4]Wydział Automatyki, Elektroniki i Informatyki Politechniki Śląskie, Gliwice

Introduction: The aim of the study was to assess the external and internal compliance of the Luna EMG multifunctional robot as a tool for assessing upper limb proprioception in people after stroke.
Material and methods: The study was conducted among people in the late phase after stroke. A total of 126 respondents participated in the study, including 78 women and 48 men. The median age recorded was nearly 60 years. Proprioception measurements were performed using the Luna EMG diagnostic and rehabilitation robot to assess the left and right upper limb. The study was conducted by 2 researchers, twice, 2 weeks apart. The results were compared between the researchers and the studies.
Results: High compliance of the measurements performed for the right hand was confirmed by the interclass correlation coefficients ICC (0.996-0.998) and for the left hand ICC (0.994-0.999) as well as Pearson's linear correlation, which in all cases, both when examining the compliance between the studies and between the researchers, was recorded at a very high level. level (r=1.00) for the right and left hand.
Conclusions: Measurements performed by the multifunctional Luna EMG robot demonstrate high internal and external compliance in the assessment of proprioceptive sense of the upper limb in people after stroke. Studies have shown that the diagnostic and rehabilitation robot is a reliable tool in assessing upper limb proprioception in people after stroke.
Keywords: Luna EMG diagnostic and rehabilitation robot, proprioception, rehabilitation, upper limb

3.1.13. Assessment of external and internal compliance of the Luna EMG robot as a tool for assessing upper limb proprioception in people after stroke.

Goal:

The aim of the study was to assess the external and internal compliance of the Luna EMG multifunctional robot as a tool for assessing upper limb proprioception in people after stroke.

Conclusion:

Measurements performed by the multifunctional Luna EMG robot demonstrate high internal and external compliance in the assessment of proprioceptive sense of the upper limb in people after stroke. Studies have shown that the diagnostic and rehabilitation robot is a reliable tool in assessing upper limb proprioception in people after stroke.

Cit.:

Leszczak, J.; Pniak, B.; Poświata, A.; Roksela, A.; Mikulski, M.; Drużbicki, M.; Guzik A. *Assessment of external and internal compliance of the Luna EMG robot as a tool for assessing upper limb proprioception in people after stroke.European Journal of Clinical & Experimental Medicine, 2024, p64*

https://www.ejcem.ur.edu.pl/system/tdf/ejcem_konf_3_2024_0.pdf?file=1&type=node&id=2338&force=

3

List of publications

3.1.14. Effectiveness of robotic rehabilitation in improving muscular strength and mobility in patients with multiple sclerosis.

Goal:

The aim of this study was to assess the effects of the LUNA-EMG rehabilitation robot (RR) on muscular strength, balance, and gait in patients with multiple sclerosis (MS).

Conclusion:

The results of this study demonstrate that the use of the RR led to significant improvements in muscular strength among MS patients, particularly in the quadriceps and hamstring muscles. However, no significant differences were observed in balance, gait, quality of life, or proprioception between the RR group and the control group. These findings suggest that robot-assisted rehabilitation, as facilitated by the LUNA-EMG robot, holds promise as a method for enhancing muscular strength in MS patients. Further research with a larger sample size is warranted to confirm these findings and to explore additional outcomes.

Cit.:

Houlmont, F; Cassol, H; Maertens de Noordhout, B Thibaut, A. ; Roncins, J.; Guillaume, D.; Maillard, B.; Kaux, J-F. *Effectiveness of robotic rehabilitation in improving muscular strength and mobility in patients with multiple sclerosis. 24th European Congress of Physical and Rehabilitation Medicine - ESPRM, 2024.*

https://orbi.uliege.be/handle/2268/316661

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List of publications

cancers

MDPI

Article

LUNA EMG as a Marker of Adherence to Prehabilitation Programs and Its Effect on Postoperative Outcomes among Patients Undergoing Cytoreductive Surgery for Ovarian Cancer and Suspected Ovarian Tumors

Marcin Adam Zębalski [1], Krzysztof Parysek [2], Aleksandra Krzywon [3,†] and Krzysztof Nowosielski [1,*,†]

