Regional hypertrophy in the human quadriceps following progressive resistance training

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Introduction

Muscles typically get larger in response to strength training (hypertrophy).

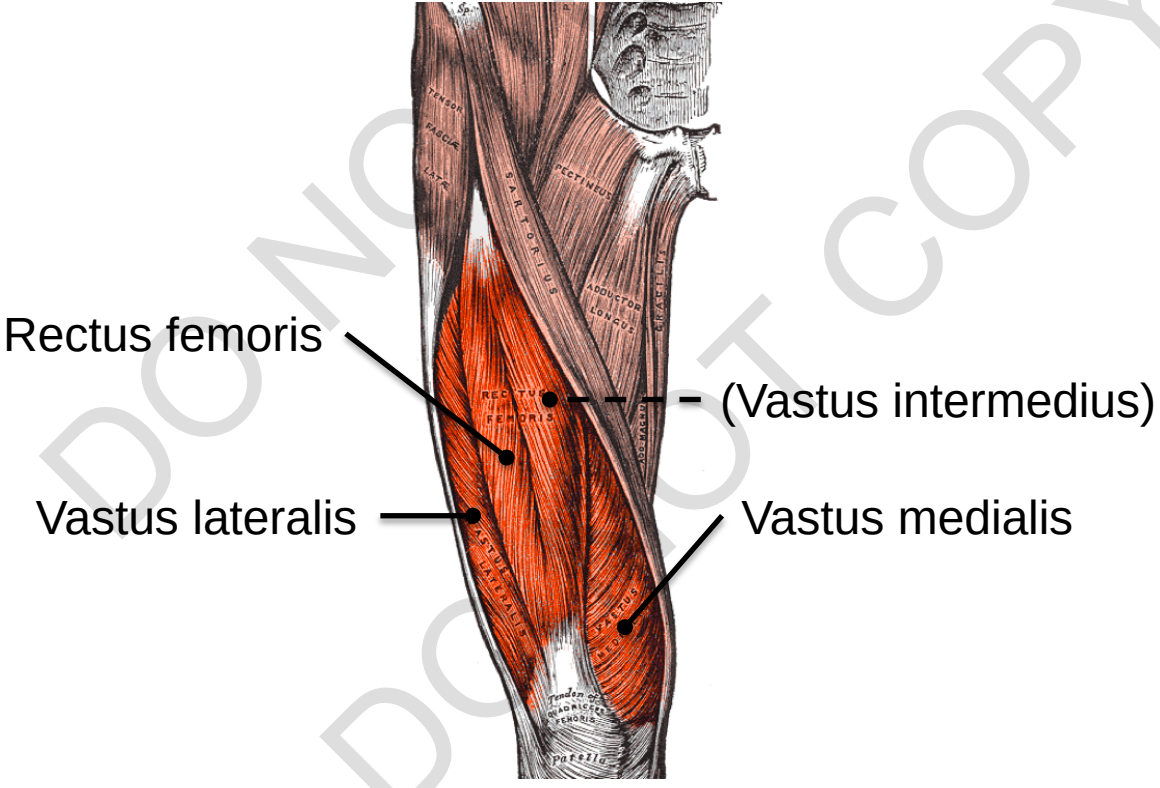
The amount of hypertrophy can vary *between muscle groups*:

- Elite sprinters have relatively larger hip and knee flexors and extensors compared to non-sprinters. (Handsfield et al., 2016)

Some studies found non-uniform hypertrophy *between muscles* of the same muscle group. (e.g. Narici et al. 1996, 1989)

Introduction

The human quadriceps femoris consists of four heads.



Introduction

The four muscles of the quadriceps have different architectures and different functions:

- the rectus femoris crosses both the knee and the hip joint, while the vasti only cross the knee joint
- the vastus medialis has a smaller proportion of fast-twitch fibres than the vastus lateralis (Edgerton et al., 1975)
- the vastus lateralis is twice as large as the vastus medialis, and three times larger than the rectus femoris and vastus intermedius

Do the four heads of the quadriceps hypertrophy by similar amounts following strength training?

Aim

The **aim of this study** was to determine whether there are differences in the amount of hypertrophy between the four muscles of the quadriceps following strength training.

Hypertrophy was measured as change in muscle volume and change in physiological cross-sectional area (PCSA).

