Effect of low-intensity resistance training combined with restricted venous blood flow on semitendinosus tendon maturation after reconstruction of the ACL

INTRODUCTION
This study focused on blood flow-restricted training as a measure aimed at early functional recovery in post-operative rehabilitation following anatomical double-bundle reconstruction of the knee anterior cruciate ligament (ACL) using the semitendinosus (ST) tendon. Atrophy, shortening of the ST muscle and regeneration of the ST tendon are known post-operative complications of ACL reconstruction. Many studies have been focused on muscular hypertrophy in blood flow-restricted training, but the effects on tendon regeneration have not been examined. The purpose of this study was to examine whether blood flow-restricted training after ACL reconstruction could promote hypertrophy and maturation of the regenerated ST tendon.

METHODS
We divided 38 males and females who had undergone ACL reconstruction on one knee into a blood flow-restricted training group and control group (training group: 12 males, 8 females, control group: 7 males, 11 females). The subjects underwent rehabilitation under instructions from their attending physician and blood flow-restricted training was carried out twice a week from week four to week 16 following surgery. MRI imaging was performed in the one to six month period following the surgery. T2 transaxial sequences were measured as follows: 5 mm slice thickness, 1 mm gap space, repetition time 3000 ms, echo time 10, 20, 30 ms (Fig. 1), field of view 160×160 mm, and matrix size 256×192 pixels. The signal intensity was measured at the joint line, 24 mm proximal from the joint line and muscle tendon junction. The cross-sectional area of the regenerated tendon and T2 relaxation time were analyzed and the hypertrophy and maturation of the regenerated ST tendon was evaluated (Fig. 2).

RESULTS
In the males of the blood flow-restricted training group, the cross-sectional area of the tendon was significantly larger four and five months following the surgery compared with that of males in the control group (Fig. 3). The subjects underwent rehabilitation under instructions from their attending physician and blood flow-restricted training was carried out twice a week from week four to week 16 following surgery. MRI imaging was performed in the one to six month period following the surgery. T2 transaxial sequences were measured as follows: 5 mm slice thickness, 1 mm gap space, repetition time 3000 ms, echo time 10, 20, 30 ms (Fig. 1), field of view 160×160 mm, and matrix size 256×192 pixels. The signal intensity was measured at the joint line, 24 mm proximal from the joint line and muscle tendon junction. The cross-sectional area of the regenerated tendon and T2 relaxation time were analyzed and the hypertrophy and maturation of the regenerated ST tendon was evaluated (Fig. 2).

DISCUSSION:
The degree of maturation of the reconstructed ACL and the regenerated ST tendon after ACL reconstruction are essential data for determining appropriate loading controls for rehabilitation. The regeneration of the tendon was excellent in the males of the blood flow-restricted group, suggesting the potential utility of this training. If we assume that the promotion of hypertrophy and maturation of the regenerated ST tendon is derived from the endocrine system, the possibility of promotion of maturation of the reconstructed ACL is also hinted, which we believe makes an early return to the competition possible. However, the effects of blood flow-restricted training were not observed in the females of the group. This mechanism warrants further examination through future studies.

REFERENCES:
1. Abe T, Kears CF, Sato Y: Muscle size and strength are increased following walk training with restricted venous blood flow from the leg muscle, Kaatsu-walk training. J Appl Physiol, 2006, 100(5):1460-6.