IN VIVO MUSCLE FASCICLE KINETICS OF THE VASTUS LATERALIS DURING ECCENTRIC CONTRACTIONS

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Introduction
Eccentric muscle contractions can induce muscle damage and, thus, may lead to longitudinal adaptation [Proske, 2001]. During eccentric exercise protocols the muscle-tendon unit is lengthened during a muscle contraction (i.e. active stretch). However, because of the tendon compliance, the lengthening of the muscle fiber may differ dramatically from that of the muscle-tendon unit [Butterfield, 2006]. Knowledge on muscle fiber kinetics during eccentric contractions can be very important for the evaluation of the applied mechanical loading on muscles. Therefore, the purpose of the current study was to investigate the fascicle behavior of the m. vastus lateralis during different eccentric knee extension contractions. Accordingly, we modified the magnitude of the eccentric stimulus, the knee angular velocity and the knee angle range of motion where the eccentric stimulus has been applied.

Methods
Nineteen physically active persons participated in the study and were divided into 2 groups. The first group (n=10) performed eccentric contractions of the knee extensors of one leg (protocol 1, P1) at 65% of the maximum voluntary contraction (MVC) and on the second leg (P2) at 100% MVC. The angular velocity of the eccentric contraction was 90°/s and the range of motion was from 25° to 100° knee angle in both legs. The second group (n=9) performed eccentric contractions with one leg (P3) in a small range of knee angle (i.e. between 25° and 65°) at 100% MVC and 90°/s angular velocity. In the second leg (P4) the angular velocity of the eccentric contraction was 240°/s. The magnitude of the loading was at 100% MVC and the range of knee angle between 25° and 100°. All participants performed 4 sets of 5 eccentric contractions on an isokinetic dynamometer (Biodex 3). M. vastus lateralis fascicle movements were captured with ultrasound (ESAOTE MYLab 60). Lower limb kinematics were recorded with a Vicon system. The fascicle kinetics of the m. vastus lateralis was analyzed with a custom written Matlab (Matlab 2010b) algorithm.

Results
In all examined eccentric contractions the fascicle behavior of the m. vastus lateralis showed three main phases (fig. 1). The muscle fascicles shortened in the beginning of the contraction. In this phase the magnitude of shortening did not differ significant (p>0.05) between the four contractions. In the second phase the muscle fascicles were stretched while the knee joint moment increased. In this phase the fascicles in protocol 3 and 4 showed a lower (p<0.05) elongation compared to the other two protocols. The third phase was characterized by a further lengthening of the fascicles while the knee joint moment decreased. In this phase the lengthening velocity was highest in protocol 4.

Discussion
The results show that the fascicle kinetics of the m. vastus lateralis during eccentric knee extension contractions are different to the elongation expected from the knee angle motion. In the beginning of all contractions the fascicles contract concentrically despite a lengthening of the muscle-tendon unit and the main lengthening of the fascicles occurs in the phase where the knee extension moment decreases.

Figure 1: Normalized fascicle length, knee moment and Biodex angle during an eccentric contraction.

References