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FES Cycle Ergometry for Multiple Sclerosis - *Evidence Library*

Contents

Outcomes After Functional Electrical Stimulation Cycle Training in Individuals with Multiple Sclerosis Who Are Nonambulatory.

Backus, D., Burdett, B., Hawkins, L., Manella, C., McCully, K.K. and Sweatman, M. (2017).

International Journal of MS Care: May/June 2017, Vol. 19, No. 3, pp. 113-121.

Abstract

Background: Exercise is safe and beneficial for people with multiple sclerosis (MS). Functional electrical stimulation (FES) cycling offers people with significant weakness and mobility challenges an option for exercise. We sought to evaluate the safety of FES cycling and its potential to improve fatigue, pain, spasticity, and quality of life in people with moderate-to-severe MS.

Methods: Sixteen participants with MS who were nonambulatory cycled for 30 minutes two to three times a week for 1 month. Outcomes assessed included MS Quality of Life Inventory (MSQLI) subscales, Modified Ashworth Scale (MAS), and manual muscle test (MMT).

Results: Fourteen participants (six women and eight men) with MS completed the training. All were able to maintain or increase their cycle time; half increased the resistance while cycling. Participants demonstrated a significant decrease in the Physical ($P = .02$) and Psychosocial ($P < .01$) subscales of the Modified Fatigue Impact Scale. There was no significant change in the other MSQLI subscale scores. There was no change in MAS and MMT scores. Type of MS and the use of antispasticity medications, disease-modifying therapies, or dalfampridine did not seem to influence response to training. There were no adverse events.

Conclusions: Functional electrical stimulation cycling may be a viable and effective exercise option for people with moderate-to-severe MS. Further study is required to examine the parameters of FES cycling that are most effective for people with different MS symptoms and to fully explore the potential benefits of optimizing function and improving health in people with MS.

Neuromuscular Electrical Stimulation Cycling Exercise for Persons with Advanced Multiple Sclerosis.

Fornusek, C; Hoang, P. (2014).

Journal of Rehabilitation Medicine, 46(7): 698-702.

Abstract

Objective: To investigate the feasibility of neuromuscular electrical stimulation cycling modified to suit persons with advanced multiple sclerosis.

Subjects: Eight women with secondary progressive multiple sclerosis.

Methods: Subjects participated in an 18-session (40 min) neuromuscular electrical stimulation cycling program. A pedaling cadence of 10 rev•min−1 was employed and stimulation intensity was not modulated to control cadence, but increased gradually throughout each session. The outcomes included the stimulation intensity tolerated, thigh circumference changes, and power output and cardiorespiratory response during cycling. Participants were interviewed about perceived benefits of the treatment including changes in transfer ability.

Results: Seven participants (Expanded Disability Status Scale 6.5–8.5) (mean 7.4 (standard deviation 0.7)) completed the training program over an average of 10 weeks. Greater stimulation intensities were tolerated than previously reported for persons with multiple sclerosis. Increases were found in thigh volume. Perceived benefits included improvements in transfer ability, leg circulation, spasticity and strength.

Conclusion: Modifying neuromuscular electrical stimulation cycling allowed persons with advanced multiple sclerosis to tolerate greater stimulation intensities and exercise their muscles more intensely than previous studies. The benefits reported, which were solely due to neuromuscular electrical stimulation cycling, demonstrate that persons with preserved sensation and muscle paralysis/paresis might benefit from neuromuscular electrical stimulation exercise when it is adjusted appropriately.

Functional electrical stimulation as a component of activity based restorative therapy may preserve function in persons with multiple sclerosis.

Hammond, E.R., Metcalf, H.M., McDonald, J.W. and Shadowsky, C.L. (2014).

The Journal of Spinal Cord Medicine, 38(1): 68-75.

Abstract

Objective - To examine the effect of functional electrical stimulation (FES) cycling on disability progression in persons with multiple sclerosis (MS).
Design - Retrospective cohort, 40 participants with mean follow-up of 15 months.
Setting - International Center for Spinal Cord Injury at Kennedy Krieger Institute in Baltimore, a rehabilitation referral center.
Participants - Forty consecutive persons with MS undergoing rehabilitation from 2007 to 2011, with at least two evaluations based on the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI).
Interventions - FES cycling as part of activity-based restorative therapy interventions.
Outcome measures - Change in Expanded Disability Status Scale (EDSS) and ISNCSCI motor, light touch, and pin prick scores from baseline to latest evaluation.
Results - In 71% of patients, activity-based rehabilitation included FES cycling. There was no disability progression on the EDSS. Lower extremity motor scores improved or stabilized in 75% of patients with primary progressive MS (PPMS), 71.4% with secondary progressive MS (SPMS), and 54.5% with relapsing remitting MS (RRMS). Among patients with improved or stabilized lower extremity motor function, PPMS recorded a mean 9% improvement, SPMS 3% and RRMS 6%. In PPMS, use of FES showed trend towards improvement in motor scores (P = 0.070).
Conclusions - FES as part of activity-based rehabilitation may help preserve or improve neurological function in patients with MS.