Methods

11 participants underwent eight weeks of progressive resistance training

Participants had not conducted strength training in the 12 months prior to the start of training.

Participant characteristics (mean ± standard deviation):

- age: 21 ± 2 years
- height: 163 ± 7 cm
- weight: 56 ± 7 kg
- 9 females

Methods

Progressive resistance training program:

- 8 weeks, 3 sessions per week
  - four sets of 8-12 repetitions of bilateral leg extension
  - four sets of 8-12 repetitions of bilateral leg press
- Load was adjusted to stay within 8-12 repetitions

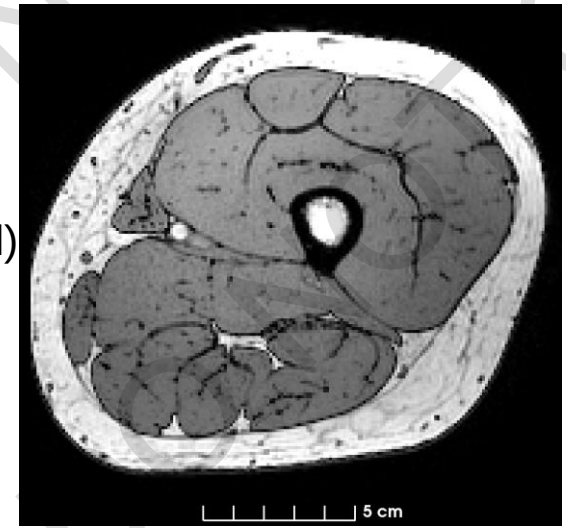
Isometric knee extensor strength was measured before and after training with a dynamometer.

Methods

Magnetic resonance imaging was performed on the left thigh before training and after training (48-72 hours after the last session)

- mDixon MRI: 180×180×320 mm, FFE sequence, TR/TE1/TE2: 6.2/3.5/4.6 msec, reconstructed voxel size: 0.94×0.94×1 mm, scan time: 6 minutes

anterior



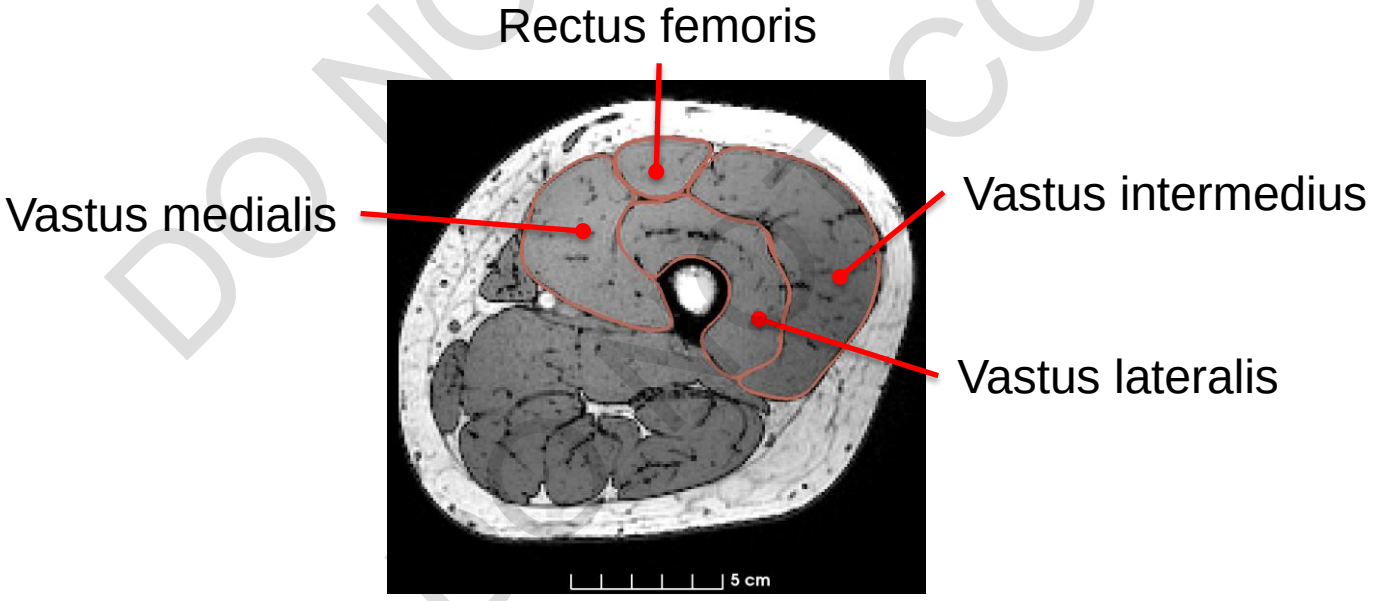
right (medial) left (lateral)

posterior

Methods

The quadriceps muscles were manually outlined on either the pre- or post-training scan (randomly selected for each participant).

