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Electrical stimulator with mechanomyography-based real-time monitoring, muscle fatigue detection, and safety shut-off: A pilot study (Article)

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Abstract

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Functional electrical stimulation (FES) has been used to produce force-related activities on the paralyzed muscle among spinal cord injury (SCI) individuals. Early muscle fatigue is an issue in all FES applications. If not properly monitored, overstimulation can occur, which can lead to muscle damage. A real-time mechanomyography (MMG)-based FES system was implemented on the quadriceps muscles of three individuals with SCI to generate an isometric force on both legs. Three threshold drop levels of MMG-root mean square (MMG-RMS) feature (thr50, thr60, and thr70; representing 50%, 60%, and 70% drop from initial MMG-RMS values, respectively) were used to terminate the stimulation session. The mean stimulation time increased when the MMG-RMS drop threshold increased (thr50: 22.7 s, thr60: 25.7 s, and thr70: 27.3 s), indicating longer sessions when lower performance drop was allowed. Moreover, at thr70, the torque dropped below 50% from the initial value in 14 trials, more than at thr50 and thr60. This is a clear indication of muscle fatigue detection using the MMG-RMS value. The stimulation time at thr70 was significantly longer ($p = 0.013$) than that at thr50. The results demonstrated that a real-time MMG-based FES monitoring system has the potential to prevent the onset of critical muscle fatigue in individuals with SCI in prolonged FES sessions. © 2020 Walter de Gruyter GmbH, Berlin/Boston 2020.

SciVal Topic Prominence ⓘ

Topic: Muscle Fatigue | Electromyography | Muscle Isometric Contraction

Prominence percentile: 83.203 ⓘ

Author keywords

FES KE MMG RMS SCI

Indexed keywords

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Drops Functional electric stimulation

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Engineering uncontrolled terms

Electrical stimulators Functional electrical stimulation Mechanomyography
Monitoring system Paralyzed muscles Real time monitoring Root Mean Square
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Engineering main heading:

Muscle

EMTREE medical terms:

adult Article clinical article diagnostic value functional electrical stimulation human
leg mechanomyography middle aged muscle fatigue muscle isometric contraction
muscle strength myography pilot study priority journal quadriceps femoris muscle
reaction time spinal cord injury torque validation study

Device tradename:

ADXL335, Biodex dynamometer System 4, Biodex, United States, RehaTrodé

Manufacturers:

Device manufacturer:

Biodex, United States;

National Instruments, United States

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