Neural and structural adaptation of human skeletal muscle to overstretch and overload through mechanical stimuli delivered by dynamometry and exoskeletons

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The primary objective of this study is to establish the relationships between structural and neural adaptation of human skeletal muscle when muscles are exposed to overstretch and overload through exercise.

Ethical review	Approved WMO
Status	Pending
Health condition type	Muscle disorders
Study type	Interventional

Summary

ID

NL-OMON51207

Source
ToetsingOnline

Brief title
Neural and structural muscle adaptation to exercise

Condition

- Muscle disorders
- Neuromuscular disorders

Synonym
spinal cord injury, stroke

Research involving
Human

Sponsors and support

Primary sponsor: University of Twente
Source(s) of monetary or material Support: European Research Council Starting Grant (no. 803035)

Intervention

Keyword: Adaptation, Exercise, Muscle

Outcome measures

Primary outcome

The primary outcome of this study will be to relate muscle volume, fascicle length, and pennation angle to motor unit discharge rate, inter-spike interval, and recruitment threshold.

Secondary outcome

The secondary outcome of this study will be to compare muscle fascicle length changes and shortening velocity, and motor neuron discharge rate, inter-spike interval, and recruitment threshold before and after the training intervention.

Study description

Background summary

Understanding human-machine motor interaction requires accounting for the variable nature of the human body. By a simplified example, the same neural command to a muscle would yield different force profiles (i.e. function) depending on the muscle form, e.g. changes in muscle cross-sectional area post-impairment. How changing form alters function is central for understanding motor function, dysfunction and recovery. Structural changes in the central nervous system (i.e. following a brain lesion) are shown to induce structural changes in muscles, ligaments, tendon properties. In stroke survivors this leads to abnormal neuro-musculoskeletal function underlying paresis, muscle spastic tone, abnormal joint couplings. Although treatment programs can improve paretic muscle control and global motor capacity the neuro-muscular structural changes that drive recovery are not fully understood, thus limiting treatment

effectiveness. How the change in muscle structure is associated with neural alterations is currently unknown. Once these relationships are established, and once it is known how structural and neural adaptations affect muscle force generation and function, individualised and more optimal rehabilitation strategies can be developed.

Study objective

The primary objective of this study is to establish the relationships between structural and neural adaptation of human skeletal muscle when muscles are exposed to overstretch and overload through exercise.

Study design

The experiment is of a longitudinal design including a exercise intervention with a total of 34 sessions spanned across 16 weeks.

Intervention

For the experiment, the exercise intervention will consist of maximal voluntary ankle eccentric plantarflexion contractions. Two training session will be performed per week for a training period of 8 weeks. Per session, 5 bouts of 10 repetitions will be performed.

Study burden and risks

This study does not create a direct benefit for the participants. There is a considerate time commitment for participating in this study. However, participants will be fairly compensated financially and in form of a smartwatch for participating in this study. The risks associated with participating in this study are negligible. The prospect of developing individualised and more optimal rehabilitation strategies based on the structural and neural relationships established in this study will hopefully lead to improved quality of life for stroke and spinal cord injury patients, in the future.

Contacts

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Trial sites

Listed location countries

Netherlands

Eligibility criteria

Age
Adults (18-64 years)

Inclusion criteria

- Age between 18 and 55,
- legal capacity to give their consent at their own will

Exclusion criteria

- neuromuscular disease,
- carrier of infectious diseases (COVID19),
- degenerative mental impairment, e.g. dementia,
- inability to cooperate, e.g. due to cognitive deficits (in understanding instructions) or a level of motor impairment that does not permit execution of the intended tasks,
- subjects suffering from known cardiac conditions (e.g., pacemakers, arrhythmias, and cardiac conduction disturbances) or peripheral neuropathy.
- skin sensitivity or allergies as these are typical contraindications for the application of surface EMG electrodes via adhesive elements and conductive gels.
- If participants have one of the following objects in their bodies: metal (splinters) (e.g., by working in the metal industry); pacemaker, pacemaker leads or an implanted defibrillator; an artificial heart valve/aorta valve or a stent; clips on blood vessels; implanted magnets in the jaw; fixed hearing aid, bladder stimulator, insulin pump, neurostimulator, baclofen pump, tissue expander; eye or ear implants; foreign materials implanted in the body; braces or metallic wire fixed behind teeth; piercings. Participants with these objects

in/on their bodies have to be excluded as they must not be inside of a magnetic resonance imaging device
- Dependency on one or more researchers of this project

Study design

Design

Study type: Interventional

Masking:	Open (masking not used)
Control:	Uncontrolled
Primary purpose:	Prevention

Recruitment

NL

Recruitment status:	Pending
Start date (anticipated):	01-01-2022
Enrollment:	30
Type:	Anticipated

Ethics review

Approved WMO

Date:	18-05-2022
Application type:	First submission
Review commission:	CMO regio Arnhem-Nijmegen (Nijmegen)

Study registrations

Followed up by the following (possibly more current) registration

No registrations found.

Other (possibly less up-to-date) registrations in this register

No registrations found.

In other registers

Register	ID
CCMO	NL77393.091.21