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Simple Summary: Prehabilitation is a multimodal intervention including preoperative exercises, a high-protein diet, psychological support, smoking/alcohol cessation, and the optimization of preoperative laboratory results. The effectiveness of prehabilitation is different for each patient and depends on many factors. Ensuring reliable compliance with prehabilitation recommendations and active patient involvement are pivotal. To accurately assess patient adherence to prehabilitation guidelines, it is crucial to employ innovative assessment tools. To the best of our knowledge, this is the first study utilizing a LUNA EMG device as a marker of prehabilitation compliance. In this study, we implemented a prehabilitation program in a group of patients with suspected ovarian cancer and compared the results with those of the control group in which only the ERAS protocol was used. We observed an improvement in muscle strength and tension during the prehabilitation program and found an association between prehabilitation using this device and fewer complications and shorter hospital stays compared to the control group.

Abstract: Background: Prehabilitation is a novel strategy in preoperative management. The aim of this study was to investigate the effect of prehabilitation programs on peri- and postoperative outcomes and to verify if LUNA EMG has the capacity to monitor compliance with prehabilitation programs. Methods: A total of seventy patients with suspected ovarian cancer were recruited between April 2021 and September 2022 and were divided into a prehabilitation group (36 patients) or a control group (34 patients). A LUNA EMG device was utilized to monitor muscle strength and tension. Results: Within the prehabilitation group, we observed a significant increase in the 6-Minute Walk Test distance by 17 m (median, IQR: 0–42.5, $p < 0.001$) and a significant increase in muscle strength measured with LUNA EMG. In comparison to the control group, the prehabilitation group showed fewer complications according to the Clavien–Dindo classification (47.2% vs. 20.6%, $p = 0.02$) and shorter postoperative hospital stays (median 5.0 days [IQR: 4.0–6.2] vs. 7.0 days [IQR: 6.0–10.0], $p < 0.001$). Conclusion: Prehabilitation has a positive effect on physical capacity and muscle strength and is associated with a reduction in the number of complications after surgery. LUNA EMG can be a useful tool for monitoring patients' adherence to prehabilitation programs.

Keywords: prehabilitation; LUNA EMG; ERAS; ovarian cancer

check for updates

Citation: Zębalski, M.A.; Parysek, K.; Krzywon, A.; Nowosielski, K. LUNA EMG as a Marker of Adherence to Prehabilitation Programs and Its Effect on Postoperative Outcomes among Patients Undergoing Cytoreductive Surgery for Ovarian Cancer and Suspected Ovarian Tumors. *Cancers* **2024**, *16*, 2493. https://doi.org/10.3390/cancers16142493

Academic Editor: Linus T. Chuang

Received: 27 June 2024
Accepted: 2 July 2024
Published: 9 July 2024

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3.1.15. LUNA EMG as a Marker of Adherence to Prehabilitation Programs and Its Effect on Postoperative Outcomes among Patients Undergoing Cytoreductive Surgery for Ovarian Cancer and Suspected Ovarian Tumors.

Goal:

The aim of the study is to assess the impact of multimodal preparation in the prehabilitation protocol on the incidence of postoperative complications and duration of hospitalization after surgery among women scheduled for cytoreductive surgery due to advanced-stage ovarian cancer. The second aim is to evaluate if LUNA EMG might serve as a useful tool to assess patient compliance with a prehabilitation protocol.

Conclusion:

The prehabilitation program proposed in this study improves muscle strength and physical performance, which reduces the number of postoperative complications and shortens the length of hospital stays. Testing muscle tension with the LUNA EMG device can be a useful tool for monitoring the progress of physical preparation.

Cit.:

Zębalski, MA, Parysek K, Krzywoń, A, Nowosielski K. *LUNA EMG as a Marker of Adherence to Prehabilitation Programs and Its Effect on Postoperative Outcomes among Patients Undergoing Cytoreductive Surgery for Ovarian Cancer and Suspected Ovarian Tumors. Cancers 2024, 16(14), 2493;*

https://www.mdpi.com/2072-6694/16/14/2493

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List of publications

cancers

MDPI

Article

LUNA EMG as a Marker of Adherence to Prehabilitation Programs and Its Effect on Postoperative Outcomes among Patients Undergoing Cytoreductive Surgery for Ovarian Cancer and Suspected Ovarian Tumors

