MECHANISM AND TIME-COURSE OF HUMAN QUADRICEPS ARCHITECTURAL ADAPTATION
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Muscle architecture strongly influences force generation capacity. However, little is known about the factors that most influence it and the time-course of its adaptation in humans. This study examined the influence of training range of motion, contraction mode and movement velocity on its adaptive response, and assessed the temporal response of muscle architecture through a period of high-resistance training and detraining. Twenty-one men and women with no history of strength training performed concentric- or eccentric-only isokinetic knee extensor training for 10 weeks before completing a 3-month detraining period; a control group of 9 subjects did not train. At weeks 0, 5 and 10, and after the detraining period, knee extensor strength and the torque-angle relationship (isokinetic dynamometry), muscle hypertrophy (T2-weighted MRI and B-mode ultrasonography) and architecture (ultrasonography) were assessed. The training resulted in significant gains in concentric (20.2%; p<0.001) and eccentric (37.4%; p<0.001) strength, which did not revert to baseline after detraining. There was also a significant shift in the torque-angle relationship toward longer muscle lengths after 5 weeks, no further increase after 10 weeks, and a smaller increase again after detraining. The training resulted in a considerable increase in vastus lateralis (VL) physiological cross-sectional area (7.9%; p<0.01) and whole quadriceps muscle volume (10.2%; p<0.001) after training. VL fascicle length was increased after 5 wk (4.7%; p<0.05) with no difference between the training groups. No further increase was found at 10 wk, although a small increase (2.5%; n.s.) was evident after the detraining period. Similarly, fascicle angle changes were not different between the groups. Fascicle angle increased at 5 (11.0%) and 10 wk (17.9%; p<0.01) in VL only, and remained above baseline after detraining (13.2%; p<0.05); smaller changes in VM did not reach significance. Thus, there was a differential temporal response of fascicle angle and length. The similar increase in fascicle length observed between the training groups, along with the finding that the temporal responses of VL fascicle length and shifts in the torque-angle relationship were the same, is suggestive of training range of motion, rather than contraction mode or velocity, being the predominant influencing factor for fascicle length change; although the possibility still exists that the other factors play a lesser role. These findings also provide strong evidence that muscle force-length properties are strongly influenced by fascicle length; these properties are both modifiable by training. The strong relationship between fascicle angle and muscle thickness through training and detraining, but lack of between-group difference, is indicative of fascicle angle being driven by space constraints in the hypertrophying muscle rather than it being an independent anatomical adaptation to the training load.

Keywords: Fascicle Length, Strength Training, Muscle Plasticity