REPETITIVE MUSCLE CONTRACTIONS INDUCE MECHANICAL CHANGES OF ACHILLES TENDON.

Emika Kato[1], Toshiaki Oda[3], Kentaro Chino[3], Toshiyuki Kurihra[3], Toshihiko Ngayoshi[1], Tetsuo Fukunaga[2], and Yasuo Kawakami[2]
1) Graduate School of Human Sciences, Waseda University, Saitama, Japan
2) Faculty of Sport Sciences, Waseda University, Saitama, Japan
3) Department of Life Sciences, University of Tokyo, Tokyo, Japan
E-mail: e-kato@suou.waseda.jp

INTRODUCTION

Muscle contraction induces tendon elongation[1)]. Repetitive muscle contractions are known to induce tendon creep[2)], but the presence of concurrent changes in mechanical properties of the tendon has not been elucidated. The purpose of this study was to investigate changes in the muscle-tendon complex mechanical properties during and after repetitive muscle contractions.

METHODS

Six men (mean±SD for the age, body mass and height was 23.5±1.2 years, 68.3±7.1 kg, 172.7±5.6 cm) performed 15 repetitive isometric ramp contractions. The subject was seated with the knee extended, and the ankle joint was attached to the foot plate at the right angles to the tibial axis. Preceding the experiment, MVC torque was measured, and the target torque was determined based on MVC. Before and after repetitive contractions, the following flexibility test was performed. The subject was seated with the knee extended, and the ankle joint was attached to the foot plate at an angle of 30˚ plantarflexion. The foot plate was connected to a dynamometer (VINE, Japan), by which the ankle joint was passively dorsiflexed with torque gradually increasing from zero to a value at which the passive loading to the ankle joint was just tolerable for each subject. The dorsiflexion angle and passive torque generated by plantar flexor muscles were measured during the test. During the passive loading, real-time ultrasonogram (SSD-6500, Aloka, Japan) was taken to track the movement MTJ (muscle-tendon junction of the gastrocnemius medialis and Achilles tendon). The movement of MTJ with dorsiflexion was assumed to be equal to the elongation of muscle belly (dMus). According to the estimated Achilles tendon moment arm[1)]. The change of MTC (muscle-tendon complex) length (dMTC) during the passive dorsiflexion was estimated from changes in ankle joint angle. Tendon elongation (dTen) was calculated by subtracting dMus from dMTC. Tendon force (TF) was estimated from the torque and moment arm length[3)].

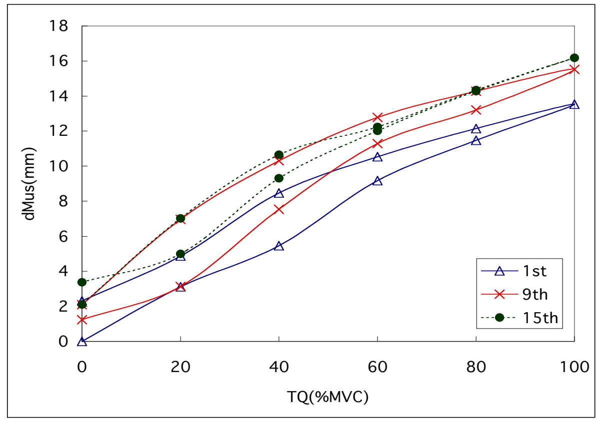

Figure 1: The relation between tendon force and dmus during 15 repetitive contractions, just only the 1st, 9th and 15th contractions are shown.

RESULTS AND DISCUSSION

The changes in dMus during 15 repetitive contractions are shown in Figure 1. The first contraction showed a different pattern compared with other contractions ($p<0.05$), dMus shifted proximally during repetitive contractions. This result indicates that repetitive contractions induced tendon creep. The flexibility test showed dMTC which involved an increase in dTen ($p<0.05$), but dMus did not change significantly. The elongated tendon changed its passive length-force curve, especially at the toe-region. Altered toe-region of the tendon length-force curve suggests structural changes of tendon as a result of repetitive contractions.

REFERENCES

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Table 1: Elongation of MTC, Muscle and tendon during flexibility test.( ):post test, *: p<0.05

Tendon Force (N)	100	200	300	400	500
Elongation (mm)					
MTC	16.0±3.0 (21.9±7.4*)	23.8±7.5 (29.3±5.9*)	28.4±10.3 (32.6±5.2*)	33.1±10.7 (34.9±5.1)	35.0±14.1 (37.0±5.2)
Muscle	11.5±6.0 (13.8±5.4)	18.4±7.4 (20.0±4.8)	20.8±7.1 (22.6±4.6)	23.0±7.3 (23.8±4.4)	24.4±7.1 (25.7±4.5)
Tendon	4.5±3.5 (8.1±2.7*)	5.5±3.1 (9.3±2.3*)	7.6±4.2 (10.0±3.2)	10.1±4.6 (11.1±3.3)	10.7±4.2 (11.4±3.4)