Detecting Musculoskeletal Parameters by Magnetic Resonance Imaging for Biomechanical Models

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

Summary

ID

NL-OMON39569

Source
ToetsingOnline

Brief title
Development of Biomechanical models by MRI

Condition

- Other condition

Synonym
N.A.

Health condition

Geen, niet gericht op aandoeningen

Research involving
Human

Sponsors and support

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

Intervention

Keyword: modelling, motion capture, mri, personalized

Outcome measures

Primary outcome

MRI Parameters:

- Individual muscle volumes

- Fiber trajectory

- Fiber length

- Physiological cross sectional area

- Attachement points (origo + insertion of muscles)

- Bone gyometry

Biomechanical parameters

- Maximal contractions (voluntary and including electronic stimulation)

- Muscle activities during activities of daily living (ADL-tasks)

- kinematic parameters during ADL-taken

- kinetic parameters during ADL-taken

Secondary outcome

N.A.

Study description

Background summary

Musculoskeletal biomechanical models are used to study mechanics of musculoskeletal disorders and simulate surgical treatments [1]. To date, biomechanical models are based on human cadaveric measurements. Bone surfaces and muscle characteristics (e.g. muscle fiber length, muscle mass, pennation angle) were obtained from these cadavers and from this anthropometrical data biomechanical models were programmed. To personalize these musculoskeletal biomechanical models scaling was introduced. For generic purpose this scaling worked rather well. However for individual purpose these scaled models were insufficient, for example to predict muscle activations [2]. This inaccuracy in subject specific modelling is a major disadvantage to use these biomechanical models in a clinical setting. Besides, these generic models are only tested on healthy subjects; patients with musculoskeletal disorders are known to show even larger deviations. Imaging techniques are expected to play an important role for capturing individual musculoskeletal parameters for biomechanical models [1].
Murphy et al (1986) [3] showed one of the first applications of MRI on skeletal muscles. Their MRI scanner conducted low contrast pictures; nevertheless they were able to distinguish different muscles. Modern MRI-scanners, 3 tesla or higher, are able to produce pictures of the muscles with high contrast. Moreover, nowadays MRI- protocols can detect musculoskeletal parameters, for example muscle volume and fiber trajectories [4]. Froeling et al 2012 [5] showed the visualisation of muscle fiber trajectories within a muscle by using an advanced technique of MRI, Diffusion Tensor Imaging (DTI). This implies a possibility for using this technique to determine Physiological Cross Sectional Area (PCSA). The maximal force of a muscle is proportional to the PCSA. Therefore, PCSA is an important determinant within biomechanical models. Another possibility of in-vivo MRI is to determine insertion points of muscles to the bones [6]. These insertion points have a large inter-individual variation [7], for biomechanical models this is an important parameter to take into account. Individual musculoskeletal parameters (e.g. PCSA and insertion points of muscles) are necessary to obtain to make biomechanical models subject-specific.

Study objective

The main aim of this study is to estimate internal joint loading and muscle activations during activities of daily living. Therefore, biomechanical models are used that can predict these internal parameters non-invasively. However, to make these biomechanical models accurate, subject specific data will be necessary. For this reason musculoskeletal properties will be obtained by magnetic resonance imaging (MRI).

Study design

Cross-sectional study, including a subset for reproducability.

Study burden and risks

The involved tests are minimally invasive. During the motion capture analysis in the human movement laboratory, subjects will perform Daily activity tasks (level walking, walking the stairs, sitting and rising from a chair). As safety measure for walking the stairs we included handrails. Test subjects will be guided by the investigator. Their is a possible risk for muscle soreness on the day performing the maximal strength test, or the day(s) after.
Next a MRI scan will be performed. This requires lying down very still from a subject for about two hours. The Radiology department will assist in preparing the subject and explaining the protocol. All metal objects are removed from the subject. The potential risks involved could be previously not mentioned claustrophobia. If this ought to be an acute problem to the subject, then subjects as well as the MRI-performing radiology-assistant are allowed to withdraw from testing at all times. Otherwise we conclude there are no other risks involved.

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Trial sites

Listed location countries

Netherlands

Eligibility criteria

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

Inclusion criteria

We will include 30 subjects for the screening (step 1). Subjects will perform a standard maximal voluntary isometric knee extension on the biodex (step 2). Thereafter all 30 subjects will be arranged from low to high maximal isometric knee extension torque. Based on their maximal knee extension torque 10 subjects will be selected. From the male participants one with the highest maximal torque and one with the lowest maximal torque and three intermediate will be selected. The same selection will be performed for the female participants. These 10 participants will complete the MRI-protocol and the measurements at the Department of Human Movement Sciences (step 3). Based on this wide variety of strength between subjects, a high diversity of personalized models can be tested. Furthermore, the subjects should be between 18 and 65 years of age and should be able to complete all tests, instructed by the researcher. Finally we will select 5 subjects in the reproducibility study (step 4), who finished step 3.

Exclusion criteria

Clinical exclusion criteria: all musculoskeletal disorders of the lower extremities, which still affect their locomotion, prosthesis on the lower limbs and mental illnesses with visible changes of activities in daily living (walking, stair walking and chair raising). MRI exclusion criteria: weight > 150 kg, claustrophobia, pacemaker, pregnancy or breastfeeding. Electro stimulation exclusion criterion: pacemaker. Finally, volunteers older than 65 will be excluded, because of an increased risk of musculoskeletal disorders, and a decreased ability to exert full muscle potential.

Study design

Design

Study type: Observational non invasive

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

Recruitment

NL

Recruitment status:	Recruitment stopped
Start date (anticipated):	01-03-2013
Enrollment:	30
Type:	Actual

Ethics review

Approved WMO

Date:	27-03-2013
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	NL42545.068.12