TENDON ADAPTIVE RESPONSE TO PARALYSIS

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INTRODUCTION

A well-established adaptation to long-term paralysis is an increase in the speed of muscle contraction and/or rate of force development. This characteristic behaviour has been associated exclusively with transformation of type I muscle fibres to type II muscle fibres due to changes in the expression of relevant myosin heavy chain isoforms [e.g. 1-3]. Information is lacking, however, regarding the degree to which potential disuse-induced changes in the mechanical properties of tendons contribute to the above phenomenon.

To address this issue, we examined in vivo the tensile behaviour of the patellar tendon in spinal cord injured (SCI) and able-bodied (AB) humans.

METHODS

Six SCI men (age: 36±5 y, height: 186±9 cm, body mass: 80±15 kg; mean±SD) and six age-matched AB men (age: 37±4 y, height: 183±7, body mass: 78±7 kg) volunteered to participate after the study was approved by the local Ethics Committee. The measurements were taken at 90 deg knee angle. Ultrasonography (ALOKA, SSD 5000SV) was used to obtain the patellar tendon resting dimensions and its elongation during isometric contractions of increasing intensity elicited by tetanic (150 Hz) stimulation of the quadriceps muscle [4]. The maximal current used corresponded to 50% of the current producing maximal knee extension torque during femoral nerve stimulation. The patellar tendon forces during contraction were estimated from the torque values produced and moment arm lengths measured on lateral-view pQCT scans (XCT 2000). From the slope of the force−elongation curves produced, the stiffness and Young's modulus of the tendon were calculated in the force region 0-450 N. Independent samples student *t*-tests were used to test for differences in all relevant measured or calculated parameters between the SCI and AB groups.

RESULTS AND DISCUSSION

The resting length of the patellar tendon was similar in the two groups ($P>0.05$), but the cross-sectional area (CSA) of the tendon was smaller by ~17% ($P<0.05$) in the SCI subjects compared with the AB subjects. Tendon stiffness was lower by ~59% ($P<0.01$) in the SCI subjects compared with the AB subjects. Tendon Young's modulus was lower by ~49% ($P<0.05$) in the SCI subjects compared with the AB subjects (Table 1).

Table 1. The main parameters examined.

Parameter	SCI	AB	P
Tendon length (mm)	44±7	47±6	P>0.05
Tendon CSA (mm^2)	101±23	122±18	P<0.05
Stiffness (N/mm)	163±101	401±158	P<0.05
Young's modulus (MPa)	77±43	152±76	P<0.01

The present results indicate that long-term paralysis deteriorates the intrinsic and structural properties of tendon. A reduction in tendon stiffness means that the changes in contractile speed of the whole muscle-tendon complex underestimate the extent of fibre type transformation in paralyzed muscles.

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