Non-rigid image registration algorithms were used to outline the muscles on the other scan of that subject (Elastix v4.8).



Methods

Three-dimensional surface models were made of the quadriceps muscles.

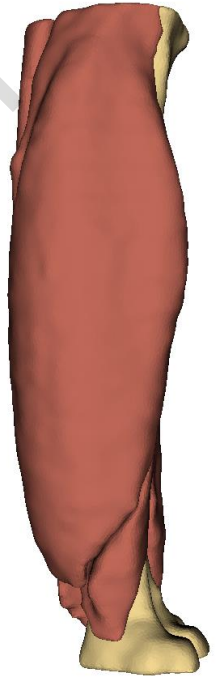
Muscle volumes were calculated as the volumes of the surface models.

PCSA was calculated as muscle volume divided by fascicle length, determined using diffusion tensor imaging

- ➢ See poster by Junya Eguchi.

Linear mixed models were used to determine:

- the effect of training on muscle volume and PCSA
- the effect of muscle on change in volume and PCSA following training



Results

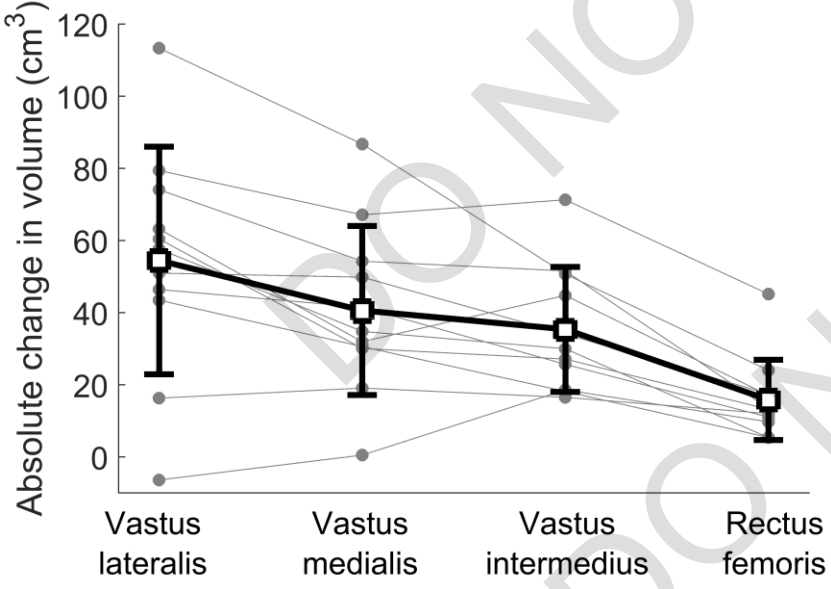
Isometric knee extensor strength increased by 12 ± 14%.

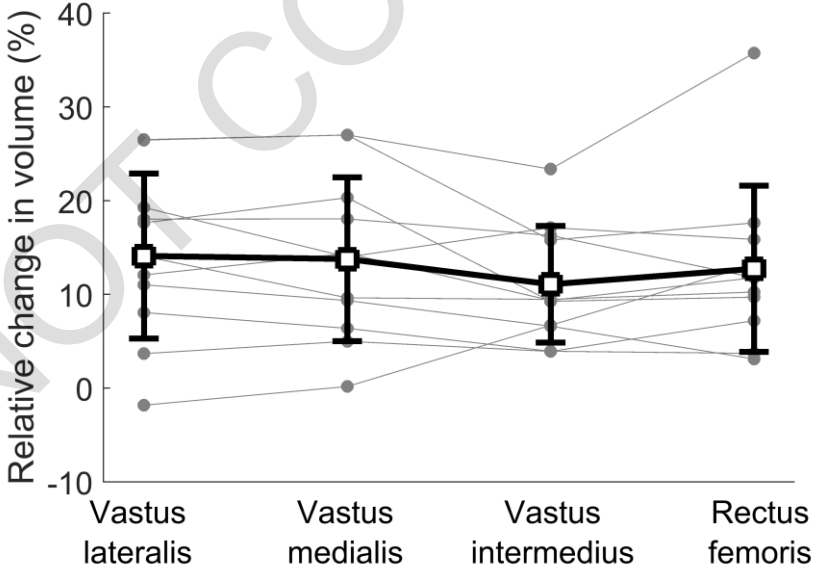
Total quadriceps volume increased by 13 ± 8%.