FES cycling reduces spastic muscle tone in a patient with multiple sclerosis.

Krause P.; Szecsi J.; Straube A. (2007).

Neurorehabilitation, 22(4): 335-337.

Abstract

We report on a multiple sclerosis patient who received functional electrical stimulation to reduce spastic muscle tone of the lower limbs. Stimulation by means of surface electrodes applied to the thigh muscles induced cycling leg movements. Spastic muscle tone was measured clinically using the modified Ashworth scale and semiautomatically by pendulum testing of spasticity. This was done before and directly after stimulation. The patient was able to endure the stimulation for ca. 30 minutes; there was a significant reduction of spasticity after each stimulation session. We conclude, that this type of stimulation could be another potential treatment modality for multiple sclerosis patients, especially those with a high score in the expanded disability Status scale.

Review: Clinical Benefits of Functional Electrical Stimulation Cycling Exercise for Subjects with Central Neurological Impairments.

Peng, C.-W.; Chen, S.-C.; Lai, C.-H.; Chen, C.-J., Chen, C.-C., Mizrahi, J. & Handa, Y. (2011).

Journal of Medical and Biological Engineering, 31(1): 1-11

Abstract

Functional electrical stimulation (FES) cycling ergometer has been utilized in recent decades for rehabilitation by sequentially stimulating the large leg-actuating muscles of paralyzed leg muscles to produce cyclical leg motion. A number of studies reported physiological adaptations after regular FES-cycling exercise (FESCE) training in subjects with spinal cord injury, stroke, cerebral palsy and other conditions. This article provides a comprehensive overview of general aspects of FES cycling systems and clinical applications of FESCE. The studies cited in this article provide supportive findings for the potential clinical efficacy of FESCE for reducing the risk of secondary medical complications in subjects with paralysis. The potential therapeutic benefits of FESCE include conditioning the cardiopulmonary, muscular, and skeletal systems, and improving other physiological and psychological

performances. Our recent pilot study also indicated that the decrease of leg spasticity in subjects with cerebral palsy is one of the acute effects of FESCE. In conclusion, we recommend that FESCE is of benefit in a variety of aspects to improve the general condition and to prevent deterioration in subjects with central neurological impairments.

Rationale and design of a randomized controlled clinical trial of functional electrical stimulation cycling in persons with severe multiple sclerosis.

Pilutti, L.A., Motl, R.W., Edwards, T.A. & Wilund, K.R. (2016).

Contemporary Clinical Trials Communications, 3: 147-152

Abstract

Background - This randomized controlled trial (RCT) will examine the efficacy of supervised functional electrical stimulation (FES) cycling on walking performance and physiological function among persons with multiple sclerosis (MS) with severe mobility disability.
Methods/design - This RCT will recruit 16 persons with MS that require unilateral or bilateral assistance for ambulation (i.e., Expanded Disability Status Scale (EDSS) score = 6.0–6.5). Participants will be randomized to one of two conditions: supervised FES cycling or passive cycling. The FES cycling condition will involve mild electrical stimulation that will generate an activation pattern that results in cycling the leg ergometer. The passive cycling condition will not provide any electrical stimulation, rather the movement of the pedals will be controlled by the electrical motor. Both conditions will be delivered 3 days/week for the same duration, over 6 months. Primary outcomes will include walking performance assessed as walking speed, endurance, and agility. Secondary outcomes will include physiological function assessed as cardiorespiratory fitness, muscular strength, and balance. Assessments will take place at baseline, mid-point (3-months), and immediately following the intervention (6-months).
Discussion - This study will lay the foundation for the design of a future RCT by: (1) providing effect sizes that can be included in a power analysis for optimal sample size estimation; and (2) identifying cardiorespiratory fitness, muscular strength, and balance (i.e., physiological function) as mechanisms for the beneficial effects of FES cycling on walking performance. This trial will provide important information on a novel exercise rehabilitation therapy for managing walking impairment in persons with severe MS.

A pilot study of functional electrical stimulation cycling in progressive multiple sclerosis.

Ratchford J.N.; Shore W.; Hammond E.R.; Rose J.G.; Rifkin R.; Nie P.; Tan K.; Quigg M.E.; de Lateur B.J.; Kerr D.A. (2010).