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* Correspondence: knowosielski@sum.edu.pl; Tel.: +48-32-789-4731
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Abstract: Background: Prehabilitation is a novel strategy in preoperative management. The aim of this study was to investigate the effect of prehabilitation programs on peri- and postoperative outcomes and to verify if LUNA EMG has the capacity to monitor compliance with prehabilitation programs. Methods: A total of seventy patients with suspected ovarian cancer were recruited between April 2021 and September 2022 and were divided into a prehabilitation group (36 patients) or a control group (34 patients). A LUNA EMG device was utilized to monitor muscle strength and tension. Results: Within the prehabilitation group, we observed a significant increase in the 6-Minute Walk Test distance by 17 m (median, IQR: 0–42.5, $p < 0.001$) and a significant increase in muscle strength measured with LUNA EMG. In comparison to the control group, the prehabilitation group showed fewer complications according to the Clavien–Dindo classification (47.2% vs. 20.6%, $p = 0.02$) and shorter postoperative hospital stays (median 5.0 days [IQR: 4.0–6.2] vs. 7.0 days [IQR: 6.0–10.0], $p < 0.001$). Conclusion: Prehabilitation has a positive effect on physical capacity and muscle strength and is associated with a reduction in the number of complications after surgery. LUNA EMG can be a useful tool for monitoring patients' adherence to prehabilitation programs.

Keywords: prehabilitation; LUNA EMG; ERAS; ovarian cancer

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Academic Editor: Linus T. Chuang

Received: 27 June 2024
Accepted: 2 July 2024
Published: 9 July 2024

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3.1.16. Surface electromyography vs clinical outcome measures after robot-assisted gait training in patients with spinal cord injury after post-acute phase of rehabilitation.

Goal:

The aim of the study was to evaluate the usefulness of sEMG for outcome measures in patients with subacute SCI who underwent RAGT, compared with those who underwent DPT. A secondary aim was to correlate sEMG changes with clinical status, as tested using functional scales (including spasticity) and muscle strength testing.

Conclusion:

sEMG may be a valuable addition to the basic examination of patients following SCI (functional and neurological scales). However, muscle fatigue, which is observed in patients with SCI after DPT more than after RAGT, may pose a challenge to conducting the sEMG test. Knee joint kinematics is an important parameter for evaluating patients undergoing RAGT which has the potential to alleviate spasticity in patients with incomplete SCI.

Cit.:

Korczyński, B, Frasuńska, J, Poświata, A, Siemianowicz, A, Mikulski, M, Tarnacka, B. *Surface electromyography vs clinical outcome measures after robot-assisted gait training in patients with spinal cord injury after post-acute phase of rehabilitation. Ann Agric Environ Med.* 2024

https://www.aaem.pl/Surface-electromyography-vs-clinical-outcome-measures-after-robot-assisted-gait-training,189609,0,2.html

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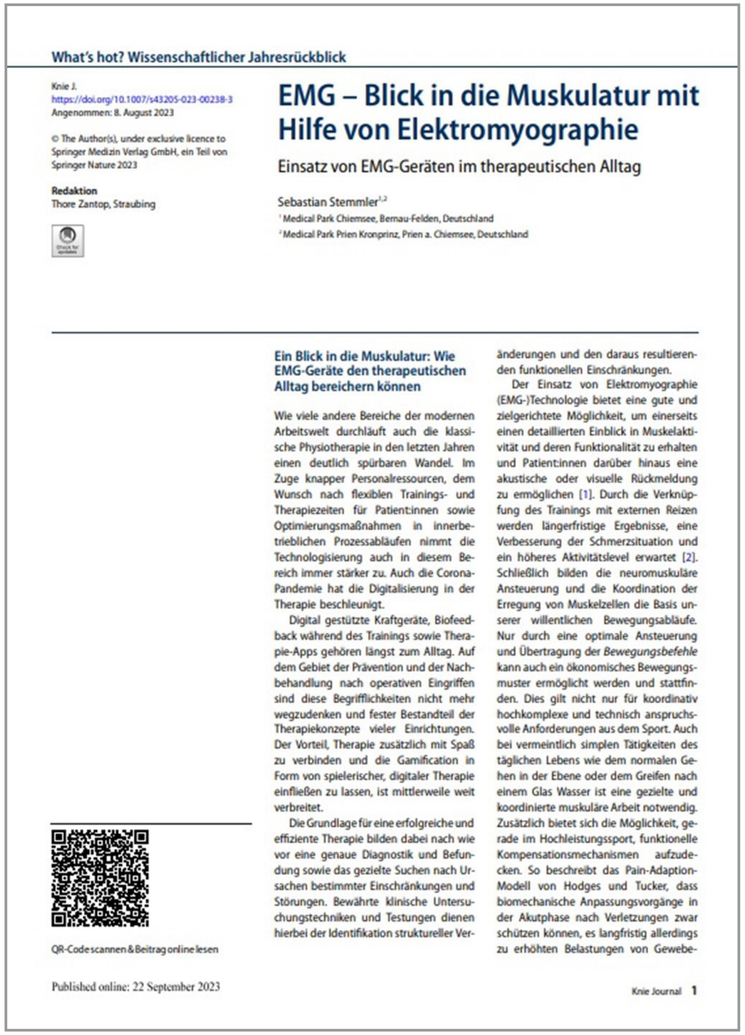
List of publications