Results

All muscles increased in volume following training (range 11% to 14%).

We did not find differences between muscles in relative increase in volume.

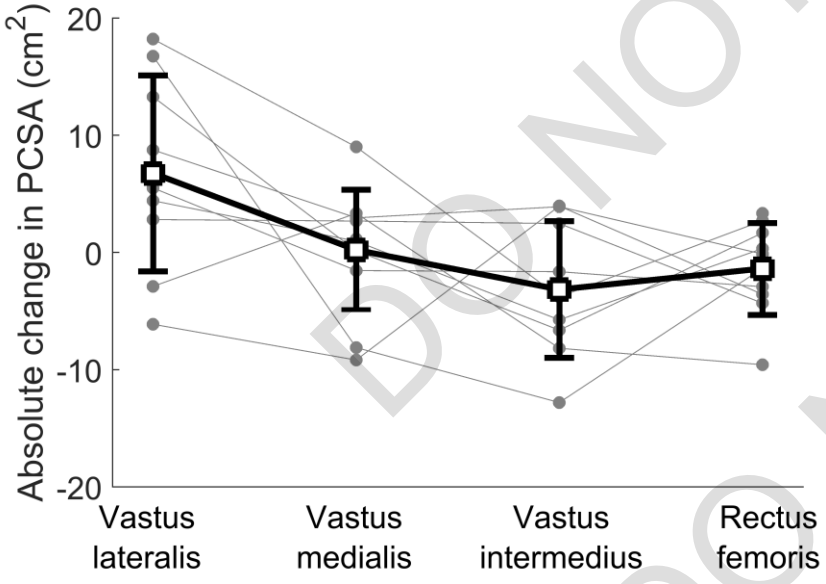


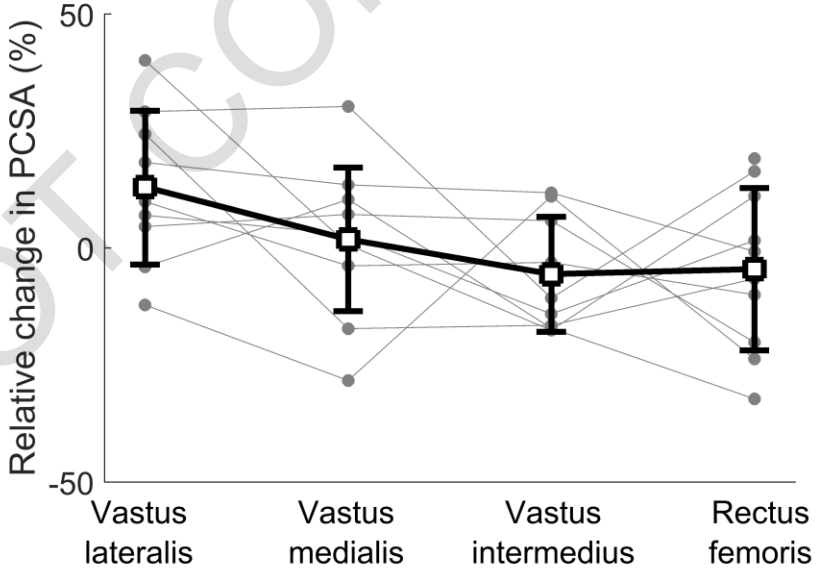


Results

Of all muscles, only the PCSA of the vastus lateralis changed (13 ± 17%, p=0.04).

The change in PCSA of the vastus lateralis was different from the other muscles.





Conclusion

All four heads of the quadriceps muscles increased in volume following eight weeks of progressive resistance training.

On average, muscles increased in volume in equal proportions of their initial volume → no evidence for regional hypertrophy in volume.

The PCSA of the vastus lateralis, but not of other muscles, increased with training.