APONEUROSIS AND TENDON LENGTH CHANGES IN TIBIALIS ANTERIOR MUSCLE UPON CONTRACTION MEASURED BY 3D-ULTRASONOGRAPHY

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INTRODUCTION
It is very important to know the architectural and functional characteristics of the aponeurosis and tendon for the understanding of mechanics of translating fiber force to external output. Recent studies on human muscles and tendinous tissues during contraction have been done in vivo using ultrasonography (Kawakami et al. 1998, 2000; Muramatsu et al. 2002). But since these studies are based on 2D planar imaging, there is limitation to investigate the three-dimensional structure of tissues. The aim of the present study is to clarify the behavior of tendon and aponeurosis of the human tibialis anterior muscle during isometric contraction by using 3D-ultrasonography.

METHODS
Five healthy men participated as subjects in the experiments. The ankle joint was fixed at 30 deg plantar flexion with the knee joint positioned at 0 deg (full extension). In the present study, we employed 3D-ultrasonogram (USE-1200, Nihon-Kohden, Japan) with an electromagnetic position sensor attached to the ultrasonic transducer. During the scanning, the probe was moved by the tester along the longitudinal axis of the muscle belly from the distal end of the tibia toward the proximal end. Transverse serial images of the tibialis anterior muscle including the tendon were retrieved as composite video signals from the ultrasonic machine and three-dimensional ultrasound images were reconstructed using a software (Tomtec3D, Tomtec, Germany). During the ultrasonic data acquisition, the subjects were asked to relax then maintain isometric dorsiflexion at five force levels (20,40,60,80,100% of the maximal voluntary force level [MVC]).

Using the software, the x-y-z coordinates of the proximal end of the central aponeurosis, the distal muscle-tendon junction, and the distal tendon over the prominence of tibia were detected. The changes in length between these landmarks were measured as elongations of the central aponeurosis and external tendon.

RESULTS AND DISCUSSION
The central aponeurosis was elongated slightly with increasing force, but statistical significance from the rest condition was seen only at 80%MVC. The mean (SD) central aponeurosis length increased from 15.1(1.5) cm at rest to 15.6 (1.3) cm at 80%MVC. The external tendon lengths at intensities of 20% and above [9.7, 9.7, 9.8, 9.8cm] were significantly longer than at rest [8.8cm]. The strain of central aponeurosis was 3.3% that was smaller than that of the external tendon of 11.4%. Our data is in disagreement with previous reports where more compliant aponeurosis compared with tendon have been documented (e.g., Maganaris and Paul, 2000a). Our results call for re-consideration of the mechanical characteristics of tendinous tissues and their changes upon contraction.

REFERENCES
Kawakami Y. et al. (2002). J.Physiol., 540:635-646

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