What's hot? Wissenschaftlicher Jahresrückblick

Knie J.
https://doi.org/10.1007/s43205-023-00238-3
Angenommen: 8. August 2023

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Redaktion
Thore Zantop, Straubing

EMG – Blick in die Muskulatur mit Hilfe von Elektromyographie

Einsatz von EMG-Geräten im therapeutischen Alltag

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Ein Blick in die Muskulatur: Wie EMG-Geräte den therapeutischen Alltag bereichern können

Wie viele andere Bereiche der modernen Arbeitswelt durchläuft auch die klassische Physiotherapie in den letzten Jahren einen deutlich spürbaren Wandel. Im Zuge knapper Personalressourcen, dem Wunsch nach flexiblen Trainings- und Therapiezeiten für Patient:innen sowie Optimierungsmaßnahmen in innerbetrieblichen Prozessabläufen nimmt die Technologisierung auch in diesem Bereich immer stärker zu. Auch die Corona-Pandemie hat die Digitalisierung in der Therapie beschleunigt.

Digital gestützte Kraftgeräte, Biofeedback während des Trainings sowie Therapie-Apps gehören längst zum Alltag. Auf dem Gebiet der Prävention und der Nachbehandlung nach operativen Eingriffen sind diese Begrifflichkeiten nicht mehr wegzudenken und fester Bestandteil der Therapiekonzepte vieler Einrichtungen. Der Vorteil, Therapie zusätzlich mit Spaß zu verbinden und die Gamification in Form von spielerischer, digitaler Therapie einfließen zu lassen, ist mittlerweile weit verbreitet.

Die Grundlage für eine erfolgreiche und effiziente Therapie bilden dabei nach wie vor eine genaue Diagnostik und Befundung sowie das gezielte Suchen nach Ursachen bestimmter Einschränkungen und Störungen. Bewährte klinische Untersuchungstechniken und Testungen dienen hierbei der Identifikation struktureller Veränderungen und den daraus resultierenden funktionellen Einschränkungen.

Der Einsatz von Elektromyographie (EMG-)Technologie bietet eine gute und zielgerichtete Möglichkeit, um einerseits einen detaillierten Einblick in Muskelaktivität und deren Funktionalität zu erhalten und Patient:innen darüber hinaus eine akustische oder visuelle Rückmeldung zu ermöglichen [1]. Durch die Verknüpfung des Trainings mit externen Reizen werden längerfristige Ergebnisse, eine Verbesserung der Schmerzsituation und ein höheres Aktivitätslevel erwartet [2]. Schließlich bilden die neuromuskuläre Ansteuerung und die Koordination der Erregung von Muskelzellen die Basis unserer willentlichen Bewegungsabläufe. Nur durch eine optimale Ansteuerung und Übertragung der *Bewegungsbefehle* kann auch ein ökonomisches Bewegungsmuster ermöglicht werden und stattfinden. Dies gilt nicht nur für koordinativ hochkomplexe und technisch anspruchsvolle Anforderungen aus dem Sport. Auch bei vermeintlich simplen Tätigkeiten des täglichen Lebens wie dem normalen Gehen in der Ebene oder dem Greifen nach einem Glas Wasser ist eine gezielte und koordinierte muskuläre Arbeit notwendig. Zusätzlich bietet sich die Möglichkeit, gerade im Hochleistungssport, funktionelle Kompensationsmechanismen aufzudecken. So beschreibt das Pain-Adaption-Modell von Hodges und Tucker, dass biomechanische Anpassungsvorgänge in der Akutphase nach Verletzungen zwar schützen können, es langfristig allerdings zu erhöhten Belastungen von Gewebe-