NeuroRehabilitation, 27(2): 121-128.

Abstract

Background: Functional electrical stimulation (FES) cycling is used by spinal cord injury patients to facilitate neurologic recovery and may also be useful for progressive MS patients. Objective: To evaluate the safety and preliminary efficacy of home FES cycling in progressive MS and to explore how it changes cerebrospinal fluid (CSF) cytokine levels. Methods: Five patients with primary or secondary progressive MS were given an FES cycle for six months. Main outcome measures were: Two Minute Walk Test, Timed 25-foot Walk, Timed Up and Go Test, leg strength, Expanded Disability Status Scale (EDSS) score, and Multiple Sclerosis Functional Composite (MSFC) score. Quality-of-life was measured using the Short-Form 36 (SF-36). Cytokines and growth factors were measured in the CSF before and after FES cycling. Results: Improvements were seen in the Two Minute Walk Test, Timed 25-foot Walk, and Timed Up and Go tests. Strength improved in muscles stimulated by the FES cycle, but not in other muscles. No change was seen in the EDSS score, but the MSFC score improved. The physical and mental health subscores and the total SF-36 score improved. Conclusions: FES cycling was reasonably well tolerated by progressive MS patients and encouraging improvements were seen in walking and quality-of-life. Larger studies of FES cycling in progressive MS are indicated.

Pilot Study: Evaluation of Functional Electrical Stimulation Cycling on Muscle Metabolism in Nonambuatory People With Multiple Sclerosis.

Reynolds, M.A.; McCully, K.; Burdett, B.; Manella, C.; Hawkins, L.; Backus, D. (2015).

Archives of Physical Medicine and Rehabilitation, 96(4): 627-632.

Abstract

Objective: To investigate the changes in muscle oxygen consumption (mMath EqO2) using near-infrared spectroscopy (NIRS) after 4 weeks of training with functional electrical stimulation (FES) cycling in nonambulatory people with multiple sclerosis (MS).

Design: Four-week before-after trial to assess changes in mMath EqO2 after an FES cycling intervention.

Setting: Rehabilitation hospital.
Participants: People (N=8; 7 men, 1 women) from a volunteer/referred sample with moderate to severe MS (Expanded Disability Status Scale score>6.0).
Intervention: Participants cycled 30 minutes per session, 3d/wk for 4 weeks or a total of 12 sessions.

Main Outcome Measures: mMath EqO2 of the right vastus lateralis muscle was measured with NIRS before and within 1 week after the intervention. Six bouts of 15-second electrical stimulation increasing from 2 to 7Hz were used to activate the muscle. mMath EqO2 was assessed by analyzing the slope of the NIRS oxygen signal during a 10-second arterial occlusion after each electrical stimulation bout.

Results: Significant FES training by electrical stimulation frequency level interaction was observed (P=.031), with an average increase in mMath EqO2 of 47% across frequencies with a main effect of training (P=.047).

Conclusions: FES cycling for 4 weeks improved mMath EqO2, suggesting that FES cycling is a potential therapy for improving muscle health in people with MS who are nonambulatory.

Functional electrical Stimulation-assisted cycling of patient with multiple sclerosis: biomechanical and functional outcome - a pilot study.

Szecsi J.; Schlick C.; Schiller M.; Pollmann W.; Koenig N.; Straube A. (2009).

Journal of Rehabilitation Medicine, 41(8): 675-680.

Abstract

Objective: To determine whether functional electrical stimulation-supported ergometric training of patients with multiple sclerosis has a prosthetic or therapeutic effect on biomechanical (power, smoothness of cycling) and functional outcomes (walking capability, strength of muscle, spasticity).

Design: Twelve subjects with multiple sclerosis participated in an electrical stimulation-supported ergometric training (3 sessions/week for 2 weeks). Measurements were made in a cross-over design to study prosthetic (with and without stimulation) and therapeutic effects (before and after training).
Methods: Power and smoothness were calculated by cadence and torque recordings of cycling and spasticity; strength and walking capability were measured by the Modified Ashworth Scale, Manual Muscle Test, and 10-Metre Walk Test.

Results: The power and smoothness of pedalling significantly improved prosthetically with electrical stimulation ($p=0.02$), but did not show significant improvement over the 2 weeks of training. Significant short-term reductions in spasticity (before vs after training session; $p<0.05$) were found. Isometric strength did not increase significantly during the 2-week training period and there was no improvement in walking ability.

Conclusion: Patients with multiple sclerosis are able to improve their cycling power and smoothness by pedalling with stimulation. We suggest that severely affected patients benefit more from functional electric stimulation-cycling therapy than do slightly affected patients.

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