BIOMECHANICAL FEATURES OF NORMAL PATELLAR TENDONS AND THOSE WITH PATELLAR TENDINOPATHY

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INTRODUCTION

The aetiology of patellar tendinopathy commonly suffered by recreational and higher level athletes in jumping sports ('jumper's knee') is uncertain. Currently there is controversy as to whether the most often affected posterior fibres of the patellar tendon (PT) at the patella inferior pole are subjected to greater or lesser stress [1,2]. Particular gross features of PTs that may predispose them to tendinopathy have not been found. Symptomatic PTs are commonly seen to be thickened on MRI [3], however no clear differences in absolute AP width between symptomatic and asymptomatic PTs have been found. Cross-sectional area (CSA) in PTs has not been studied along the entire PT length, with or without tendinopathy. The aim of this study was to characterise this CSA, and determine if tendinopathy resulted in differences in CSA, or PT stress during a maximal contraction, compared to normal PTs.

METHODS

16 symptomatic patients (12M/4F, 27.3±6.6 yr) and 22 asymptomatic controls (15M/7F, 23.0±4.7 yr) were studied. Symptomatic subjects had a PT lesion detected on ultrasound, a stereotypical history of patellar tendinopathy symptoms sufficient to affect exercise activity for 6 months or more, with no previous knee surgery or signs of other knee pathology. Both groups participated in jumping sports at least once a week.

MRI was performed in a 1.5T magnet (GE Sigma Horizon LX) and extremity array coil, on the symptomatic knee in patients and the 'jumping' knee in controls, in full extension. Multiple 3.5 mm PD images (512x384 matrix) were obtained in the sagittal and axial planes. As a proportional indication of the likely moment to which the knee extensor mechanism including the PT might be exposed in jumping sport activities, the maximum isometric knee extension moment was recorded on a Kincom 125-AP dynamometer at 60 degs flexion, with correction for gravitational torque.

The PT was outlined in each axial slice and CSA calculated using Image-J software (NIH). The PT moment arm was measured from the tibiofemoral contact point to the mid-PT in the sagittal plane [4] and adjusted to account for the difference between full extension and 60 degs flexion. Force and stress in the PT were estimated as follows:

$$F_{PT} = M_{KE} / r_{PT} \qquad \sigma_{PT} = F_{PT} / A_{PT}$$

Where: F_{PT} = PT force (N)
M_{KE} = knee extension moment (N.m)
A_{PT} = PT CSA (mm^2)
r_{PT} = PT moment arm (mm)
σ_{PT} = PT stress (MPa)

RESULTS AND DISCUSSION

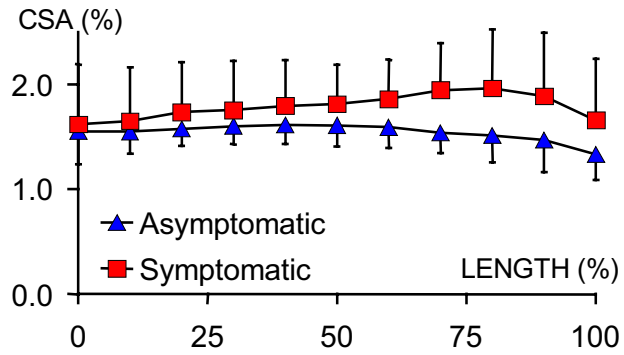

Figure 1: Scaled PT CSA (% tibial width^2) vs PT length (0% = tibial tuberosity; 100% = patella inferior pole).

Table 1: Measured and calculated variables for asymptomatic and symptomatic subjects; mean (SD)

	Asymp.	Symp.	p
Height (cm)	177.9 (7.9)	178.5 (8.2)	.808
Body mass (kg)	70.9 (10.2)	82.9 (15.7)	.007*
Peak isometric moment (N.m)	152.9 (42.9)	163.6 (56.5)	.503
Peak isometric moment (N.m/kg)	2.16 (0.42)	2.00 (0.64)	.356
Max PT CSA (mm^2)	103.1 (24.1)	126.6 (32.8)	.014*
Min PT CSA (mm^2)	72.6 (20.0)	77.3 (29.4)	.557
Mean PT CSA (mm^2)	89.6 (19.0)	103.7 (25.5)	.055
Max scaled PT CSA[1] (%)	1.76 (0.22)	2.18 (0.51)	.007*
Min scaled PT CSA[1] (%)	1.25 (0.25)	1.35 (0.52)	.479
Mean scaled PT CSA[1] (%)	1.54 (0.16)	1.79 (0.41)	.034*
Peak PT force (N)	3588 (991)	3966 (1278)	.305
Stress for max PT CSA (MPa)	35.8 (9.6)	33.3 (12.5)	.481
Stress for min PT CSA (MPa)	54.2 (28.6)	67.5 (65.2)	.392
Stress for mean PT CSA (MPa)	40.9 (10.7)	40.5 (15.7)	.936

[1]scaled to % tibial width squared * $p < 0.05$

PT force and CSA in these young adult PTs (Table 1) were higher than has been reported for elderly PTs, while PT stress (based on mean CSA) was similar [5]. CSA did not increase at the distal insertion (Figure 1) as in the Achilles tendon [6]; in fact PTs tended to *decrease* CSA at the *opposite* end, the patella inferior pole. Maximum PT CSA was greater in the symptomatic group, but PT stress was not significantly different. Greater CSA is consistent with pathological thickening often seen on MRI, although this was highly variable. Future longitudinal studies will be required to identify any differences prior to symptom onset.

REFERENCES

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