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Published online: 22 September 2023

3.2. Stella BIO

3.2.1. EMG – look into the muscles with the help of electromyography.

Goal:

An article on the use of electromyography in therapy and assessment of muscle function in patients. Benefits of modern solutions in therapy.

Conclusion:

Therapy currently poses greater challenges than ever – a targeted, economic and effective approach to therapy is essential. EMG helps to remain objective when assessing and recheck treatment approaches on effectiveness. Automatized and standardised reports make comparison of parameters among different stages of Rehabilitation easier.

Cit.:

Stemmler, S. *EMG – Blick in die Muskulatur mit Hilfe von Elektromyographie. Knie J. (2023)*

https://link.springer.com/article/10.1007/s43205-023-00238-3

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List of publications

EMG mapping technique for pinch meter robot extension

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Abstract. Rehabilitation of patients with impaired grip functions involves standard exercise that should be repeated in a predefined sequence. They are aimed to gradually improve patients' ability to grip and operate objects used in daily life. Rehabilitation robots, employing surface EMG (sEMG) as a diagnostic and feedback signal may be used to support these exercises and trace the rehabilitation progress. However, to properly employ exercise regimen, information about what force should be used to hold and operate various objects is needed. This work is focused on finding the correlation between the value of sEMG signal and the force required to grip a particular object. Calibration plots obtained that way will reduce the need for additional equipment, such as specialized gloves, and at the same time provide information needed for better exercise protocols.

Keywords: EMG · mapping · force · pinch meter · robotics.

1 Introduction

SEMG (Surface Electromyography) is a non-invasive measurement technique that facilitates analysis of skeletal muscle activity by recording electrical signals generated by muscle fibers during contractions. The method involves placing electrodes on the skin surface, over the muscles being studied. SEMG allows for the assessment of muscle activation timing, intensity, and coordination.

SEMG has many applications in various fields such as sports science, rehabilitation, ergonomics, and neurophysiology (see, e.g. the review in [6]). It is used to study, e.g., muscle function, movement, and fatigue. SEMG can provide valuable information about muscle activity during different activities, such as walking, running, or weightlifting.

The results of SEMG measurements are used in a variety of ways, including understanding the mechanisms of muscle contractions, monitoring the progression of muscle disease treatment, assessing the impact of therapy and rehabilitation on muscle function, and analyzing movement and ergonomic work [1–3]. The

3.2.2. EMG mapping technique for pinch meter robot extension.

Goal:

In this work authors concentrate on exercises consisting in using a key-type handle, aiming at improving gripping and turning motor skills. This type of a handle may represent various objects, such as a lock key, TV remote, a credit card, a fork, a medium-sized cup, a smartphone, a small or large plate.

Conclusion:

The proposed calibration workstation, consisting of a simple force measurement module with a trapezoidal grip overlay provides sufficient hand contact for a scissor grip.

Cit.:

Smolinski, M.; Mikulski, M.; Śmieja, J. (2024). *EMG Mapping Technique for Pinch Meter Robot Extension.* In: Strumiłło, P., Klepaczko, A., Strzelecki, M., Bociąga, D. (eds) *The Latest Developments and Challenges in Biomedical Engineering. PCBEE 2023. Lecture Notes in Networks and Systems, vol 746. Springer, Cham.*

https://link.springer.com/chapter/10.1007/978-3-031-38430-1_26#citeas

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List of publications

sensors

MDPI

Article

Surface Electromyography Data Analysis for Evaluation of Physical Exercise Habits between Athletes and Non-Athletes during Indoor Rowing

