Muscle endurance of the upper and lower extremity

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- Examine the reproducibility of the non-volitional endurance test in healthy subjects. The hypothesis is that the non-volitional endurance test is reproducible.- Comparing arm and leg muscle endurance in healthy subjects. It is expected that arm...

Ethical review	Approved WMO
Status	Recruitment stopped
Health condition type	Other condition
Study type	Observational non invasive

Summary

ID

NL-OMON34536

Source
ToetsingOnline

Brief title
Muscle endurance of the upper and lower extremity

Condition

- Other condition

Synonym
n.v.t.

Health condition

n.v.t.

Research involving
Human

Sponsors and support

Primary sponsor: Medisch Universitair Ziekenhuis Maastricht
Source(s) of monetary or material Support: Ministerie van OC&W

Intervention

Keyword: Arm, Electrical muscle stimulation, Leg, Muscle endurance

Outcome measures

Primary outcome

Muscle endurance of the biceps brachii and quadriceps femori.

- number of contractions until 20, 30 and 40% torque decline)

- steady state (% peak torque)

- transition point of the torque decline curve

Secondary outcome

Date of birth

gender

length

weight

BMI

Study description

Background summary

Muscle dysfunction is commonly observed in patients with chronic obstructive pulmonary disease (COPD). Muscle function is reflected by muscle strength and muscle endurance. Strength is the capacity of a muscle to develop maximal force, while endurance is the capacity of a muscle to maintain a certain force. Loss of one of these components will result in muscle weakness and impaired muscle performance. At cellular level, lower limb muscles show a reduced cross-sectional area and fiber type redistribution in COPD patients, resulting

in a reduced proportion of fatigue-resistant slow fibers. In addition, lower limb muscles showed a reduced oxidative capacity, due to diminished oxidative enzyme activity. It is unclear whether muscle dysfunction is generalized or if it mainly affects the lower extremities. The majority of studies on muscle function assessment in COPD patients focus on lower limb muscles. Particularly the quadriceps femoris is often assessed, a primary locomotor muscle which is easily accessible. Nevertheless, the quadriceps femoris may not reflect general skeletal muscle function, since this is one of muscles that probably are under used in COPD. Moreover, it is expected that upper limb muscle function is relatively preserved in COPD patients.

At present, a wide range of test models and protocols is being used for quantification of muscle endurance in COPD patients. This probably contributes to divergent results. The methods for muscle endurance quantification can be divided on basis of muscle activation strategy, involving voluntary effort or exogenous stimulation. Within voluntary assessment, the exercise conditions consist of isokinetic, isometric or isotonic contractions of the examined muscle. Within exogenous muscle stimulation, options comprise stimulation of the motor nerve, or stimulation of motor end plates. When interested in muscle endurance, maximal muscle activation is a requirement. A sub-maximal test could also be appropriate, if it could be confirmed that the same muscle fibres are activated during each contraction. However, during a sub-maximal muscle contraction, subjects can vary in contracted muscle fibres to achieve the requested task. Dyspnea and fatigue, which are frequent features of COPD patients, can interfere with an exercise test. Consequently, tests involving maximal voluntary contractions (MVC*s) are likely to obtain sub-maximal test results when used in COPD patients and might therefore not be appropriate to quantify muscle function in COPD.

Limitations of voluntary manoeuvres are overcome by non-volitional muscle activation. The muscle response of electrical stimulation can be measured in an isometric condition. A benefit of the electrical stimulation technique is that the generated force accurately reflects maximal strength. Furthermore, obtained data is independent of patient motivation and central activation factors. The first option of stimulation is to deliver stimuli to the motor nerve. A weakness of this procedure is that endurance data is difficult to obtain. It is a painful technique and constancy of stimulation is hard to preserve because the stimulation coil can move relative to the nerve. An other disadvantage is that it can not be used for assessment of the upper limb muscle. That is, stimulation of the brachial plexus innervates the biceps brachii as well as the antagonistic triceps brachii. Consequently, the measured external force will not reflect true biceps brachii strength.

In contrast, stimulation of the motor end plates might be appropriate to quantify muscle endurance of lower and upper limbs in COPD patients. A great benefit of stimulation of the motor end plates of a muscle is that the contraction of the muscle is better tolerated. Up till now, this technique had only been applied on the quadriceps muscle in COPD patients. In 2007, Swallow et al. made use of repetitive magnetic stimulation of the intramuscular branches of the femoral nerve to induce and quantify quadriceps endurance in

healthy subjects and COPD patients. Stimuli were given at 30 Hz, a duty cycle of 0.4 (2 s on, 3 s off), and for 50 trains. They found a shorter time for force to fall to 70% of baseline (T70) in the COPD group. In addition, they concluded that quadriceps endurance, assessed using repetitive muscle stimulation, can be safely and reproducibly measured in healthy older humans and in patients with a serious medical condition (COPD). Wüst et al. (2008) assessed fatigue resistance in smokers and non-smokers, by stimulating the quadriceps muscle with 30-Hz trains for 2 min (1 s on, 1 s off). The main finding of this study was a lower skeletal muscle fatigue resistance in smokers. Furthermore, this type of stimulation seems also applicable to upper limb muscles.
The effects of electrical muscle stimulation parameters (e.g. amplitude, frequency and duration) on muscle fatigue of the knee extensors have been studies in healthy subjects. However, information on the reproducibility of an endurance test using electrical stimulation for both the lower and upper limbs is currently lacking. Moreover, reference values on the ratio between lower and upper limb muscle endurance are not available. Before testing muscle endurance using electrical stimulation extensively in a clinical population (such as COPD), the reproducibility of the endurance test needs to be examined in healthy subjects.

