A biomechanical analysis of the single-leg Roman chair hold and the Nordic hamstring curl

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Primary Objective: Investigate wether fascicle length changes of the biceps femoris long head are larger than the typical error during the NHC and the SLRCH.Secondary Objective(s): compare the NHC and the SLRCH on their required hamstring muscle...

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

Summary

ID

NL-OMON48674

Source
ToetsingOnline

Brief title
Biomechanical analysis of the Roman chair hold and the Nordic curl

Condition

- Other condition

Synonym
Hamstring injuries

Health condition

Sportblessures

Research involving
Human

Sponsors and support

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

Intervention

Keyword: Biomechanics, Exercises, Hamstrings, Injuries

Outcome measures

Primary outcome

The primary parameter in this study is fascicle length changes as determined by

B-mode ultrasound

Secondary outcome

Secondary study parameters are muscle activity as determined by surface

electrodes and muscle forces as determined by static inverse dynamics from

external force measurements and 3D motion analysis.

Other study parameters are body height, mass, age and training experience.

Study description

Background summary

Exercise has been proposed as an effective primary and secondary prevention strategy for many diseases.1 A recent meta-analysis of different sports found the strongest evidence for the health benefits of football and running.2 However, hamstring injuries are one of the most common injuries in sports that involve high-speed running such as football and they have a high risk of recurrence.3-5 Specifically, the incidence of hamstring injuries has been reported to range from 20.3-36.9 per 1000h of match play3 6 and the re-injury rate has been reported to range from 12-33%.7 Reducing the number of hamstring injuries can result in greater health benefits from exercise2 8-10 and improve sports performance.11-13
Traditionally, it has been assumed that there is an eccentric hamstring muscle

fiber action (i.e., the fibers lengthen while being activated) during the swing phase of high-speed running.14 Since improvements in force production following training are largely specific to the contraction type15, exercises thought to produce an eccentric muscle fiber action have been used to specifically condition the hamstrings for high-speed running and hereby prevent hamstring injuries.16 Although several studies have shown eccentric training to be effective in reducing the number of hamstring injuries17, the overall hamstrings injury rate has not decreased in the last 30 years18, but even increased by an average of 2.3% per year from 2001-2014 in professional football.19

It has recently been argued that there is no eccentric, but an isometric hamstring muscle fiber action during the swing phase of high-speed running.14 Additionally, the authors suggested that an inability of the muscle fibers to remain isometric due to a lack of isometric strength could lead to hamstring injuries. Isometric hamstring exercises were therefore hypothesized to be more specific and hence more effective than eccentric exercises in strengthening the hamstrings for high-speed running and preventing injuries.17 However, no study has investigated whether isometric hamstring exercises are indeed more effective at improving running performance and in preventing hamstring injuries than eccentric exercises.

Exercises that require a high muscle activity and force production are likely the most effective at conditioning the hamstrings and preventing hamstring injuries. For example, loading intensity has been found to be the primarily stimulus for molecular responses in both muscle and tendinous tissue20 21 and the findings of a meta-analysis suggest that loading intensity is the primarily stimulus for improving neuromuscular function in Achilles and patella tendinopathy.22 Therefore, by investigating the muscle activity and muscle forces elicited by an exercise, it can be determined which exercise has the highest potential to elicit training adaptations.23 Since non-invasive direct measurements of muscle forces during movement is not possible in humans, muscle forces have to be estimated using other methods such as computational modelling24-26 or supersonic shear imaging.27 Furthermore, since the hamstring muscle fibers likely function isometric in their optimum length during the swing phase of high-speed running14, an isometric exercise would likely have the greatest transfer to performance and injury prevention.17 However, the behavior of the muscle fascicles during most hamstring exercises is unknown.

For example, although the Nordic hamstring curl (NHC) is arguably the most widely used *eccentric* exercise, it is actually unknown whether this exercise really requires an eccentric muscle fiber action and whether the force measured during this exercise does therefore indeed represent eccentric force.

Similarly, although the *isometric* singe-leg Roman chair hold (SLRCH) has recently shown promising results in reducing a risk factor for hamstring injuries28, it is unknown whether this exercise is indeed isometric.

Therefore, the aim of this study is to investigate which exercise is theoretically most effective in improving high-speed running performance and preventing hamstring injuries by comparing the NHC to the SLRCH on their required hamstring muscle activity, force and fascicle length changes.

Male athletes that participate in running-based sports will be used as participants since these individuals are most likely to experience a hamstring injury and it is therefore important to know which exercise is most beneficial to prevent hamstring injuries in these individuals. Furthermore, B-mode ultrasound images of the hamstrings are more clear when these muscles are better conditioned. Since the hamstrings are highly involved in running29, it can be expected that individuals that participate in running-based sports have better conditioned hamstrings compared to individuals not participating in running-based sports. Finally, participants who have already some experience in sports are likely faster familiarized with the exercise than individuals who have no or very little experience in sports.

Study objective

Primary Objective: Investigate wether fascicle length changes of the biceps femoris long head are larger than the typical error during the NHC and the SLRCH.

Secondary Objective(s): compare the NHC and the SLRCH on their required hamstring muscle activity and muscle force.

Study design

This study will be a cross-sectional study. All tests will be performed within approximately 3 months in the Gait Lab of the department of Human Movement Sciences of Maastricht University.

Study burden and risks

Two experimental sessions of approximately 1 hour for the first session and 3 hours for the second session, with at least 3 and maximum 7 days between the sessions. Additionally, the procedures are non-invasive and the exercises are unlikely to lead to injuries. The only discomfort that some participants will possibly experience is delayed onset of muscle soreness 24-48 hours after the exercises. However, the number of repetitions will be small so the total amount of muscle soreness will also be limited. The direct benefit for the participants is that they will receive information on the strength of their hamstrings. Furthermore, the research will benefit the population by providing new information on hamstring injury prevention and performance improvement. Traveling costs will be reimbursed for all participants (¤ 0.19 per km).

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

- Between 18-30 years old
- Participating in a sport that involves a considerable amount of high-speed running (i.e., > ~18 km/h) for at least three times a week. Sports that meet this criterion are football (soccer) rugby, hockey, running (when performing high-intensity interval training for at least three times a week);
- Male
- >1.70 m of height because long individuals are needed for a simultaneous measurement of ultrasound and surface electromyographic activity.

Exclusion criteria

- Severe visual or hearing impairment;
- History of a previous injury to the leg or back within the previous 24 months;

Study design

Design

Study type: Observational non invasive

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

Recruitment

NL

Recruitment status:	Recruitment stopped
Start date (anticipated):	14-10-2019
Enrollment:	10
Type:	Actual

Ethics review

Approved WMO

Date:	14-03-2018
Application type:	First submission
Review commission:	METC academisch ziekenhuis Maastricht/Universiteit Maastricht, METC azM/UM (Maastricht)

Approved WMO

Date:	04-07-2018
Application type:	Amendment
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

ID: 23832
Source: NTR
Title:

In other registers

Register	ID
CCMO	NL63290.068.17
OMON	NL-OMON23832