Tomasz Grzejszczak [1,*], Anna Roksela [2,*], Anna Poświata [2], Anna Siemianowicz [3], Agnieszka Kiełboń [3] and Michał Mikulski [2,3]

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Abstract: In this paper, surface electromyography (sEMG) is used to gather the activation neural signal from muscles during an indoor rowing exercise. The exercise was performed by professional athletes and amateur non-athletes. The data acquisition and processing are described to obtain a set of parameters: number of cycles, average cycle time, cycle time standard deviation, fatigue time, muscle activation time, and muscle energy. These parameters are used to draw conclusions on common non-athletes' mistakes during exercise for better training advice and a way of statistically distinguishing an athlete from a non-athlete.

Keywords: surface electromyography (sEMG); muscle activation measurement; physical exercise evaluation

check for updates

Citation: Grzejszczak, T.; Roksela, A.; Poświata, A.; Siemianowicz, A.; Kiełboń, A.; Mikulski, M. Surface Electromyography Data Analysis for Evaluation of Physical Exercise Habits between Athletes and Non-Athletes during Indoor Rowing. *Sensors* **2024**, *24*, 1964. https://doi.org/10.3390/s24061964

Academic Editor: Francesca Miraglia

Received: 29 February 2024
Revised: 16 March 2024
Accepted: 18 March 2024
Published: 19 March 2024

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1. Introduction

Nowadays, one can notice an increased willingness of people to take care of their personal physical development and practice amateur sports. Additionally, amateurs often use various types of equipment and gadgets to help them exercise. Wearable devices measuring some physical or physiological quantity can enhance the process of sensing and provide better coaching advice. The application of science and technology may offer a significant competitive advantage [1]. Wearable technology holds immense potential in the near future for being able to flatten the cost curve of healthcare [2].

Indoor rowing activates multiple muscles and body parts, especially arms (biceps), legs (quadriceps), and stomach muscles. Usually, the indoor rowing machine is equipped with an air resistance mechanism and a sensor that recalculates an applied pulling force. The performance is measured according to this force in each stroke. This device and its internal sensors can be used as research parameters on exercising behaviors [3,4].

In this research, the muscle activation time is measured and processed. Muscle activation time is frequently used to determine the correctness of performed tasks or to identify limits [5–7]. Muscle activation can be used to determine muscle fatigue [8–10] or can be an indicator of an illness for diagnostic purpose [11–13]. Usually, this is performed using surface electromyography (sEMG), but recent studies show the possibility of utilizing other sensors, such as an inertial measurement unit (IMU) [14–16], or contactless options with use of motion capture, computer vision, and deep learning pose estimation [17–19].

sEMG is capable of detecting muscle contraction time and strength for diagnosis and rehabilitation purposes [20,21]. Despite medical purposes and rehabilitation, sEMG is used to investigate novel approaches to human–robot interaction (HRI). Detecting muscle contractions with sEMG can be used for hand gesture recognition [22,23] or for direct manipulator control [24–26].

3.2.3. Surface Electromyography Data Analysis for Evaluation of Physical Exercise Habits between Athletes and Non-Athletes during Indoor Rowing.

Goal:

The aim of this paper is to analyze surface electromyography (sEMG) data from the biceps and quadriceps during indoor rowing. It aims to identify performance parameters and common errors, distinguish between athletes and non-athletes, and recognize individuals with sports potential. Ultimately, the study seeks to provide insights into muscle activation patterns for improved coaching and training recommendations.

Conclusion:

The conclusion of this research highlights the effectiveness of measuring individual sports activities and identifies key findings: professionals outperform amateurs, fatigue affects muscle strength over time, and the research offers a method for quantifying these phenomena. By utilizing muscle activation times and local extrema positions, along with indicators of fatigue such as changes in cycle amplitude and time, this study provides valuable insights for coaching and training recommendations during exercise.

Cit.:

Grzejszczak, T.; Roksela, A.; Poświata, A.; Siemianowicz, A.; Kiełboń, A.; Mikulski, M. *Surface Electromyography Data Analysis for Evaluation of Physical Exercise Habits between Athletes and-Non-Athletes during Indoor Rowing. Sensors 2024, 24, 1964.*

https://www.mdpi.com/1424-8220/24/6/1964

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