Study objective

- Examine the reproducibility of the non-volitional endurance test in healthy subjects. The hypothesis is that the non-volitional endurance test is reproducible.
- Comparing arm and leg muscle endurance in healthy subjects. It is expected that arm muscle endurance is lower than leg muscle endurance.
- Comparison of muscle endurance tested at three different stimulation intensities. It is hypothesised that there is no effect of stimulation intensity.

Study design

All subjects will be recruited at Maastricht University. Participating subjects have to give written informed consent and are required to visit the movement laboratory of Maastricht University on five occasions. The subjects will be instructed to arrive at the movement laboratory in a rested state, they may not have performed heavy exercise in the preceding 24 hours. During the first visit, subjects will be familiarized with all equipment and testing procedures and perform a leg and arm maximal strength test. During the next three visits, the subjects will perform three leg and three arm endurance tests, on three different stimulation intensities. During the last visit, one arm and one leg endurance test will be repeated on the highest intensity of the three preceding intensities. For the participants, the total duration of the study will be 225 minutes.

Test procedures
Participants will be informed both verbally as in written. Subjects have at least one day time for reflection before decide if they are willing to participate. Subject characteristics as age, gender, height, weight and BMI will be collected. Both the strength and the endurance test will be performed on a dynamometer (Biodex system 3, Biodex corporation, Shirley, New York, U.S.), which will be initialized and calibrated according to the manufacturer*s instructions. In both the upper and lower extremity tests, the right limb will be measured. All experiments will begin with establishment of the correct seating position. The correct seating position will be determined during the first visit and will be replicated during the next visit(s).

Strength test
Subjects will carry out two separate strength tests, one for measurement of knee extensor strength and one for measurement of arm flexor strength. To this end, three isometric MVCs will be performed, each lasting 3 s and separated by 120 s rest. A countdown will be given, followed by strong verbal encouragement to maximize torque. The measured maximal torque (Nm) will be used for estimation of the percentage MVC that corresponds with the peak torque measured during the endurance test.

Endurance test
The endurance test will be performed with muscle stimulation. For the upper extremity endurance test, two rubber electrodes (4 x 6 cm) covered in sponges will be placed on the biceps brachii motor end plates. For the lower extremity endurance test, two rubber electrodes (8 x 12 cm) covered in sponges will be placed on the quadriceps femoris motor end plates. The electrodes will be secured on the muscle with use of Velcro bandages. Electrical stimulation will be provided with the TENSMED S84 (Enraf Nonius). The stimulation protocol consists of 2 s stimulation and 2 s rest. The stimulation frequency will be set at 30 Hz, with a pulse width of 400 µs.

From the dynamometer output, the peak torque (Nm) and TLIM (number of contractions until 20, 30 and 40% torque decline) will be calculated.

Study burden and risks

The total duration of the experiment will be 225 minutes (5 days, 45 minutes per day). During the first visit, subjects will be asked to perform three maximal voluntary contractions with their arm flexors and knee extensors on a dynamometer. During the next three visits, the subjects will perform leg and arm endurance tests with use of muscle stimulation. These tests will be implemented on three different intensities. The electrical stimuli (300s: 2s on 2s off, 30Hz) will be delivered trough two rubber electrodes on the motor end plates of the biceps brachii and of the quadriceps femoris. There are no risks or benefits associated with this study.

Contacts

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Trial sites

Listed location countries

Netherlands

Eligibility criteria

Age
Adults (18-64 years)
Elderly (65 years and older)

Inclusion criteria

Informed consent
Healthy: no neuromuscular disorders, no joint disorders, no metal implants, no pacemaker
Age: 21-30 years
Eight men, eight women
Different physical activity levels (five sportsmen, six semi-sportsmen, five non-sportsmen)

Exclusion criteria

Neuromuscular disorders
Joint disorders
Metal implants

Cardiale pacemaker or Internal Cardiac Defibrillator (ICD)
Lack of motivation

Study design

Design

Study type: Observational non invasive

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

Recruitment

NL

Recruitment status:	Recruitment stopped
Start date (anticipated):	29-10-2010
Enrollment:	16
Type:	Actual

Ethics review

Approved WMO

Date:	23-07-2010
Application type:	First submission
Review commission:	METC academisch ziekenhuis Maastricht/Universiteit Maastricht, METC azM/UM (Maastricht)

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	NL32277.068.10